MISO Futures Series 2

Introduction to MISO Futures Redesign Series 2

February 28, 2025

Executive Summary

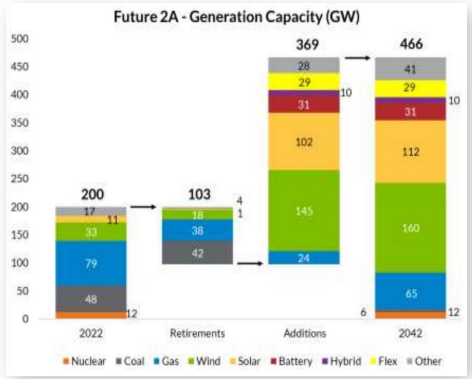
- MISO creates future scenarios (Futures) to capture a range of potential system conditions in a 20-year horizon
  - These Futures have historically formed the basis for long-term transmission efforts such as LRTP
  - The new series will also be used to inform states and load serving entities in resource planning discussions
- In recent years, changes in load growth and shifts in risks around what generation may be constructed have driven the need to update the Futures and create a new scenario
- Today, we will review the Futures framework and the high-level outline of the four scenarios for Series 2
  - We will then seek feedback on the variables within the Future Scenario Definitions which drive differences between scenarios

MISO translates member goals into planning scenarios, or Futures, to bookend future outcomes

- Long-term planning analyses require the application of sufficient resources throughout the study period
- The amount of resources needed typically exceeds what's currently known or publicly planned by members
- MISO Futures help fill the resource gap and showcase areas for focus throughout MISO

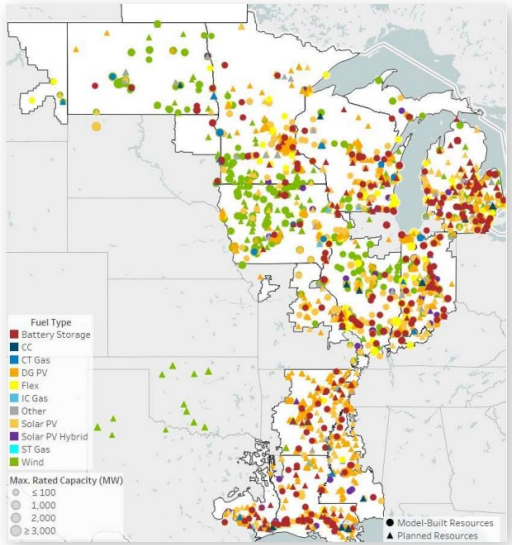
Resource Expansion

- Apply Futures assumptions
- Incorporate member plans – clean energy goals, resource additions, retirements
- Perform resource expansion to economically determine type, magnitude, and timing of new resources



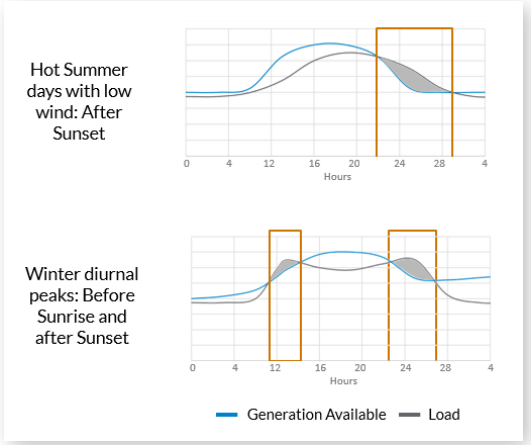
Siting

- Determine location to place each new resource in the transmission system



Resource & Energy Adequacy

- Ensure all hours meet energy requirements
- New: ensure DLOL accredited capacity requirements are met



Resource Expansion, Siting and Energy Adequacy graphics: examples only (Series 1A)

The Series 2 update, which began with the December 2024 load forecast, will extend the use of these futures from transmission planning to also inform resource planning discussions

What Are They: Futures establish a range of power system outcomes over a 20-year period related to economic, policy, and technology drivers (e.g. load growth, carbon policy, generation retirements, State and LSE resource plans)

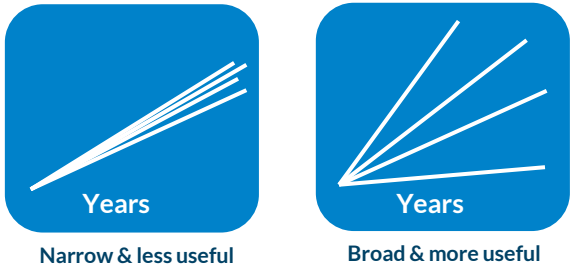
Where Are They Used: Long Range Transmission and Interregional Planning, Market Efficiency Planning, and inform State and Member resource planning

Why Are We Redesigning Them: To reflect recent changes to load and supply, identify transmission needs, and inform State and LSE resource plans that will lead to efficient, reliable, least-cost grid development

It's very difficult to accurately predict the future

Develop Futures

- Create multiple scenarios to simplify planning for the uncertain future
- Scenarios hedge uncertainty and "bookend" a range of economic, political, and technological possibilities
- Cover a 20-year span

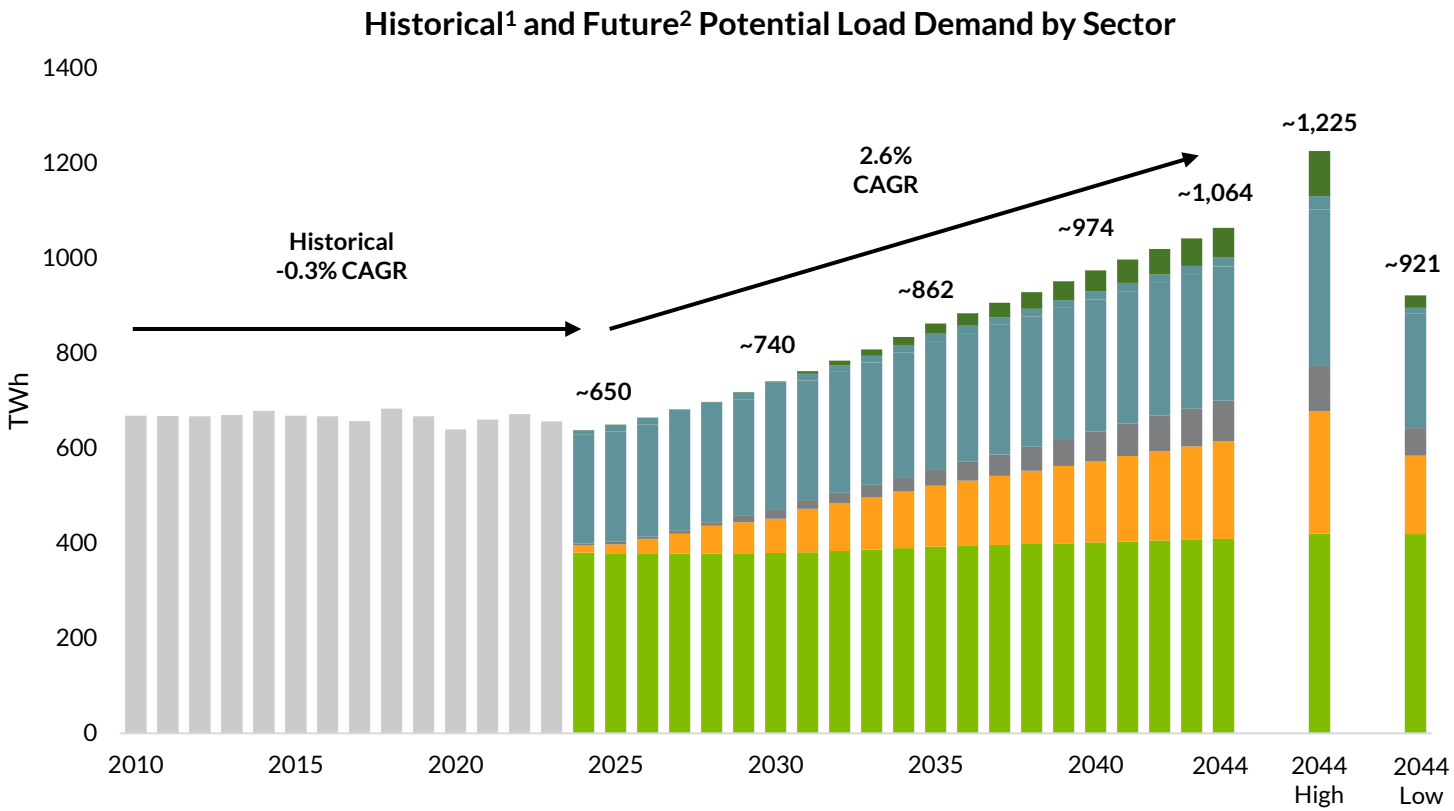


Narrow & less useful

Broad & more useful

Artificial Intelligence-driven acceleration in data center loads, reshoring of industry and electrification are materially increasing expectations for load growth

Current Trends Outlook



[1] *Net Load* [2] *Gross Load*

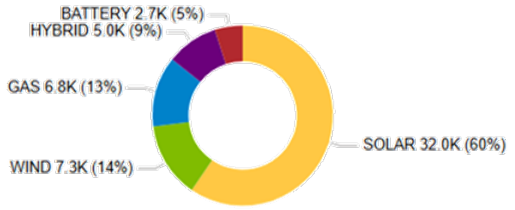
* *Expected likelihood of load growth materializing*

	CAGR % Low-High (2024-44)	Growth TWh Low-High (2024-44)	Level of Certainty*
Hydrogen	27-32	26-95	Low
Industry Development & Reshoring	3-7	21-105	Medium
EVs	14-17	54-91	Medium-High
Data Centers	12-15	149-241	Medium-High
Building Electrification	0.45-0.54	36-43	High

Increasing current and the potential for future frictions in bringing on new generation capacity online may shift the velocity of supply growth

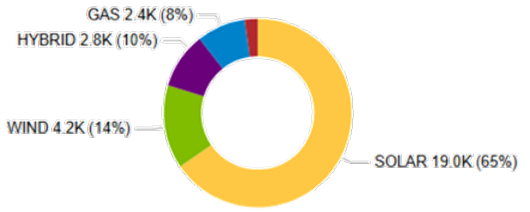
WAITING PROJECTS

345 CP Nodes Waiting | **53,721** MW Waiting



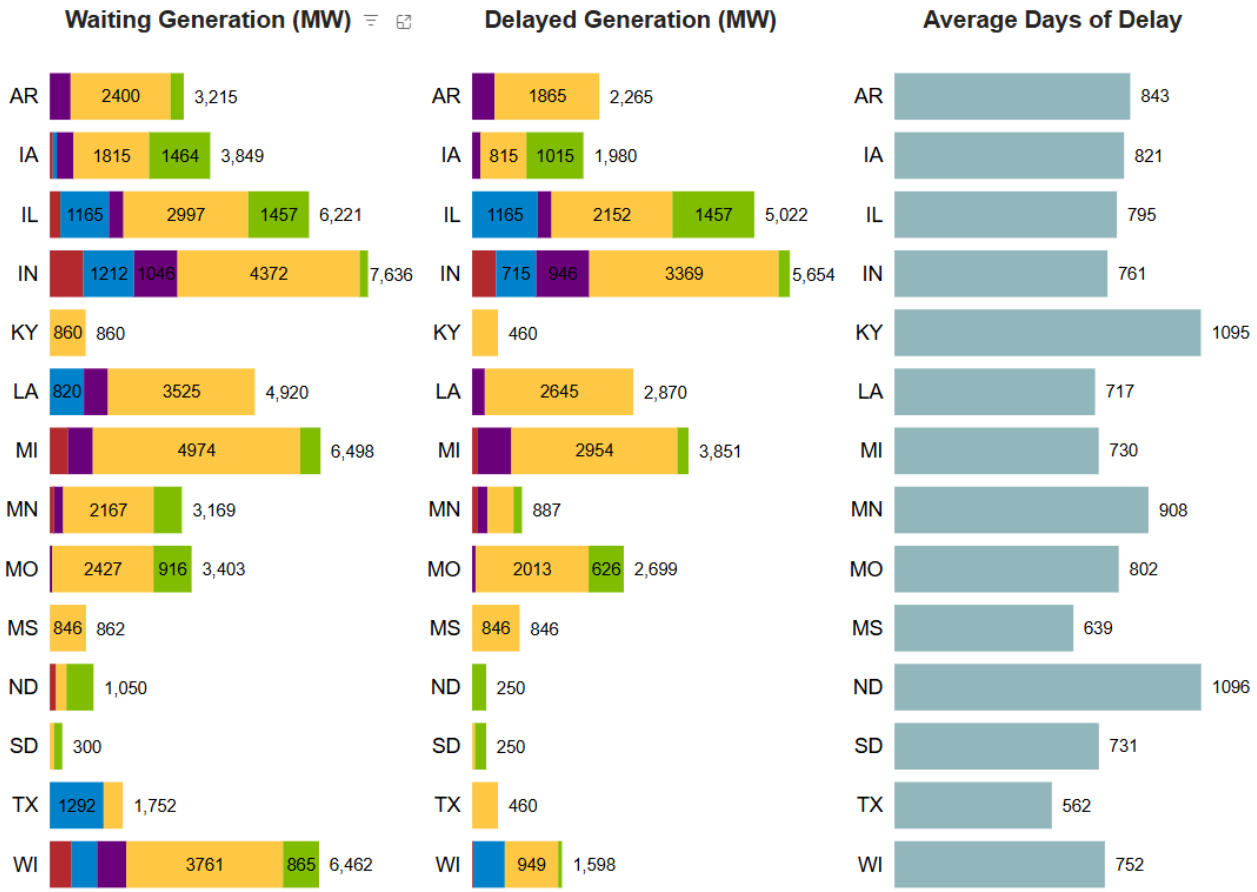
DELAYED PROJECTS

182 CP Nodes Delayed | **29,090** MW Delayed



Click here to access the COD tool

BREAKDOWN OF DELAYED PROJECTS*



Supply chain, permitting, labor and interconnection delays are limiting the rate of generator additions

Coal Gas Wind Solar Hybrid Nuclear Storage

*Data as of 1/21/2025. CP = Commercial Pricing.

Changing Future Scenario Definitions creates a redesign and new series (Series 1 and Series 2) while updating Future Data Assumptions constitutes a refresh (Series 1A, Series 1B)

Future Scenario Definitions

Footprint Development

- Integrated Resource Plans
- Discounted Announcements

Emissions

- Footprint-wide Decarbonization Floor

Load Growth

- Demand and Energy growth by Future

Generation Retirements

- Planned Retirements
- Age-Based Generation Retirements (if no date provided)

Future Data Assumptions

Planning Reserve Margin

Inflation Reduction Act and CEJA Incentives

Resource Type & Cost Modeling

Resource Accreditation

Existing and Planned Resources

DERs/DSM Application

Resource Siting

The 2025 MISO Futures Series 2 will build upon the MISO Futures Series 1/1A framework

Tranche 1

Future 1 / 1A

- Footprint develops in line with 100% of utility Integrated Resource Plans and 85% of utility/state announcements
- Footprint-wide decarbonization of 40% minimum
- Load growth is consistent with current trends
- Age-based generation retirements

Tranche 2.1

Future 2 / 2A

- Companies/states meet their goals, policies and announcements
- Footprint-wide decarbonization of 60% minimum
- Energy increases 30%, driven by electrification
- Accelerated age-based generation retirements

Future 3 / 3A

- Companies/states meet their goals, policies and announcements
- Footprint-wide decarbonization of 80% minimum
- Increased electrification drives a 50% increase in energy demand
- Advanced age-based generation retirements

FUTURES

Minimize the resource fleet's cost while respecting constraints such as:

- **Peak Demand + Planning Reserve Margin**
- **Annual Energy**
- **Decarbonization Goals**
- **Renewable Portfolio Standards & Clean Energy Goals**

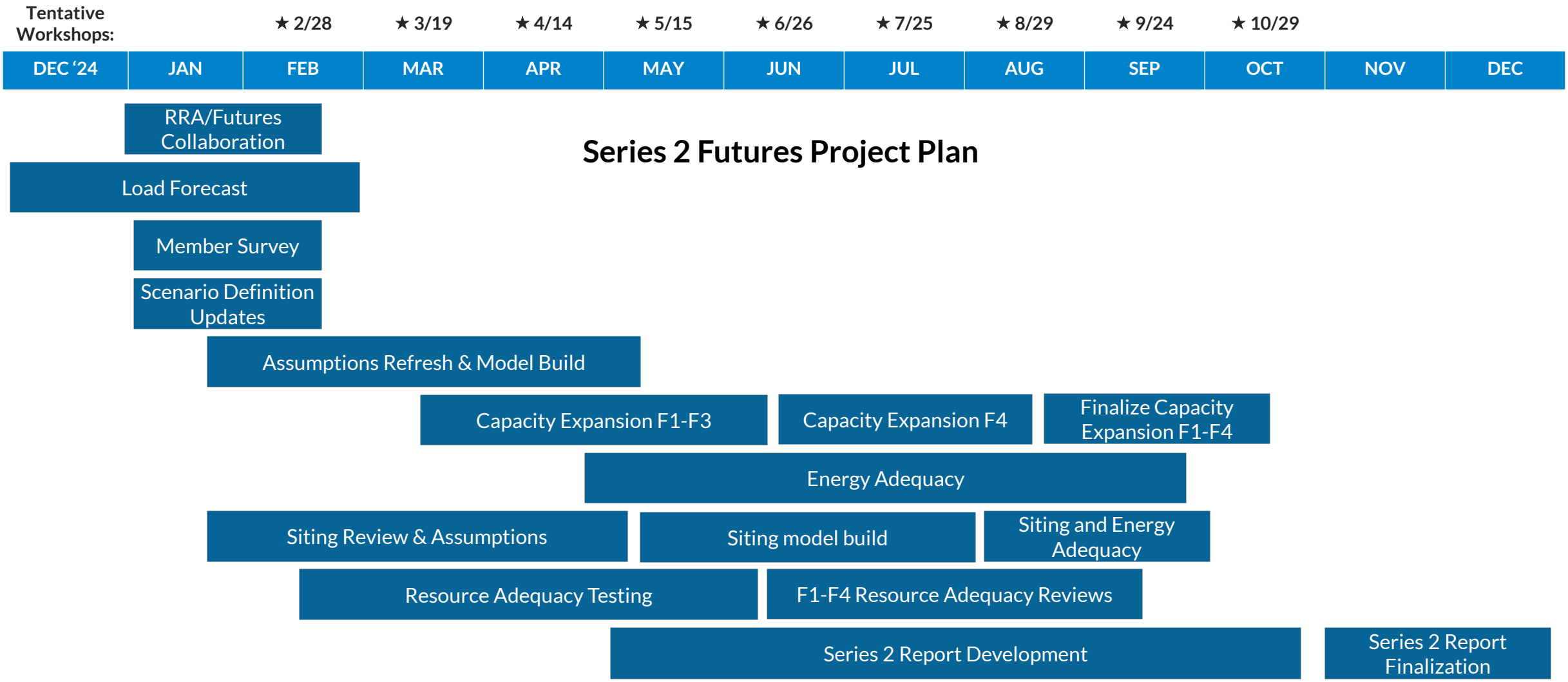
The Series 2 Futures will focus on the impacts of changes in load growth assumptions and include a new fourth scenario to focus on changes in supply

Future Scenario Definitions

	Lower Load Growth	*Stated Policy*	*Higher Load Growth*	*Supply Shift*
	FUTURE 1	**FUTURE 2**	**FUTURE 3**	**FUTURE 4**
	Series 2 (New) Purpose	*Series 2 (New) Purpose*	*Series 2 (New) Purpose*	*Series 2 (New) Purpose*
Footprint Development **Emissions** **Load Growth** **Generation Retirements**	Low-end demand growth bookend. Change in key macroeconomic drivers reduces the trajectory of load growth from anticipated values, leading to a decreased requirement for new supply.	Current projections of load growth are applied to define the forward-looking system needs, reflecting reindustrialization, data center growth, electrification and other key factors. Generation investment, based on current member policy plans and goals, increases to match based on economics and incentives.	High-end demand growth bookend. Changes in key macroeconomic drivers increase the trajectory of load growth from anticipated values, leading to an increased need for new supply.	Supply frictions limit the pace of generation additions and load growth must be managed with existing generation and demand-side resources. These frictions are due to a range of potential drivers including supply chain constraints, construction delays, labor shortages, interconnection delays, the policy environment, and changes in economics. Input will be sought on the appropriate generation and demand-side levers to ensure sufficient supply is available to meet capacity and energy needs.

CAGR – Compound Annual Growth Rate

MISO will host stakeholder workshops to ensure the Series 2 Futures are built in a transparent manner, with more time allocated to the new, fourth scenario



*Schedule as of February 2025. Schedule and workshops are subject to change.

Series 2 Futures 1 -3, are proposed to largely mimic the assumptions of the Series 1/1A Futures; new Future 4 largely mirrors Future 2 assumptions while testing the impacts of changes to generation supply

Future Scenario Definitions

	Lower Load Growth		*Stated Policy*		*Higher Load Growth*		*Supply Shift*
	FUTURE 1		**FUTURE 2**		**FUTURE 3**		**FUTURE 4**
	Series 1 & 1A	*Series 2 (New)*	*Series 1 & 1A*	*Series 2 (New)*	*Series 1 & 1A*	*Series 2 (New)*	*Series 2 (New)*
Footprint Development	In line with 100% of utility IRPs and state legislation; and 85% of utility/state announcements	No Change	Companies/states meet their goals, policies and announcements	No Change	Companies/states meet their goals, policies and announcements	No Change	In line with supply frictions: limits build rate and causes tension with timelines of member plans and goals
Emissions	minimum 40% reduction from 2005 levels	No Change	minimum 60% reduction from 2005 levels	No Change	minimum 80% reduction from 2005 levels	No Change	minimum 60% reduction from 2005 levels, unless supply friction build rate violated
Load Growth	Consistent with current trends (0.35% CAGR)	Consistent with low-end projections (1.1% CAGR)	30% energy increase (0.8% CAGR)	Consistent with anticipated values (1.6% CAGR)	50% energy increase (1.1% CAGR)	Consistent with high-end projections (2.1% CAGR)	Consistent with anticipated values (1.6% CAGR) – additional Demand Response if needed
Generation Retirements	Age-based and member planned generation retirements	No Change	**Accelerated** age-based and member planned generation retirements	No Change	**Advanced** age-based and member planned generation retirements	No Change	No age-based generation retirements – delayed retirements if needed

IRP – Integrated Resource Plan
CAGR – Compound Annual Growth Rate
Series 2 (New) load growth CAGR starts from 2024. Series 1A Futures load growth CAGR starts from 2019

The Series 2 Futures will focus on the goals of the load serving entities and states within MISO; Future 4 will contemplate the impacts of supply constraints on the timing of those goals

	Lower Load Growth		*Stated Policy*		*Higher Load Growth*		*Supply Shift*
	FUTURE 1		**FUTURE 2**		**FUTURE 3**		**FUTURE 4**
	Series 1 & 1A	*Series 2 (New)*	*Series 1 & 1A*	*Series 2 (New)*	*Series 1 & 1A*	*Series 2 (New)*	*Series 2 (New)*
Footprint Development	In line with 100% of utility IRPs and state legislation; and 85% of utility/state announcements	No Change	Companies/states meet their goals, policies and announcements	No Change	Companies/states meet their goals, policies and announcements	No Change	In line with supply frictions: limits build rate and causes tension with timelines of member plans and goals

Assumption Variables

FUTURE 1	FUTURE 2-3	FUTURE 4
Non-legislated and non-IRP decarb and renewable member goals are discounted by 15%.	Assumes members and states meet their stated decarb and renewable goals.	Assumes members and states meet their stated decarb and renewable goals unless they exceed the total ability to build those assets.

IRP – Integrated Resource Plan

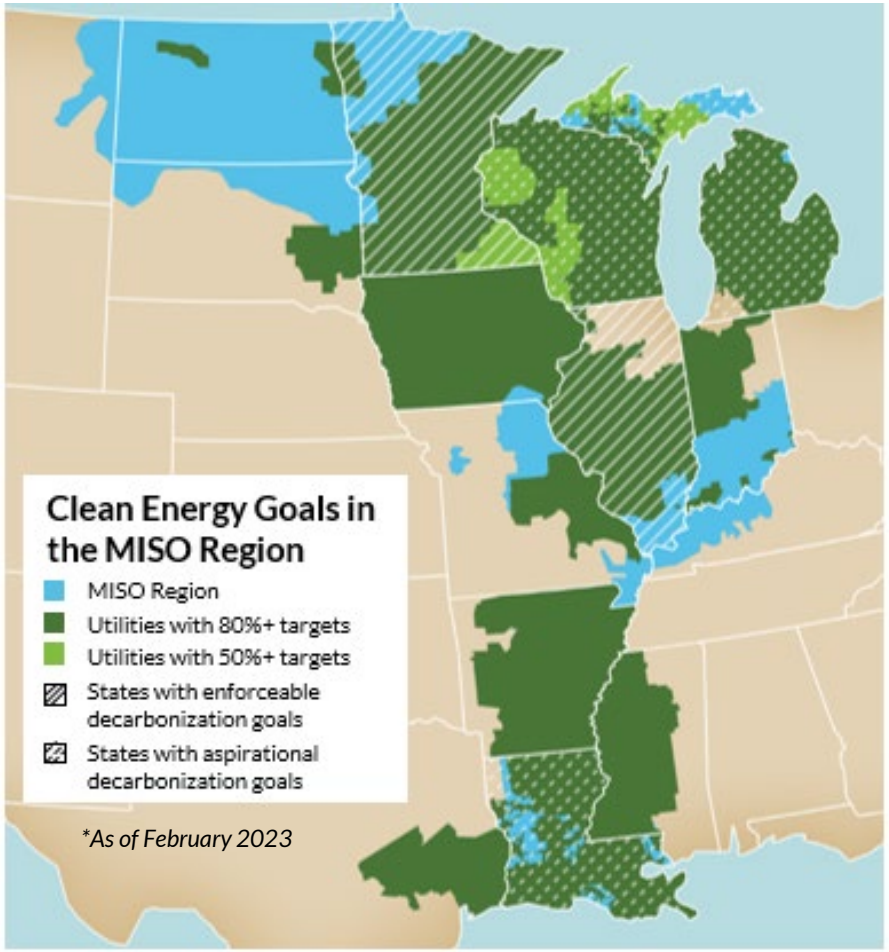
The Series 2 emissions targets will mimic the Series 1/1A modeling; in the prior Futures, the goals from states and utilities drove final emissions reductions, rather than the modeled floor

	Lower Load Growth		*Stated Policy*		*Higher Load Growth*		*Supply Shift*
	FUTURE 1		**FUTURE 2**		**FUTURE 3**		**FUTURE 4**
	Series 1 & 1A	*Series 2 (New)*	*Series 1 & 1A*	*Series 2 (New)*	*Series 1 & 1A*	*Series 2 (New)*	*Series 2 (New)*
Emissions	minimum 40% reduction from 2005 levels	No Change	minimum 60% reduction from 2005 levels	No Change	minimum 80% reduction from 2005 levels	No Change	minimum 60% reduction from 2005 levels, unless supply friction build rate violated

Assumption Variables			
FUTURE 1	**FUTURE 2**	**FUTURE 3**	**FUTURE 4**
40% minimum decarbonization "floor" (reduction in CO2 emissions), subject to additional reductions from 100% of IRP and legislated goals and 85% of non-IRP, non-legislated goals from states/utilities	60% minimum decarb floor, with 100% of goals from states/utilities	80% minimum decarb floor, with 100% of goals from states/utilities	Assumes members and states meet their stated decarb and renewable goals unless they exceed the total ability to build those assets

Emissions describe minimum amounts of decarbonization, "floors", (reduction in CO2 emissions), subject to additional reductions from each Future's Footprint Development settings for utility/state goals. Emissions reductions measured from 2005 levels.

Decarbonization goals, as modeled in the Series 1A Futures, included the impacts of member, state, and regional goals, with the state and member goals driving the largest impact



- **Decarbonization goals in Series 1A were modeled using multiple layers**
  - Model data aggregated decarbonization goals from members to Local Resource Zone/Subregion, which was modeled at the MISO system level
  - State decarbonization goals were included as separate constraints and specifically tied to the units within that state
  - Unit-specific carbon emission constraints, such as those associated with the Illinois Climate and Equitable Jobs Act (CEJA), were applied at the unit level
- **For Series 1A Future 2A**
  - Future definition assumed MISO-wide floor 60% decarbonization
  - The aggregation of member goals drove a 76% decarbonization model input
  - State Renewable Portfolio Standards, along with member plans, drove an overall 86% decarbonization outcome alone
  - The total carbon reduction driven by goals and economics was 96%

The Series 2 retirement assumptions will mimic the Series 1/1A assumptions, with age-based assumptions supplementing member plans for most scenarios

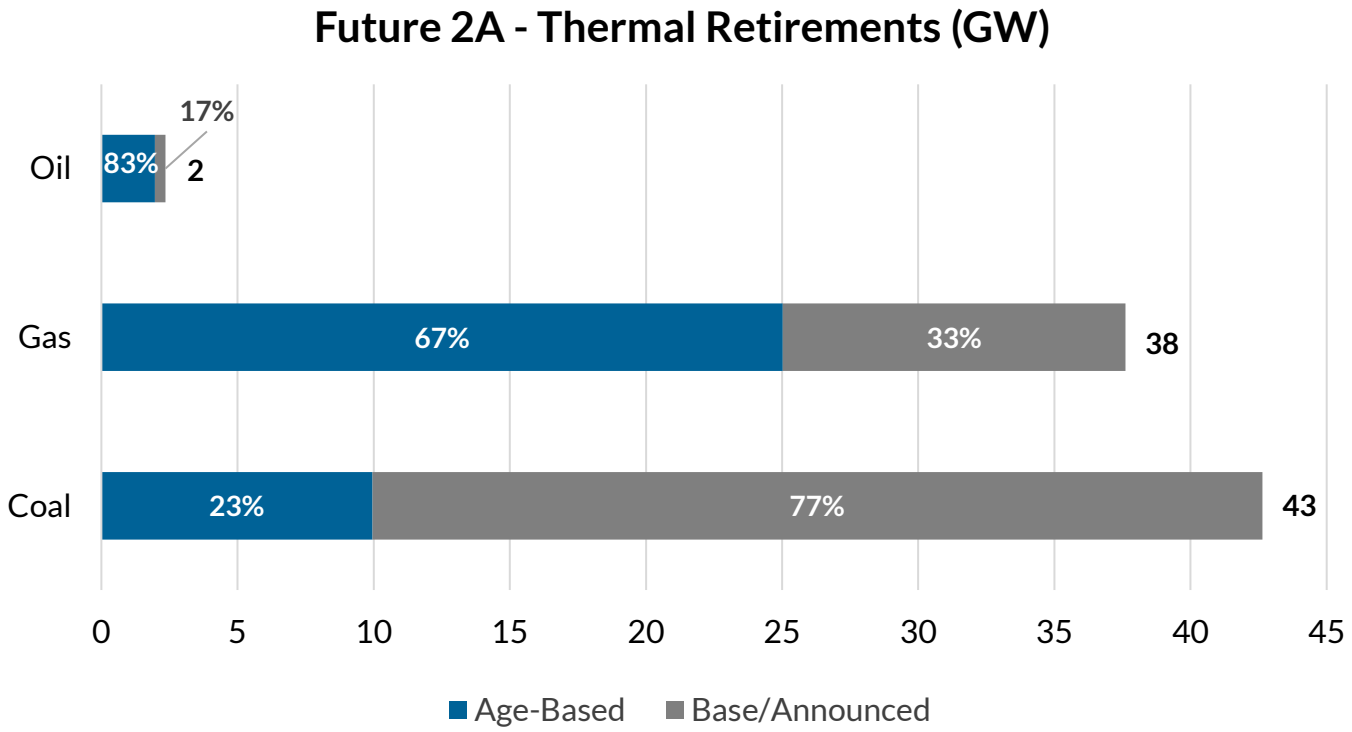
	Lower Load Growth		*Stated Policy*		*Higher Load Growth*		*Supply Shift*
	FUTURE 1		**FUTURE 2**		**FUTURE 3**		**FUTURE 4**
	Series 1 & 1A	*Series 2 (New)*	*Series 1 & 1A*	*Series 2 (New)*	*Series 1 & 1A*	*Series 2 (New)*	*Series 2 (New)*
Generation Retirements	Age-based and member planned generation retirements	No Change	**Accelerated** age-based and member planned generation retirements	No Change	**Advanced** age-based and member planned generation retirements	No Change	No age-based generation retirements – delayed retirements if needed

Assumption Variables

	FUTURE 1	FUTURE 2	FUTURE 3	FUTURE 4
	Age-Based Retirements	**Accelerated Age-Based Retirements**	**Advanced Age-Based Retirements**	**Delayed Retirements**
Coal	46	36	30	Retire only if publicly announced unless resource is needed for adequacy reasons.
Natural Gas – CC	50	45	35	
Natural Gas – Other	46	36	30	
Oil	45	40	35	
Nuclear & Hydro	Retire if Publicly Announced	Retire if Publicly Announced	Retire if Publicly Announced	
Solar – Utility-Scale	25	25	25	
Wind – Utility-Scale	25	25	25	

CAGR – Compound Annual Growth Rate

In Series 1A Futures (F1A, F2A, F3A), MISO utilized unit retirement dates supplied by member plans and applied age-based retirements if no feedback was provided



Overall, in Series 1A, Future 2A, approximately 48% of the retirements were provided by members

- ~77% of the Future 2A ***coal*** retirements were provided by members (23% were age-based)
- ~ 33% of the Future 2A ***gas*** retirements were provided by members (67% were age-based)

The Series 2 load growth assumptions represent a key driver for the new Futures series; these are based on the data discussed in the December 2024 load forecasting workshop

	Lower Load Growth		*Stated Policy*		*Higher Load Growth*		*Supply Shift*
	FUTURE 1		**FUTURE 2**		**FUTURE 3**		**FUTURE 4**
	Series 1 & 1A	*Series 2 (New)*	*Series 1 & 1A*	*Series 2 (New)*	*Series 1 & 1A*	*Series 2 (New)*	*Series 2 (New)*
Load Growth	Consistent with current trends (0.35% CAGR)	Consistent with low-end projections (1.1% CAGR)	30% energy increase (0.8% CAGR)	Consistent with anticipated values (1.6% CAGR)	50% energy increase (1.1% CAGR)	Consistent with high-end projections (2.1% CAGR)	Consistent with anticipated values (1.6% CAGR) – additional Demand Response if needed

Assumption Variables

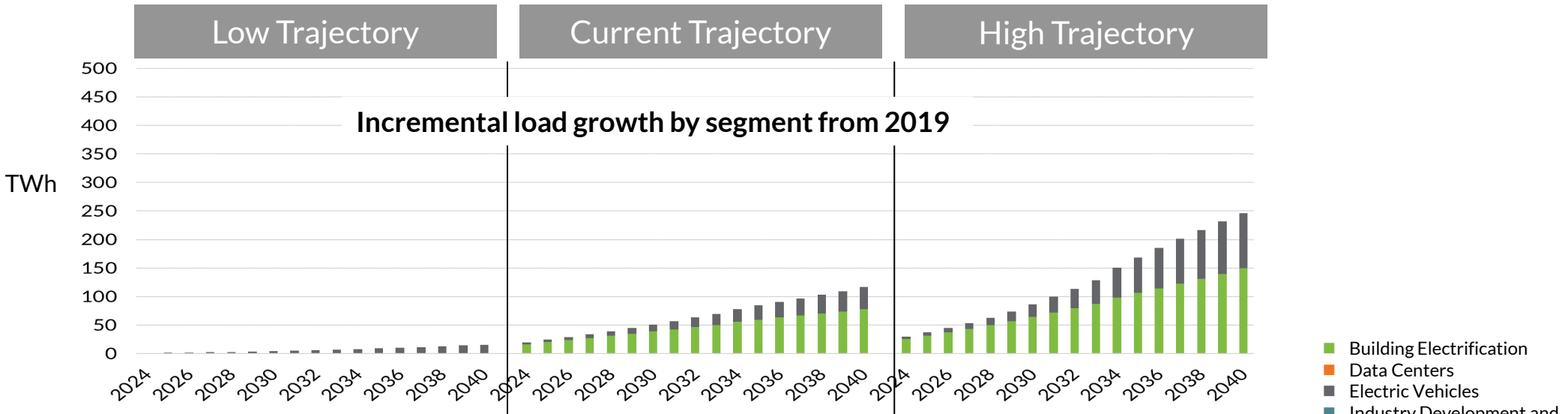
FUTURE 1	**FUTURE 2**	**FUTURE 3**	**FUTURE 4**
Account for a modest driver growth that aligns to reduced technology adoption patterns in building electrification and electric vehicles	Account for technology adoption trends, existing policy incentives and an increase in data centers, domestic manufacturing and green hydrogen facilities	Accelerated electric vehicle adoption and additional buildouts of data centers, domestic manufacturing and green hydrogen facilities	Future 2 load growth with use of additional demand response if needed

CAGR – Compound Annual Growth Rate

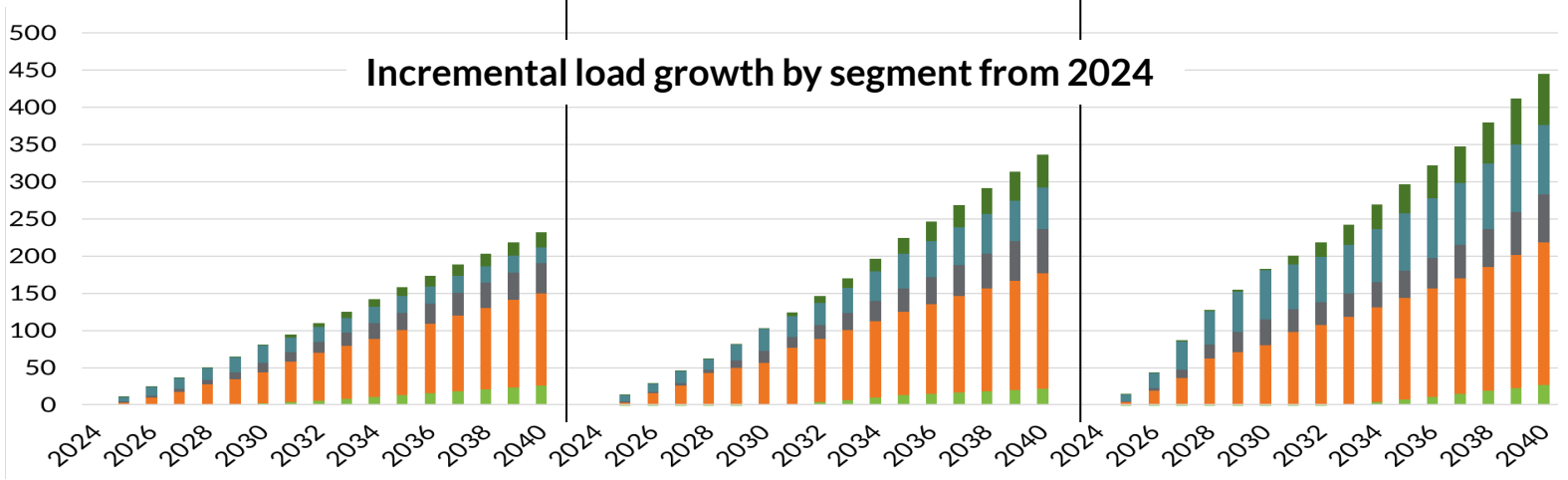
Load Forecasting Workshop, December 2024

Macroeconomics have expanded since MISO's Futures 1A report to include not only EVs and Building Electrification but also data center AI revolution, domestic manufacturing and green hydrogen

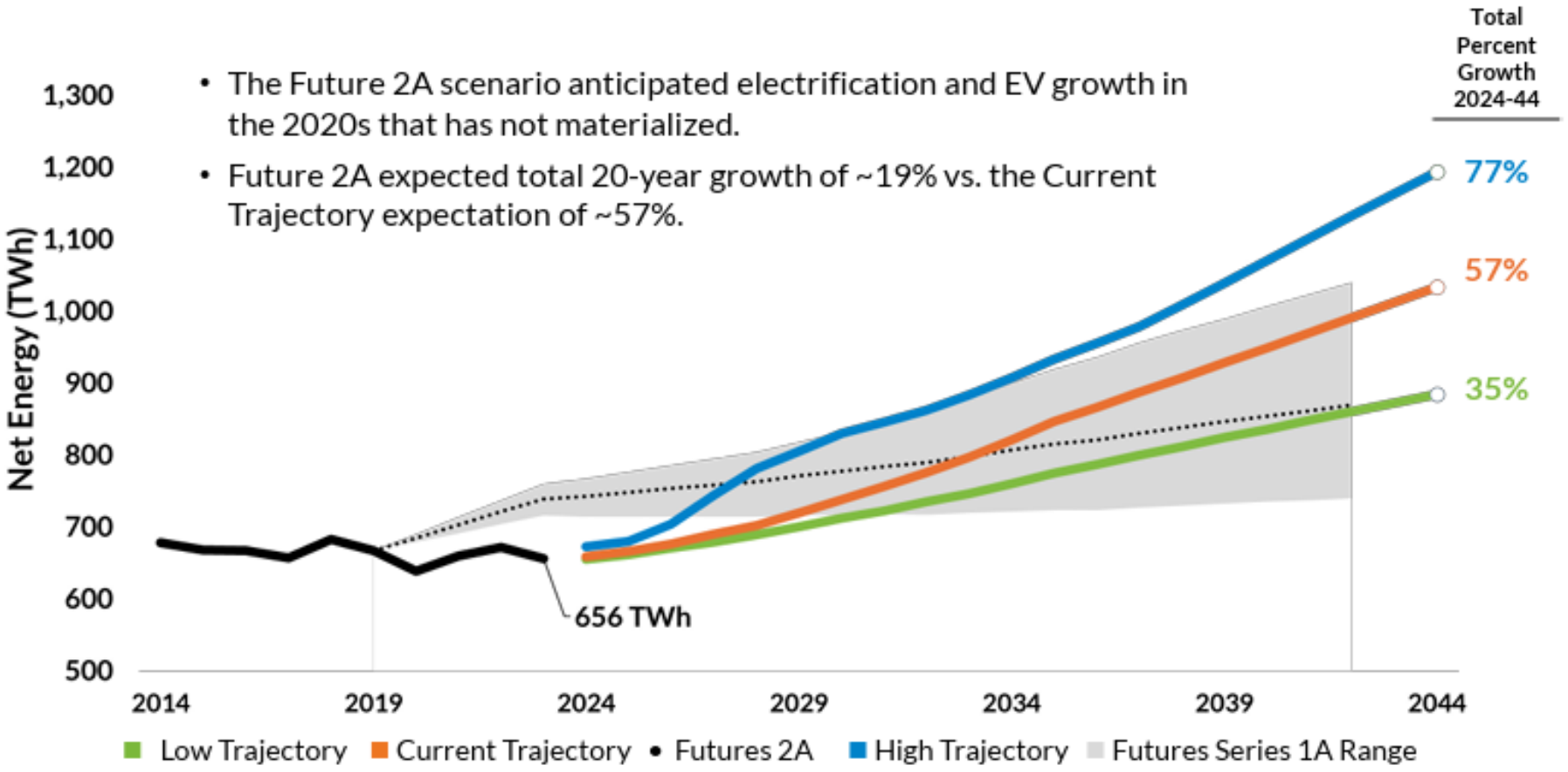
Series 1 & 1A



Series 2



Updated industry, macroeconomic and policy assumptions have resulted in new load growth trajectories since MISO's Futures Series 1A report

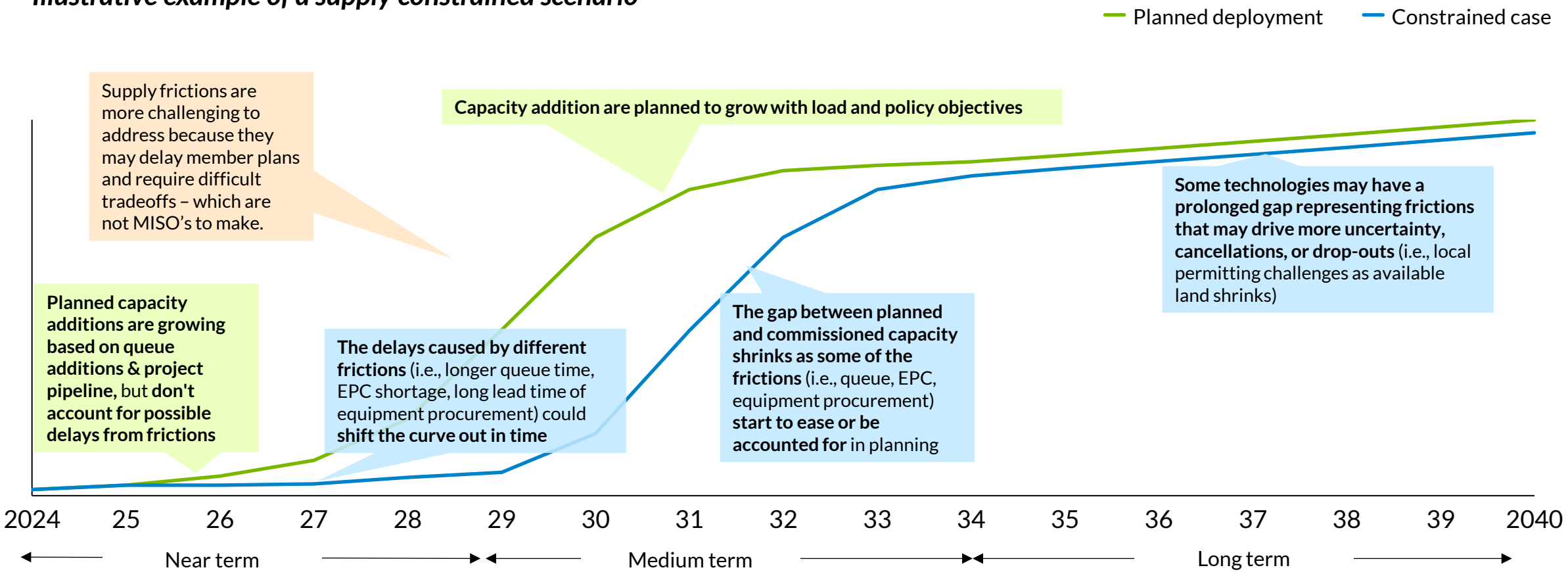


Load Growth

Higher load growth rates are balanced by less growth in the 2019-2024 timeframe, as compared to the Series 1 Futures assumptions

MISO is analyzing supply frictions and will return to stakeholders to discuss how this best may be implemented in Series 2 Future 4, including insights gained from states and resource planners

Illustrative example of a supply constrained scenario



There are **uncertainties regarding the impact from frictions** – the gap may shrink faster or slower than expected.

The Series 2 Futures will draw upon lessons learned from previous Futures and Regional Resource Assessment analysis

Historical Member Feedback Themes

Weather years:	• More recent events
Capacity Accreditation:	• Value of Loss Load (VOLL) concerns now addressed through dynamic accreditation
Siting:	• Existing busses vs greenfield
Retirements:	• Age based, economic based or policy based
Resource Mix/Inclusions:	• Battery Storage duration (12-hour), new and planned resource types, i.e., Small Modular Reactors, etc.
DSM/DER:	• Increase in Demand-Side Management/Demand Response (DSM/DR) programs • Accounting for Distributed Energy Resource (DER) additions

Initial Member Survey Insights

- Limited planned development
- Changes to planned in-service dates based on constraints
- Goals still key

MISO requests feedback on variables in the Future Scenario Definitions which drive differences between the Futures

FUTURE SCENARIO DEFINITIONS

Footprint Development | Emissions | Load Growth | Generation Retirements

The following are examples to help guide the feedback MISO is looking for. Each one points to a specific variable in the Future Scenarios Definitions that MISO is using to differentiate each Future:

1. **Future 1:** Is 85% a good assumption to discount announcements that are not included in legislated state/member goals? If not, what is a good assumption? **(Footprint development)**
2. **Future 4:** Is a 60% minimum reduction in emissions from the 2005 baseline a good setting assuming supply frictions enable this reduction? If not, what is a good assumption? **(Emissions)**
3. **Future 2:** When no retirement date is supplied for a unit, are accelerated age-based retirements a good assumption for the stated policy scenario? If not, what should be used? **(Generation Retirements)**

Given the stated purpose of the four Futures, please provide specific feedback on the variables within the Future Scenario Definitions

FUTURE SCENARIO DEFINITIONS

Footprint Development | Emissions | Load Growth | Generation Retirements

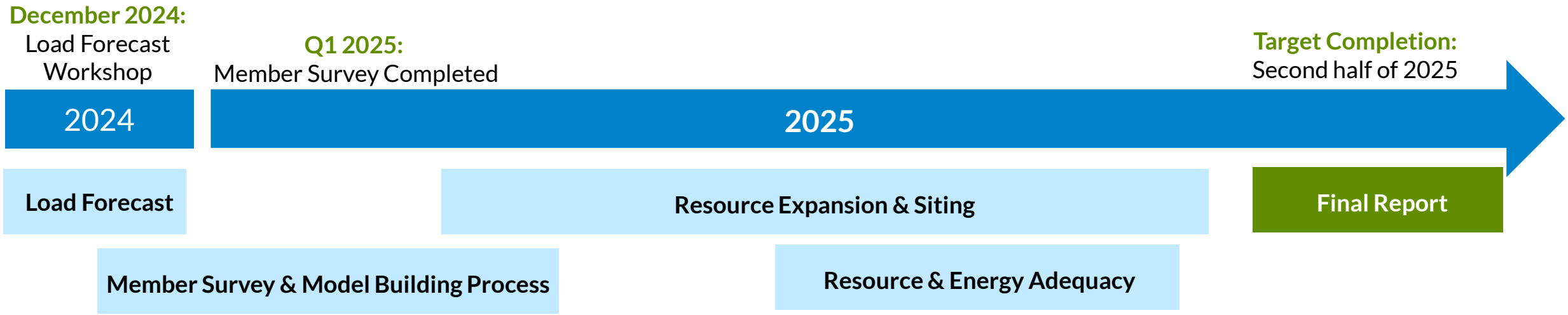
4. **Future 3:** Are the retirement years on the advanced age-based retirements the appropriate assumptions for generation retirements in that Future? If not, what are appropriate retirement year variables? **(Generation Retirements)**

5. **Future 4:** Is the anticipated load growth (CAGR 1.6%) a good assumption for the Supply Shift scenario? If not, what is an appropriate load growth, Future 1 or 3? **(Load Growth)**

Resource planners and regulators:

6. **Future 4:** How do you plan to address supply limitations? **(Footprint Development, Load Growth, Generation Retirements)**
   - Are there specific technologies which should be considered? In what timeframe?
   - What adjustments to resource plans may be considered within the boundaries of existing requirements to maintain resource adequacy (e.g., delaying retirements, increasing use of demand response, etc.)?
   - Please describe any limiting factors and potentials plans under consideration.

Next steps will focus on reviewing data input assumptions for the Series 2 work; stakeholder workshops and opportunities for formal and informal input



Stakeholder Process

- Status updates provided at PAC and RASC meetings
- Anticipate monthly technical workshops
- Currently scheduled: March 19, April 14, May 15, June 26, July 25, August 29, September 24, October 29

Q1-Q2 Workshop Topics

- Assumptions Review
- Future 4: Supply Chain Constraint Review
- Siting Assumptions Review

Formal Feedback Requests

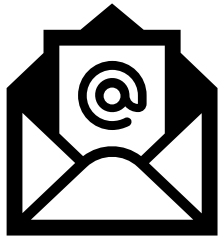
- Future Scenario Definition variables
- Siting

OMS Feedback Request

The Series 2 Futures redesign will utilize the Stakeholder Feedback Tool and team email for stakeholder communications

Stakeholder Feedback Tool*
(Click here)

Formal	• Used by MISO to seek targeted feedback from stakeholders
Informal	• Used by stakeholders to provide informal feedback of non-technical information: policy, process or other • Stakeholders can select feedback to be publicly posted or not posted



Data	• Used to provide MISO futures team members technical information only: e.g., modeling, analytical • Futures@misoenergy.org

* Stakeholder Feedback Tool: https://www.misoenergy.org/stakeholder-engagement/stakeholder-feedback

Stakeholder Feedback Request

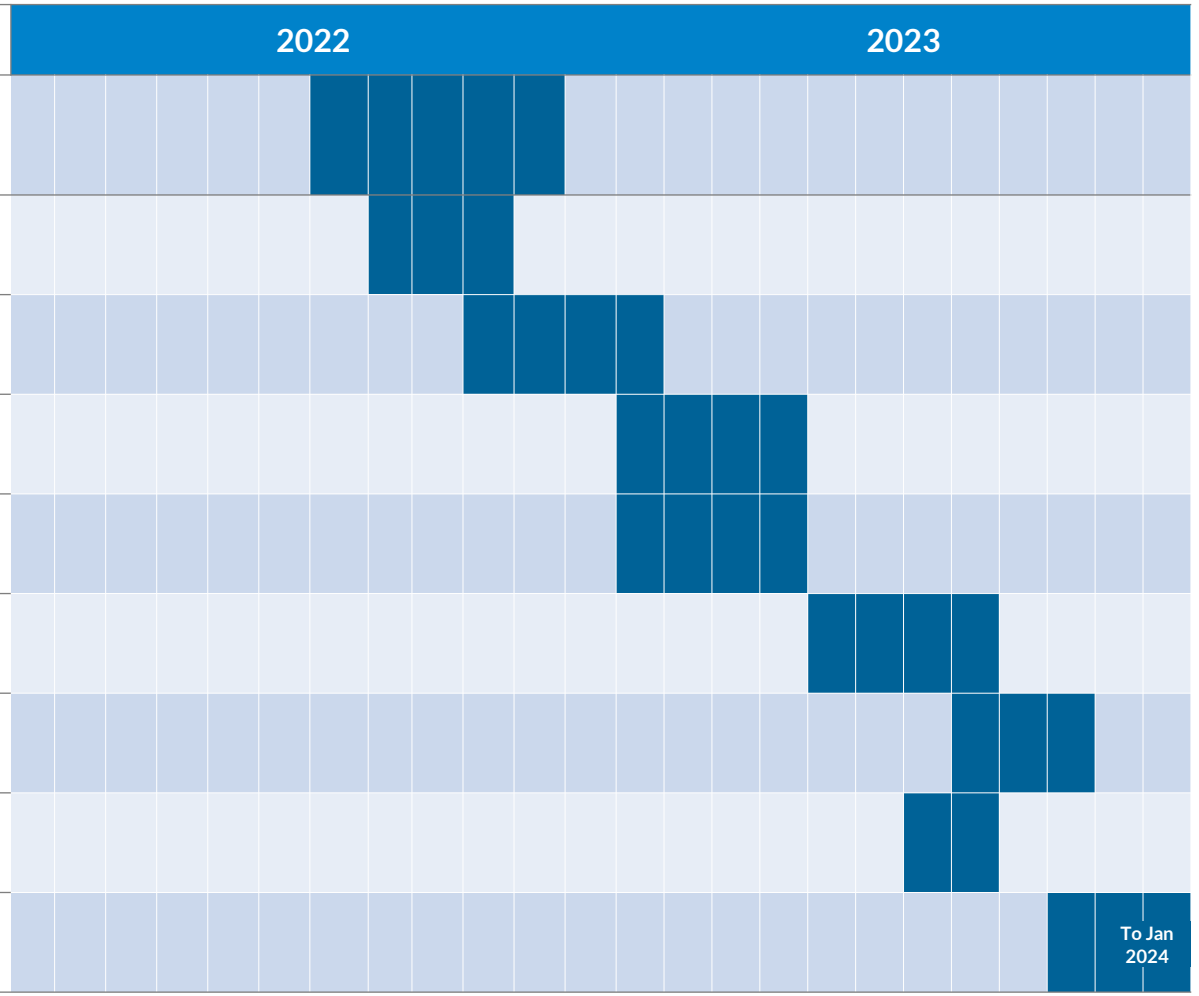
- MISO requests feedback on the content of slides 22-23 by March 14, 2025
- Feedback requests and responses are managed through the Feedback Tool on the MISO website: https://www.misoenergy.org/stakeholder-engagement/stakeholder-feedback/

Questions?

Appendix

To develop Series 1A Futures, MISO followed a rigorous, stakeholder-driven process to bridge the gap between what Members plan and the generation needed to get us to the future

Series 1A Futures Journey	
Incorporate policy impacts from Inflation Reduction Act and IL Climate and Equitable Clean Jobs Act. Update model data costs, technical parameters and reconcile with PROMOD/queue data.	
Refresh model data with updated member utility and state additions, retirements, and clean energy goals via survey responses and stakeholder outreach.	
Perform resource expansion for MISO, PJM, SPP, and TVAO to economically determine type, magnitude, and timing of new resources.	
Ensure all hours meet energy requirements in PROMOD and site resulting Flex capacity.	
Determine location to place each new resource in the transmission system. Incorporate stakeholder feedback (500+ revisions) and update Siting.	
Develop Future 2A PROMOD handoffs. Model and site Futures 1A and 3A for MISO, PJM, SPP, and TVAO; develop PROMOD handoffs.	
Write and publish Series 1A Futures Report; post Series 1A Retirements, Siting, and final Futures Assumptions Book.	
Develop and conduct screening analyses for High Gas & Battery and Low Renewable Accreditation expansions.	
Present initial screening analyses results. Conduct screening analyses for Flex, policy changes, and accreditation factors; present results.	



Stakeholder Workshop

Stakeholder Outreach

Series 2 Futures Redesign Stakeholder Workshops

	February	March	April	May	June	July	August	September	October	December
Process & Schedule, Survey Results, Scenario Definition	February 28, 2025									
Resource Review, Resource/Energy Adequacy Approach, Futures Data Assumptions		March 19, 2025								
Supply Chain Constraint Future 4 Deep Dive			April 14, 2025							
Siting Assumptions Review				May 15, 2025						
Preliminary Expansion & Results Review					June 26, 2025					
Supply Constraints Scenario (Future 4)						July 25, 2025				
Preliminary Siting Results							August 29, 2025			
Siting Response/Energy Adequacy & Resource Adequacy Results						September 24, 2025				
Final Futures (1-4)								October 29, 2025		
Futures Final Report Release									December 9, 2025	