2022 Regional Resource Assessment (RRA)

RASC

August 24, 2022

Purpose & Key Takeaways

Purpose: To review the results of the Resource Assessment modeling and discuss remaining steps

Key Takeaways:

- RRA suggests a continued capacity risk, highlighting the immediate importance of coordinated resource planning

- Reflecting publicly-available member plans and MISO assumptions, MISO's system approaches 30% of annual energy from renewables within 5 years and could reach 60% renewables by 2041

- By 2041, the MISO region is projected to reduce CO_2 emissions by 80% from the 2005 baseline

Link to 2021 Report: Regional Resource Assessment (misoenergy.org)

Today's discussion will focus on insights from the completed Resource Assessment and scope of the Flexibility Assessment and Resource Adequacy work in progress
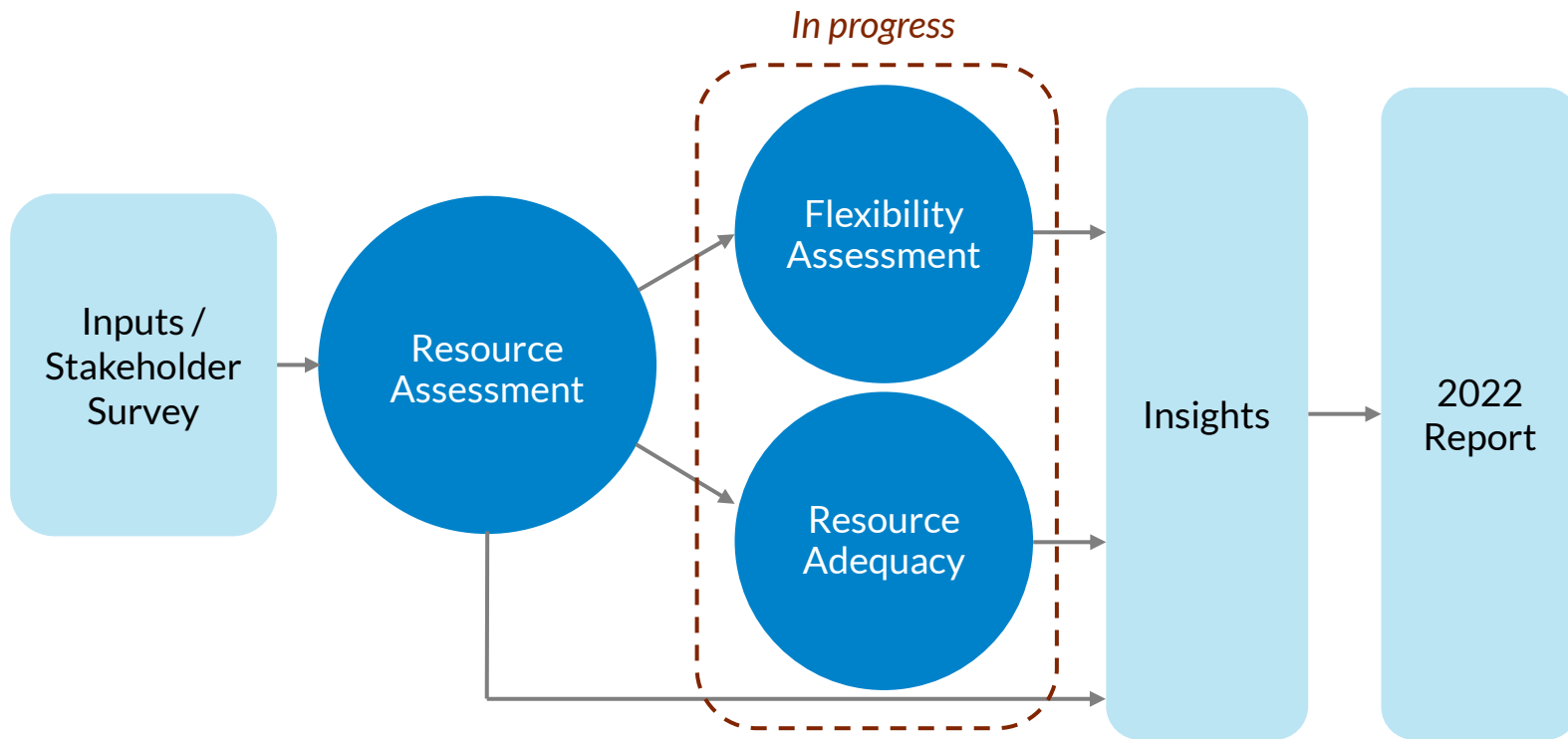
Resource Assessment Insights

2022 RRA Resource Assessment Insights

- RRA suggests a continued capacity risk, highlighting the immediate importance of coordinated resource planning

- Significant acceleration of resource expansion (100 GW) is needed to meet companies' combined carbon reduction plans by 2030

- MISO's system approaches 30% of annual energy from renewables within 5 years and could reach 60% renewables by 2041

- By 2041, the region is projected to reduce carbon emissions by nearly 80% from 2005 baseline levels

- Over the next 20 years, average capacity factors for operational natural gas and coal units decline between 10% and 30% depending on fuel type

RIIA: Renewable Integration Impact Assessment
* Results are based on company plans announced prior to January 31, 2022. The RRA represents a snapshot in time.

Important caveats to consider when interpreting the RRA Resource Assessment findings

The RRA has more nameplate and accredited capacity than either the Planning Reserve Auction (PRA) or the OMS-MISO Survey

Planning:	• RRA reflects a snapshot of regulatory process; utilities and states are continuously updating their plans to manage changing risk and meet needs • Utility plans often do not provide resource information for the full 20-year RRA study period
Assumptions:	• RRA assumes plans are met at the timing provided and does not consider additional retirements beyond what is publicly announced • RRA includes all units with signed GIAs and follows the expected in-service dates provided (to the nearest calendar year) • RRA does not distinguish between committed capacity, potentially unavailable resources or potential new capacity • RRA includes units with capacity of < 50 MW
Exemptions:	• RRA does not consider any confidential company plans • RRA does not exclude any units for long-term outages, suspension, expiring PPAs, etc.
Location:	• RRA does not model transmission

The RRA provides a favorable picture of capacity in the near-term, compared to other MISO studies

GIA = Generator Interconnection Agreement

Like all studies, the results of the RRA are sensitive to inputs and assumptions

INPUTS (for each LRZ)

- Survey of MISO member goals, plans, and retirements, publicly announced as of January 31, 2022

- MISO researched plans for any members that did not engage with the survey

- Signed generator interconnection agreements (GIAs)

- No retirements beyond what is publicly announced

- Assumed Future 1* load

- Assumed Planning Reserve Margin targets based on 21/22 PRA

- Assumed future resource accreditation based on 2021 RRA work

- Assumed capital costs of new units from 2021 National Renewable Energy Lab Annual Technology Baseline (NREL ATB)

- Assumed increased gas prices from Dec 2021 Gas Pipeline Competition Model (GPCM)
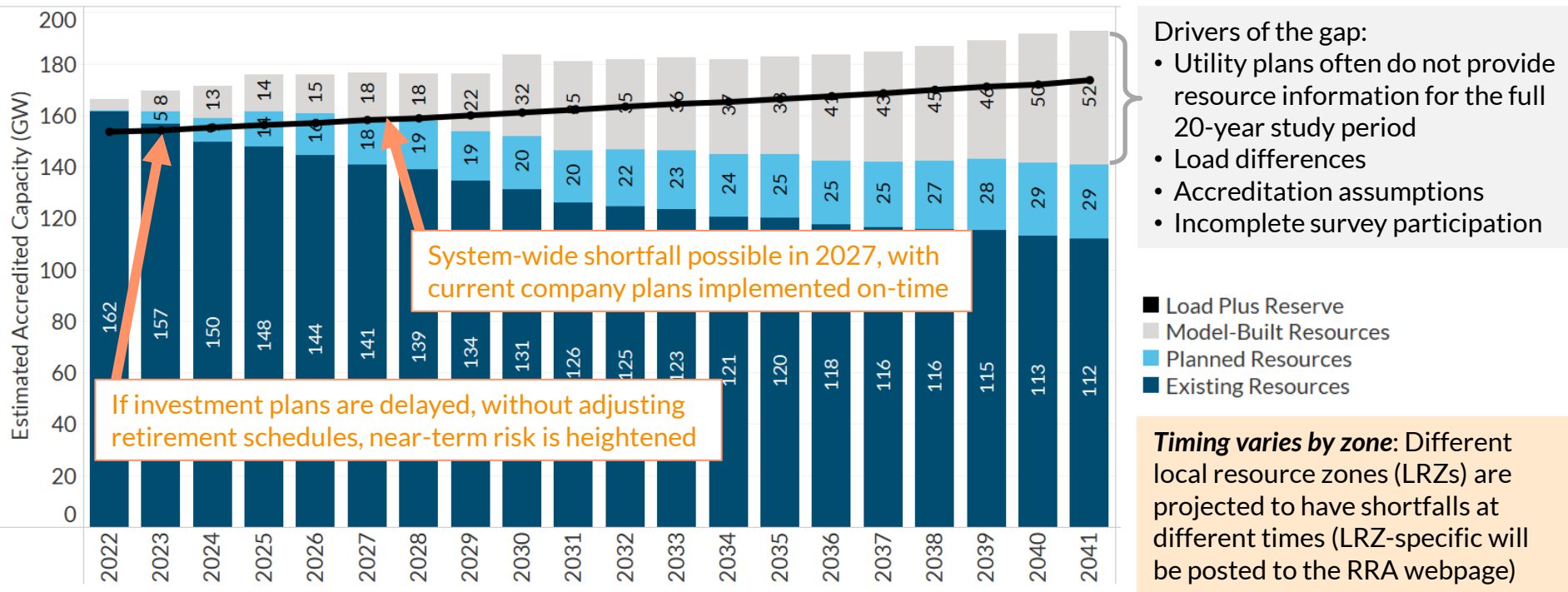
MODEL →

OUTPUT (for each LRZ)

A resource projection that satisfies the assumed planning margin and known renewable and carbon goals for the next 20 years
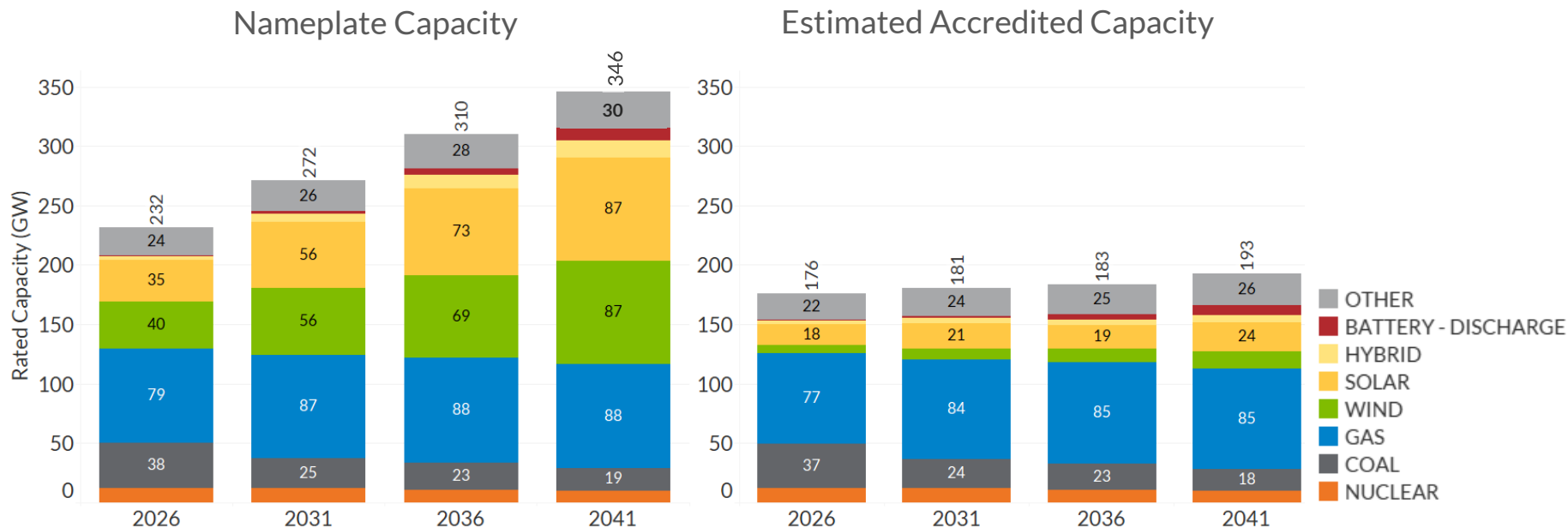
Three categories of units:

- **Existing:** resource in-service in 2022 or earlier

- **Planned:** future resource in-service after 2022 from survey, signed GIAs, or research

- **Model-built:** simulation selected resource to meet planning reserve margin, carbon, or renewable requirements

*See MISO's Futures Development

RRA suggests a continued capacity risk, highlighting the immediate importance of coordinated resource planning

Drivers of the gap:
- Utility plans often do not provide resource information for the full 20-year study period
- Load differences
- Accreditation assumptions
- Incomplete survey participation

System-wide shortfall possible in 2027, with current company plans implemented on-time

If investment plans are delayed, without adjusting retirement schedules, near-term risk is heightened

- Load Plus Reserve
- Model-Built Resources
- Planned Resources
- Existing Resources

Timing varies by zone: Different local resource zones (LRZs) are projected to have shortfalls at different times (LRZ-specific will be posted to the RRA webpage)
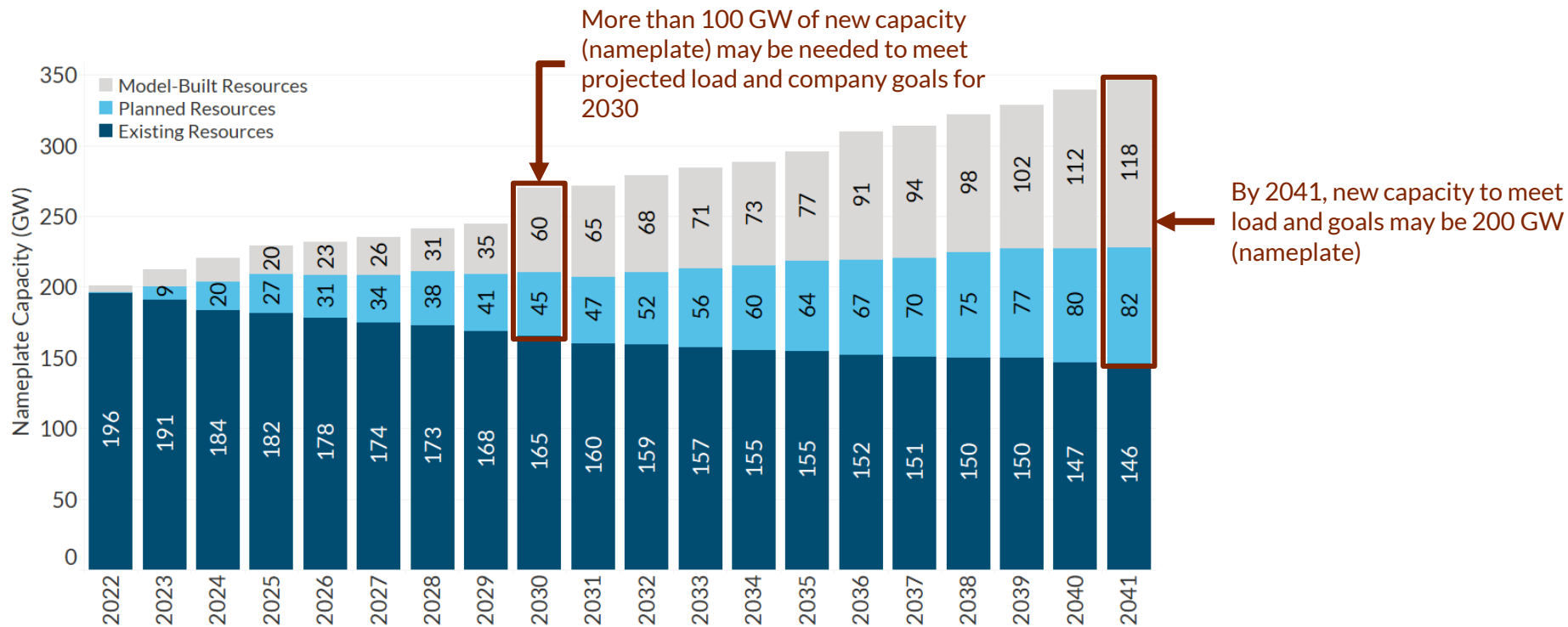
Note: Over the study period, RRA assumes wind accreditation stays at ~16.7%, solar declines from 50% to 20%, hybrid declines from 60% to 30%, and battery declines from 100% to 75%. Thermal units are accredited between 90% and 100%. The assumptions in RRA should not be taken as indicative of the outcomes of the non-thermal accreditation reform effort underway

Due to lower projected accreditation values, significantly more nameplate capacity is required to supply reserve requirements and accommodate goals

Nameplate Capacity

Year	OTHER	BATTERY - DISCHARGE	HYBRID	SOLAR	WIND	GAS	COAL	NUCLEAR	Total
2026	24		35		40	79	38		232
2031	26		56		56	87	25		272
2036	28		73		69	88	23		310
2041	30		87		87	88	19		346

Estimated Accredited Capacity

| Year	OTHER	HYBRID/SOLAR	WIND	GAS	COAL	Total
2026	22	18		77	37	176
2031	24	21		84	24	181
2036	25	19		85	23	183
2041	26	24		85	18	193

Rated Capacity (GW)

Note: Over the study period, RRA assumes wind accreditation stays at ~16.7%, solar declines from 50% to 20%, hybrid declines from 60% to 30%, and battery declines from 100% to 75%. Thermal units are accredited between 90% and 100%. The assumptions in RRA should not be taken as indicative of the outcomes of the non-thermal accreditation reform effort underway

With RRA assumptions, it is likely that 100 GW of new nameplate capacity will be needed within the next 10 years

More than 100 GW of new capacity (nameplate) may be needed to meet projected load and company goals for 2030

By 2041, new capacity to meet load and goals may be 200 GW (nameplate)

MISO's system could approach 30% of annual energy from renewables within 5 years, and renewable penetration levels may increase by ~10% every 5 years after

*Solar includes DGPV, while "Other" includes demand response and energy efficiency
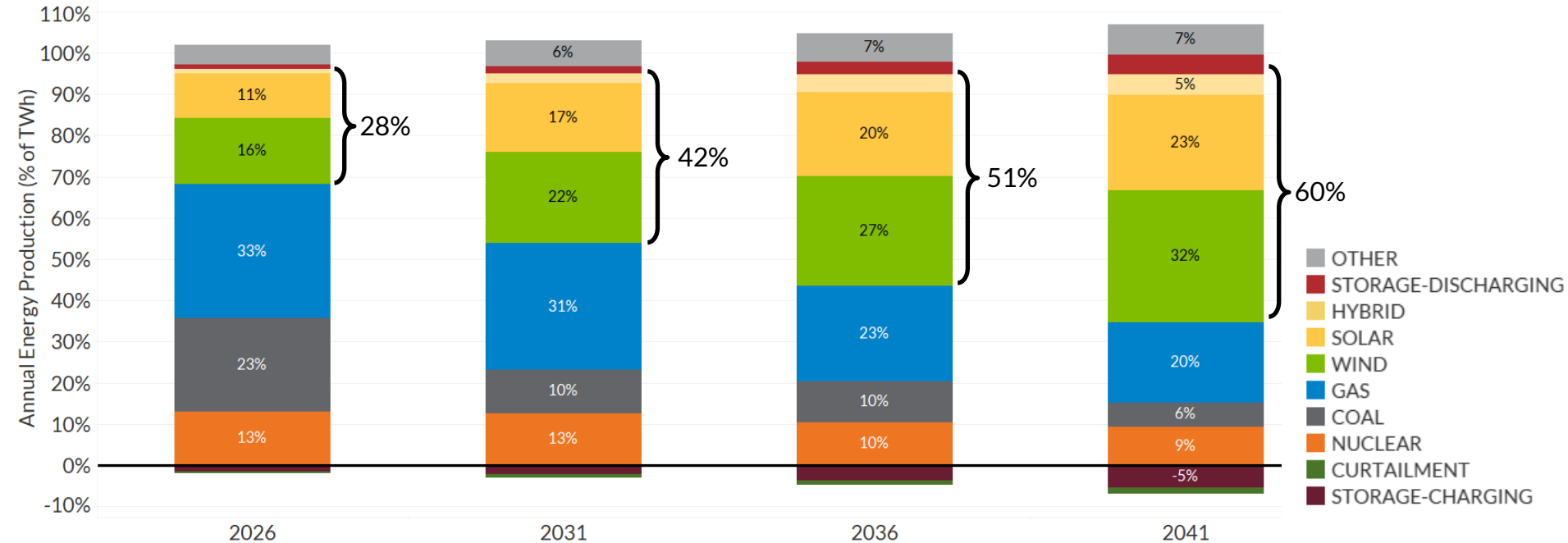
RIIA demonstrated increasing complexity with larger penetration of renewables; RRA provides visibility as to when RIIA milestones could be reached

Operating Reliability

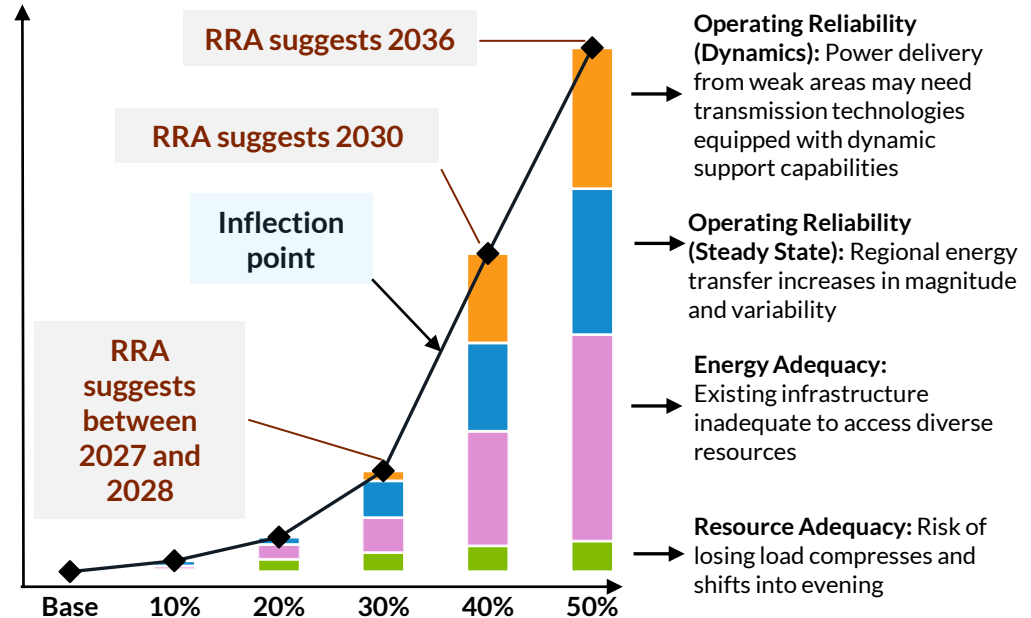Ability to withstand unanticipated component losses or disturbances

Energy Adequacy

Ability to provide energy in all operating hours continuously throughout the year
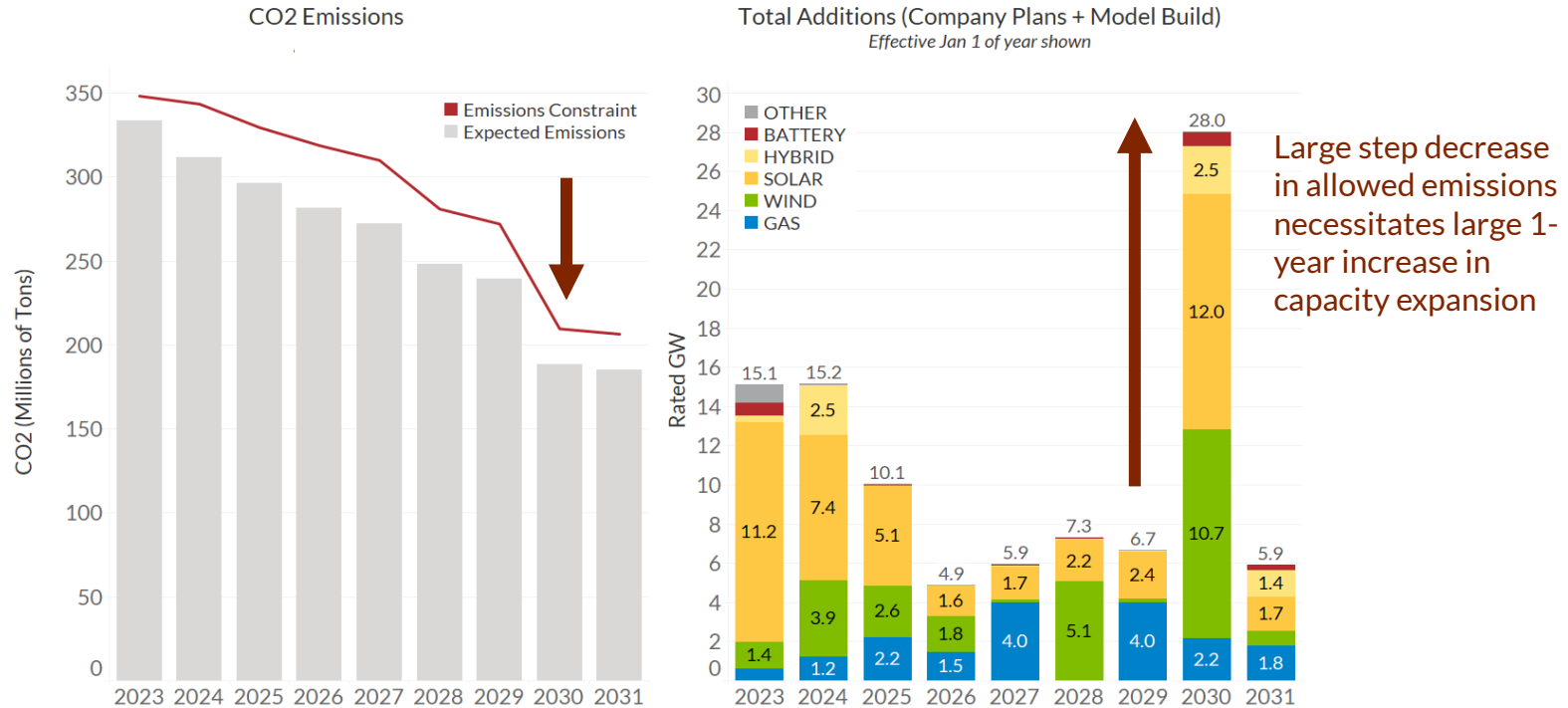
Resource Adequacy

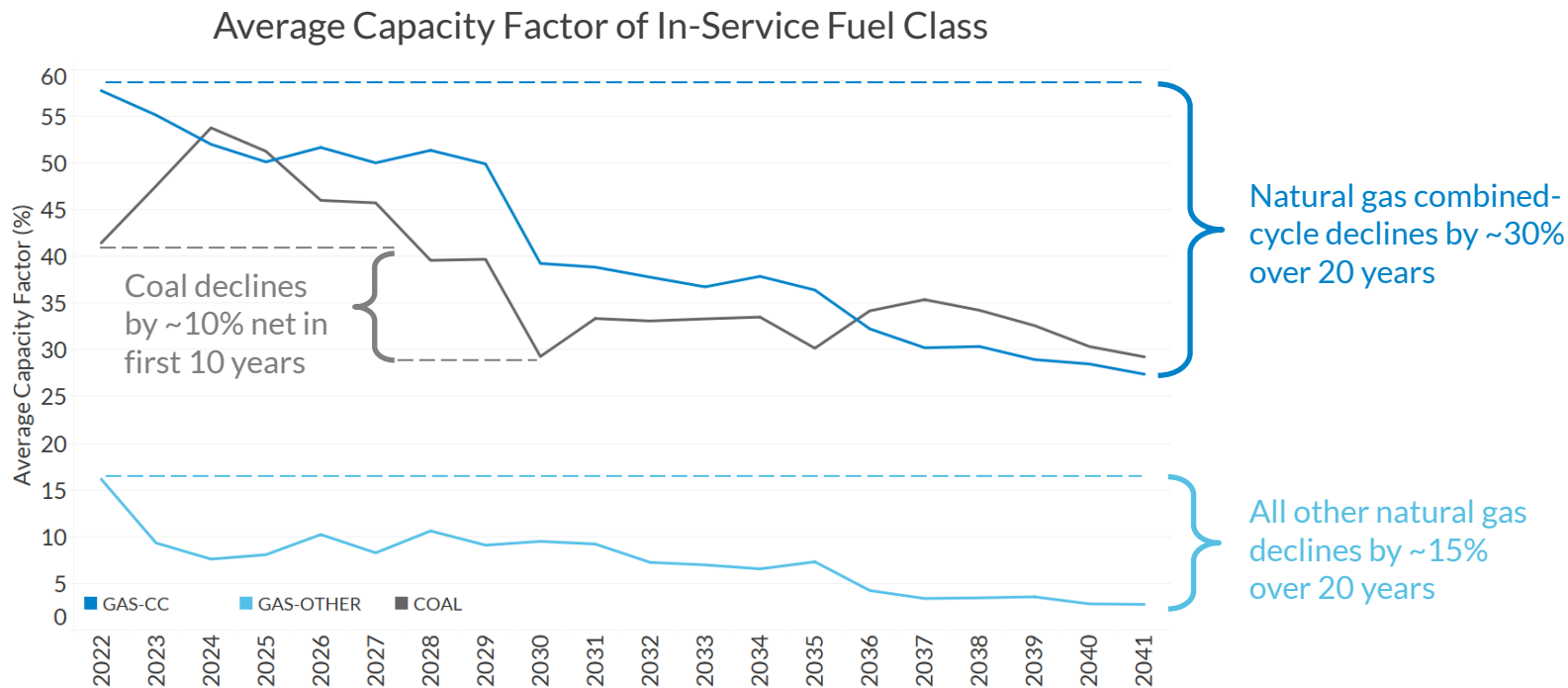Having sufficient resources to reliably serve demand

RRA suggests 2036

RRA suggests 2030

Inflection point

RRA suggests between 2027 and 2028

Base | 10% | 20% | 30% | 40% | 50%

Operating Reliability (Dynamics): Power delivery from weak areas may need transmission technologies equipped with dynamic support capabilities

Operating Reliability (Steady State): Regional energy transfer increases in magnitude and variability

Energy Adequacy: Existing infrastructure inadequate to access diverse resources

Resource Adequacy: Risk of losing load compresses and shifts into evening

RIIA: Renewable Integration Impact Assessment

MISO

By 2041, the MISO region is projected to reduce CO_2 emissions by nearly 80% from the 2005 baseline

By 2030, 65% reduction
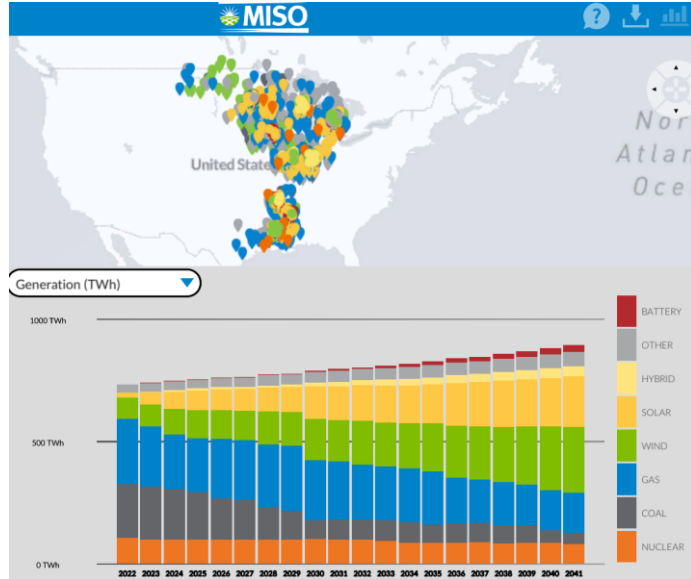
By 2041, 78% reduction

Percent reduction from 2005 CO_2 Emissions
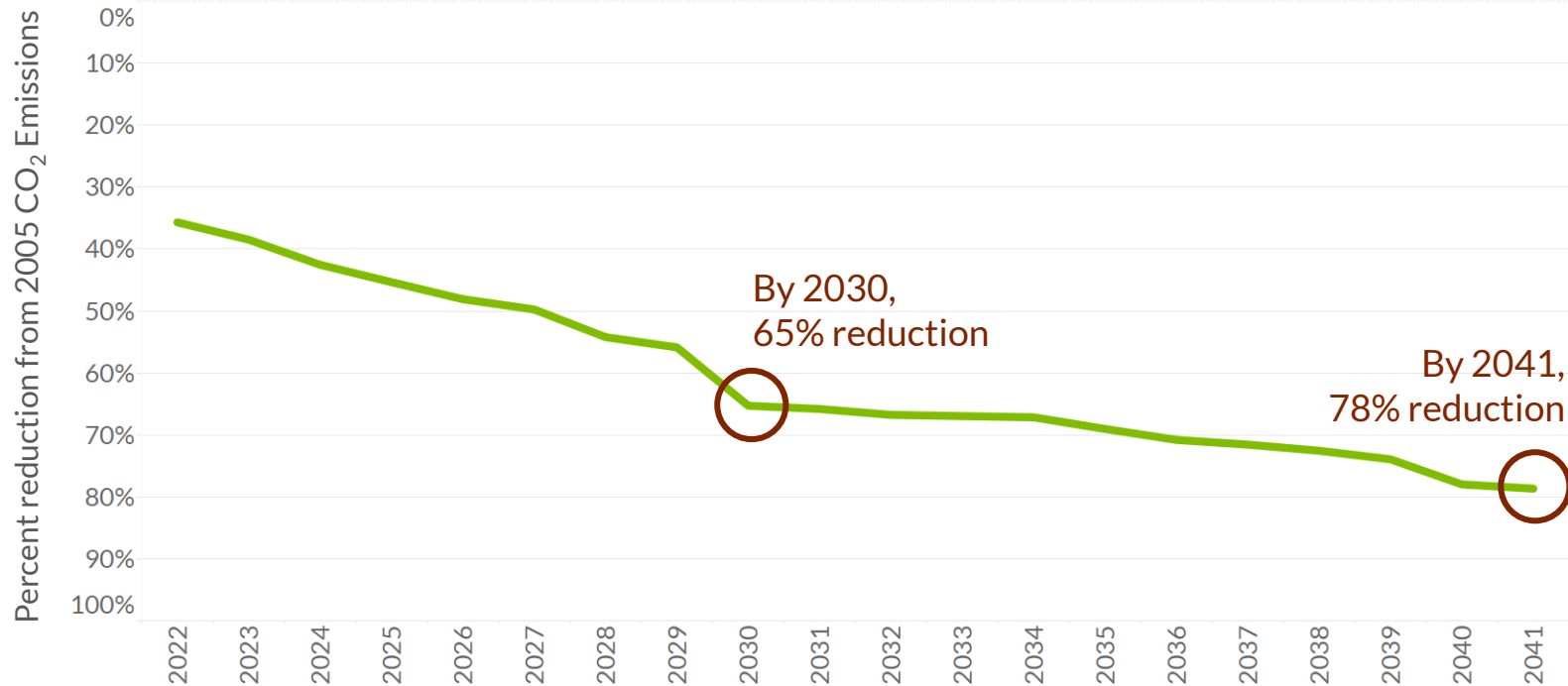
# Many companies have defined carbon reduction milestones around 2030, leading to possible large, single-year buildout

CO2 Emissions

Emissions Constraint
Expected Emissions

Total Additions (Company Plans + Model Build)
Effective Jan 1 of year shown

OTHER
BATTERY
HYBRID
SOLAR
WIND
GAS

Large step decrease in allowed emissions necessitates large 1-year increase in capacity expansion

Over the study period, the average capacity factors of coal and gas units decline

Average Capacity Factor of In-Service Fuel Class

Natural gas combined-cycle declines by ~30% over 20 years

Coal declines by ~10% net in first 10 years

All other natural gas declines by ~15% over 20 years

Interactive RRA data is available to explore through the following tools:

The Juicebox platform displays publicly available generator information and projected performance for the next 20 years (linked here)
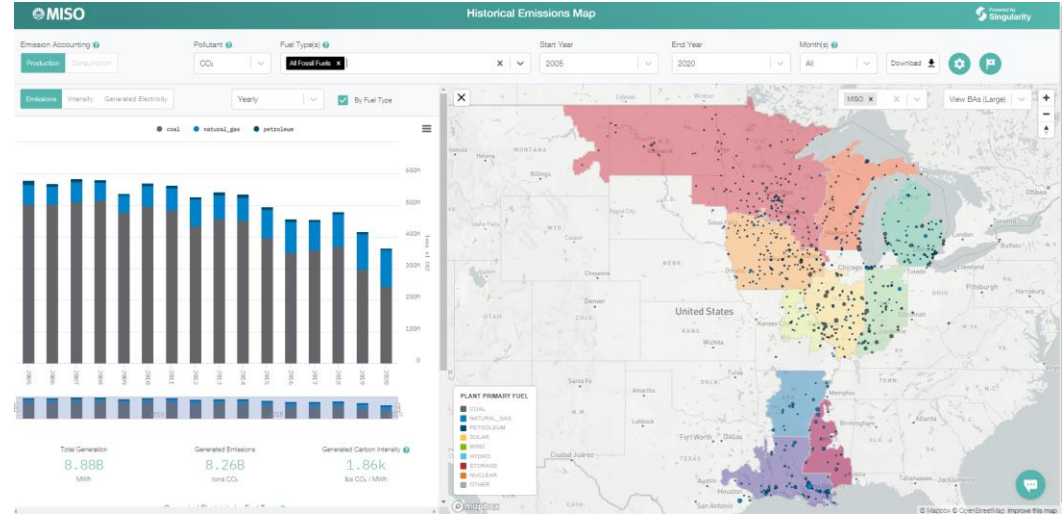
A pilot emissions portal, powered by Singularity, displays historical emissions compiled from EPA data for the entire US. Enhancements are in progress to additionally display future estimated emissions for the MISO footprint based on RRA simulations (linked here)

Next Steps

Resource Adequacy work in progress...

Objective:
To perform a loss of load expectation (LOLE) assessment to explore the long-term resource adequacy of the MISO system in years 2031 and 2041

Deliverables:
- Diurnal and sub-annual risk profiles
- The MISO-wide effective load carrying capability (ELCC) of solar, wind, hybrid, and stand-alone storage

Note: The resource adequacy methods and assumptions will be consistent with the non-thermal accreditation evaluation to-date

MISO

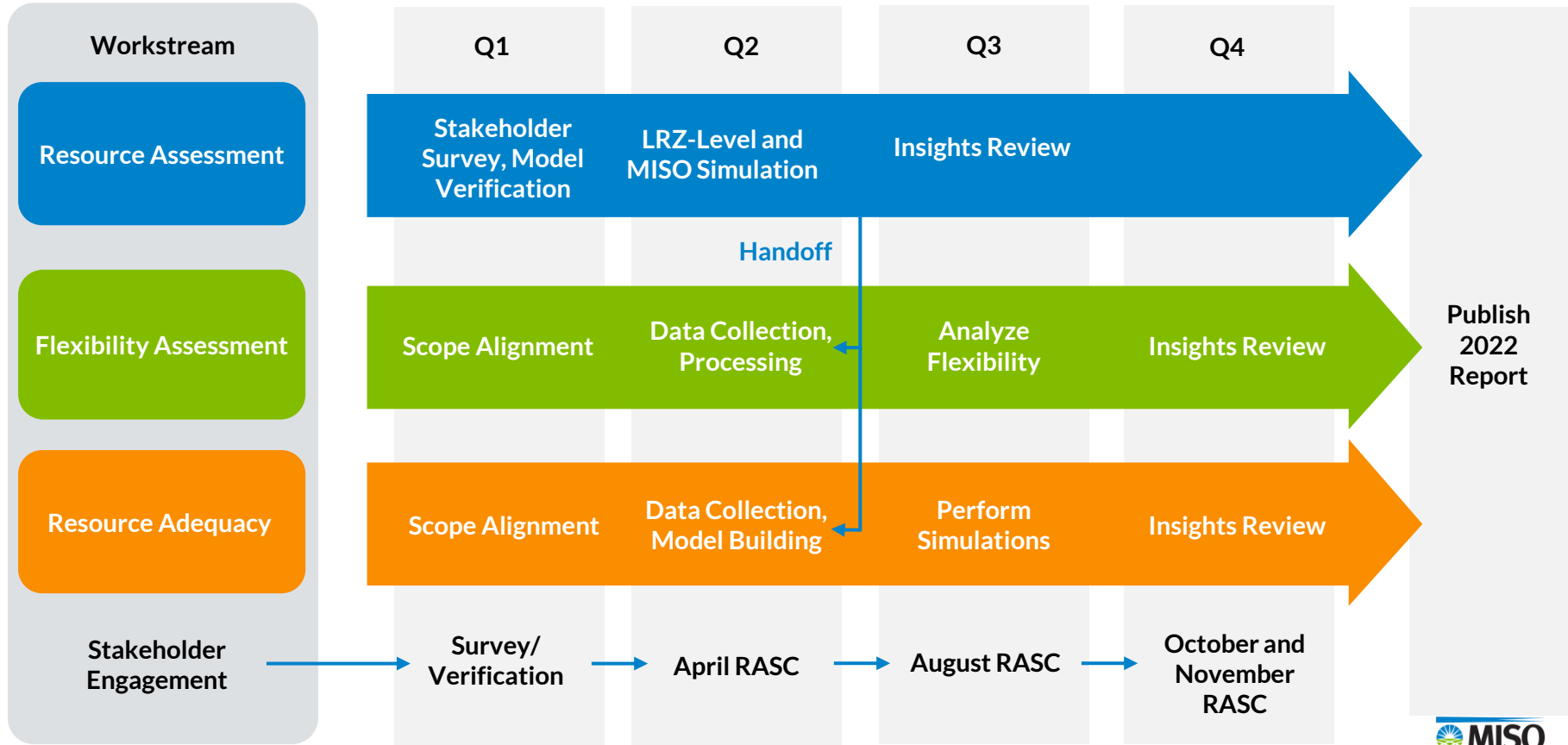# Flexibility Assessment work in progress...

Objective:
- Understand how variability needs, seasonal, and diurnal patterns change
- Quantify future short-term uncertainties and analyze the contribution of the main components (wind, solar, load) to net-load uncertainty
- Consider the combined impact of uncertainty and variability to identify system stressed days/ periods

Deliverables include visualization of:
- Ramping needs (heatmaps and curves)
- Net load diurnal and seasonal trends
- Uncertainty statistics
- Probabilistic assessment of flexibility-stressed periods

Next Steps: MISO will complete the Flexibility and Resource Adequacy Assessment and return to the October RASC to review results and insights

Workstream	Q1	Q2	Q3	Q4	
Resource Assessment	Stakeholder Survey, Model Verification	LRZ-Level and MISO Simulation	Insights Review		
		Handoff			**Publish 2022 Report**
Flexibility Assessment	Scope Alignment	Data Collection, Processing	Analyze Flexibility	Insights Review	
Resource Adequacy	Scope Alignment	Data Collection, Model Building	Perform Simulations	Insights Review	
Stakeholder Engagement	Survey/ Verification	April RASC	August RASC	October and November RASC	

Supplemental Materials:

- Appendix: Final Survey Results

  The survey results presented in the April RASC were marked preliminary while MISO completed one-on-one outreach with Members to review submission summaries and identify any errors or misinterpretation. The final results have been recompiled with minor changes. The footprint-wide trends remain

- An *LRZ-Level Assumptions and Results* deck will be posted to MISO's [Regional Resource Assessment webpage](#)

LRZ = Local Resource Zone

MISO Contacts:
Hilary Brown hbrown@misoenergy.org
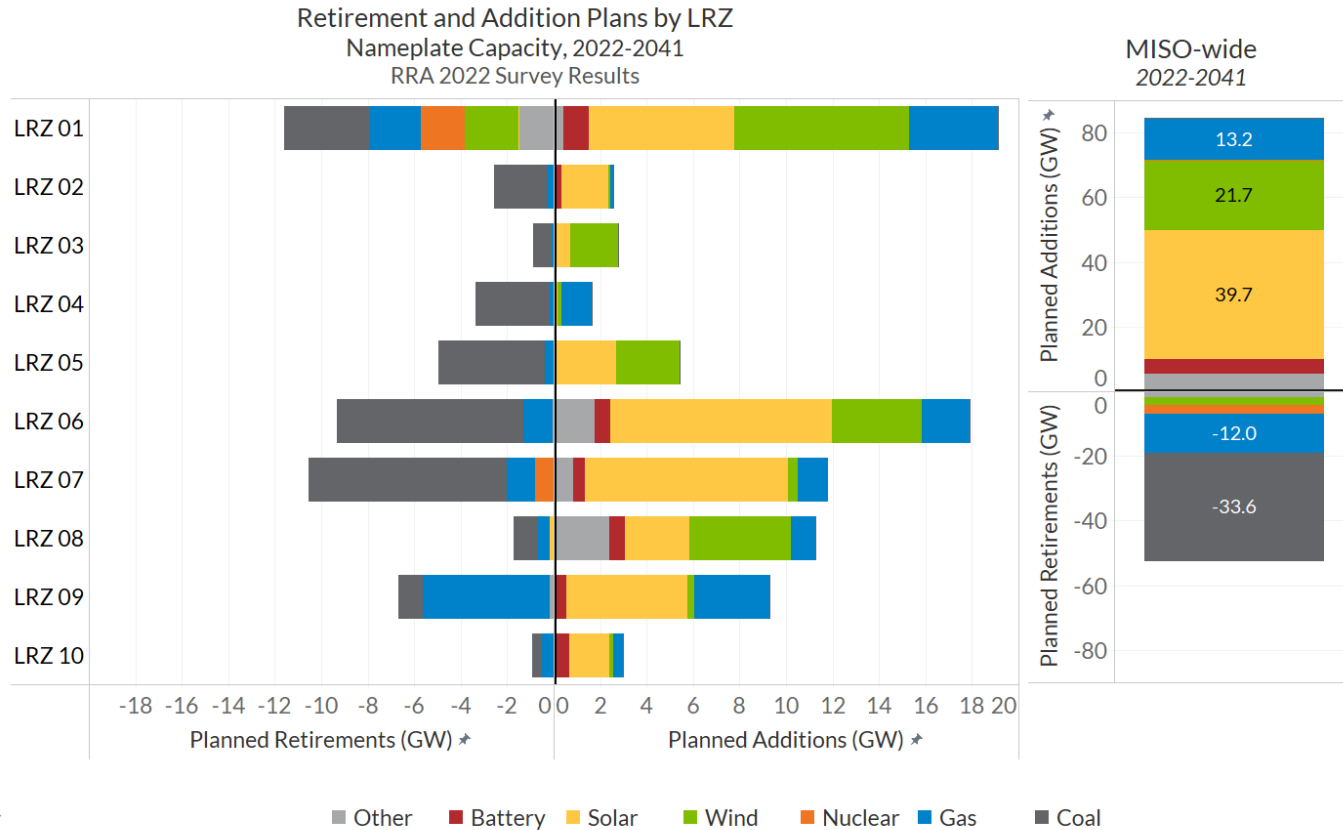Armando Figueroa-Acevedo afigueroa-acevedo@misoenergy.org
Laura Hannah lhannah@misoenergy.org
Aditya Jayam Prabhakar ajayamprabhakar@misoenergy.org
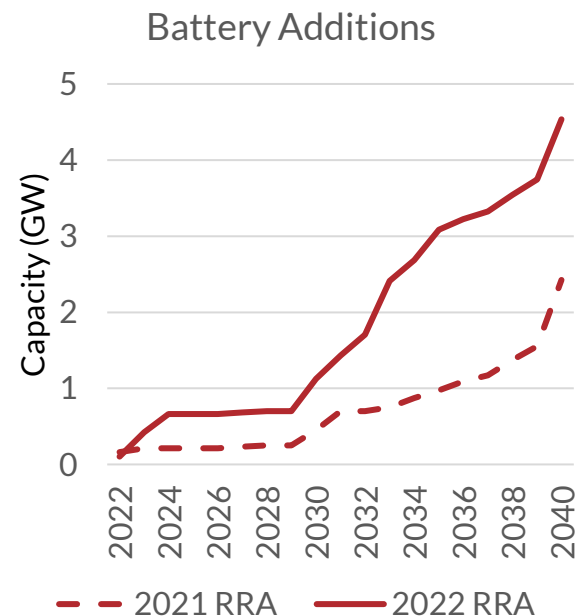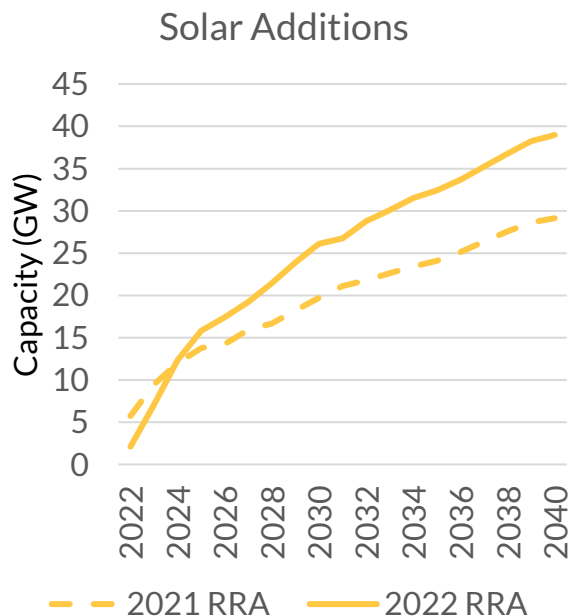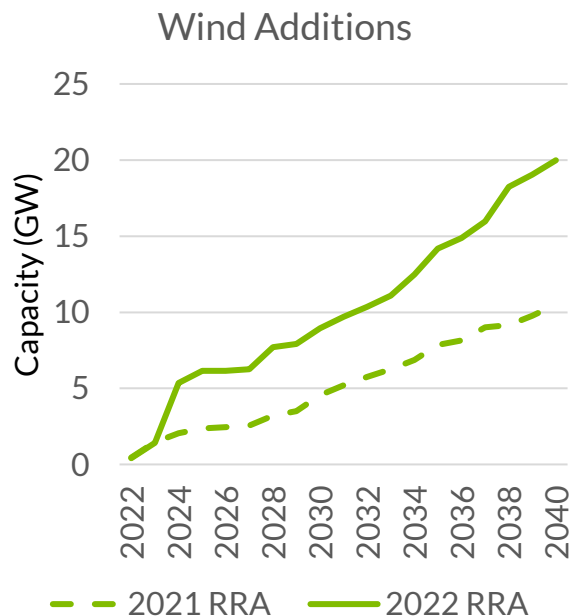Anupam Thatte athatte@misoenergy.org

Appendix: Final Survey Results

Conventional thermal capacity is being replaced with solar and wind capacity across the footprint, according to publicly announced plans
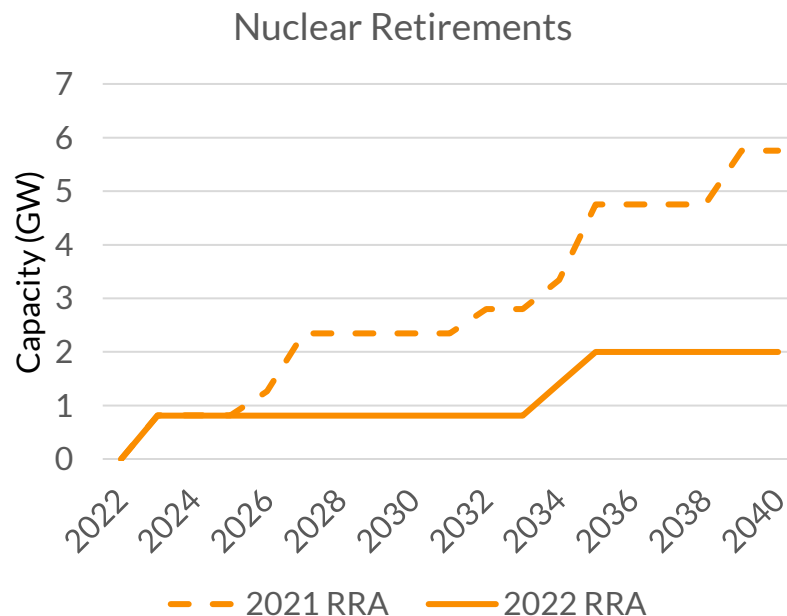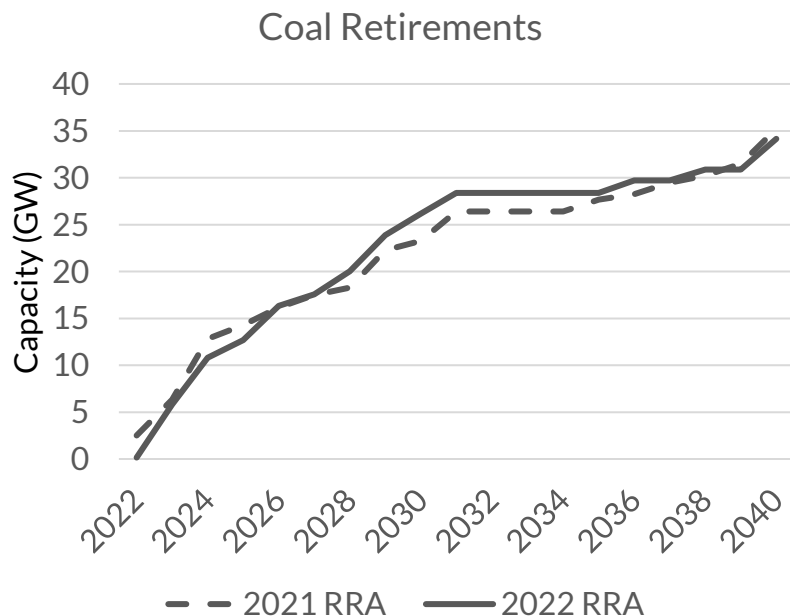

Retirement and Addition Plans by LRZ
Nameplate Capacity, 2022-2041
RRA 2022 Survey Results

MISO-wide
2022-2041

Planned Additions (GW)
- 13.2
- 21.7
- 39.7

Planned Retirements (GW)
- -12.0
- -33.6

LRZ 01, LRZ 02, LRZ 03, LRZ 04, LRZ 05, LRZ 06, LRZ 07, LRZ 08, LRZ 09, LRZ 10

Planned Retirements (GW)   Planned Additions (GW)

Slides 24-28 reflect a combination of survey responses and last year's information for non-respondents

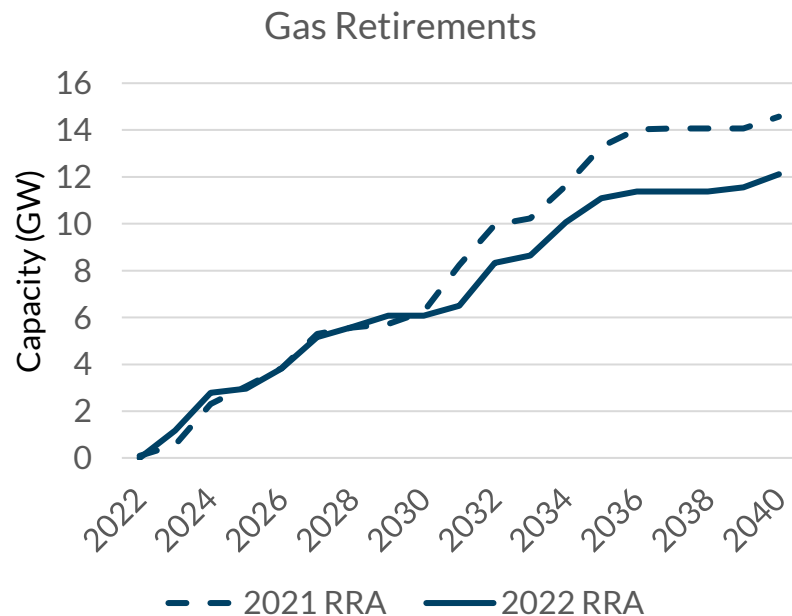Other   Battery   Solar   Wind   Nuclear   Gas   Coal

24

2022 survey results show accelerated wind, solar, and battery additions compared to 2021 RRA assumptions

Wind Additions / Solar Additions / Battery Additions

Member-provided information in 2022, consultant-provided information in 2021

MISO

Survey results indicate that 2021 study assumptions around coal aligned with member plans and support a change in assumptions for nuclear retirements

Coal Retirements

Nuclear Retirements

- - 2021 RRA   — 2022 RRA

- - 2021 RRA   — 2022 RRA

Member-provided information in 2022, consultant-provided information in 2021

2022 survey indicates approximate net-neutral retirements and additions of gas capacity

Gas Retirements

Gas Additions

- - - 2021 RRA   —— 2022 RRA

- - - 2021 RRA   —— 2022 RRA

Member-provided information in 2022, consultant-provided information in 2021
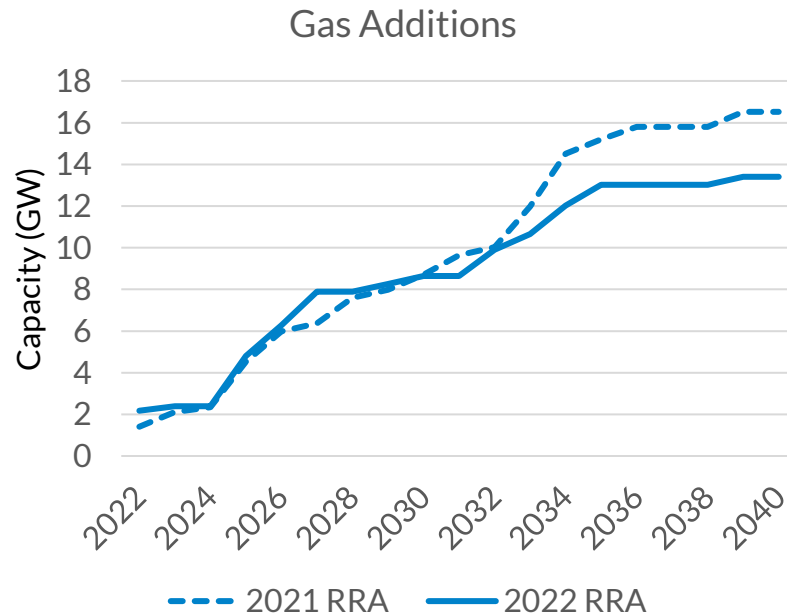
Survey results improved visibility on emissions reduction trajectory, showing expected 65% decrease from 2022 levels by 2040

Emissions Reduction Plans

35% reduction from 2022 values by 2030

65% reduction from 2022 values by 2040