CHAPTER 2: PORTFOLIO EVOLUTION

MISO manages the life cycle of an extensive and diverse fleet of resources that continues to experience a shift from conventional fossil fuel generation to advanced and carbon-free technologies. With the shift away from dispatchable generation close to load centers to remote variable energy resources, the transmission system no longer serves the same resources for which it was designed, and transmission upgrades are needed to enable integration of new resources.

In order to enable reliable and efficient effectuation of the resource portfolio evolution, MISO has to first understand and reflect on the past and identify future trends. This understanding is used to develop the spectrum of possibilities in the creation of MISO Futures. The trends and future reliability and efficiency impacts of resource evolution is the impetus behind what MISO coined the Reliability Imperative, a term that is used to describe the broad range of activities that are underway to anticipate and reliably adapt to the rapid changes that are and will be occurring. The Long Range Transmission Plan (LRTP) is one of the key activities that is part of the Reliability Imperative, and progress on that effort will continue to be reflected in future MTEP reports.

2.1 Historical Trends and Retirements

One aspect of the resource evolution that MISO assists its membership in managing is the retirement of generation facilities to ensure that the broader MISO footprint and markets remain reliable after resources are removed from service. Through the process articulated in Attachment Y of the MISO Tariff, resource owners submit a request to retire generation resources for MISO approval, which triggers an assessment into the impact that the requested resource would cause once it is retired from service. As a result of these analyses, any reliability issues are addressed through transmission reinforcements or other needed mitigation measures; and, if the reliability issue cannot be addressed prior to the planned retirement date, MISO may require the resource to remain in service as a system support resource (SSR) until the upgrade is complete, or mitigation is available. In recent years the need for system support resources has diminished and no generation resources are currently operating under a system support resource agreement.

Resource retirements of coal and gas-fired generation have seen a steady increase in the past several years as renewables have become economically and environmentally more attractive sources of energy. In the last 10 years MISO has experienced retirement of 24.9 GW of which 17.5 GW was coal based (Figure 2.1-1). The age of generating facilities retired in 2020 to date has declined to 46 years compared to 57 years in 2010 displaced largely by the interconnection of more economic renewable resources. Advancements in technology and interest in renewables are expected to continue the current trend.

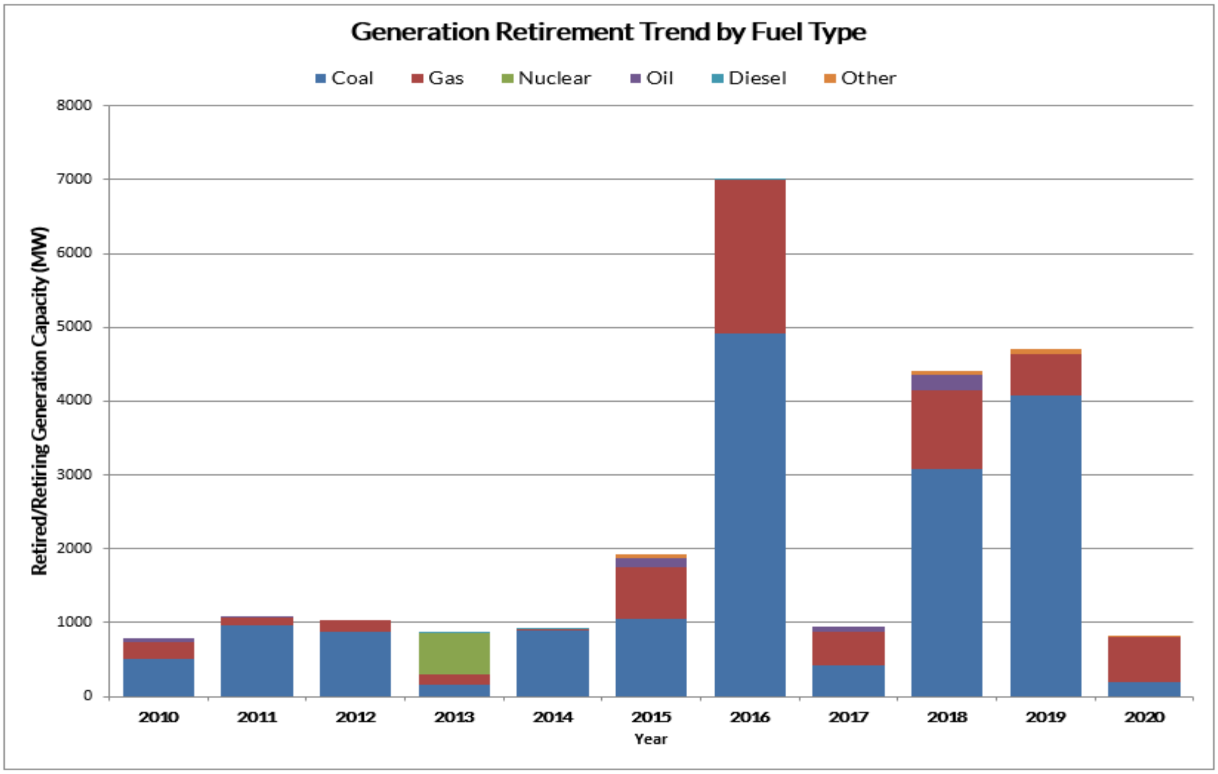

Figure 2.1-1: MW Generation Retirement by Fuel Type

2.2 Current State of Queue

The MISO generation interconnection (GI) queue provides an active and competitive mechanism to enable resource interconnections that will serve future energy and capacity needs. Projects submitted in the annual queue cycle are evaluated by MISO through an iterative study process to determine the reliability impacts and to identify transmission upgrades needed to support resource integration. Project viability is often tied to the costs of network upgrades with the most viable candidates successfully executing a Generation Interconnection Agreement (GIA).

The generation interconnection queue has experienced high volume over the last several years as a result of growing interest in renewable technology that has benefitted from declining costs of technology, favorable tax incentives and regulatory treatment. Wind has comprised a large portion of the interconnection queue volume in the last decade while solar resources have emerged more recently in part due to advances in solar technology and escalating regional transmission costs associated with integrating new wind development. As battery storage technology advances and interest continues to grow, MISO has seen an increase in number of the projects comprised of standalone storage or hybrid applications.

In 2020, MISO received 353 individual project requests representing a total of 52.5 GW of requested capacity during the application period that ended in June (Figure 2.2-1) marking a continuing trend of aggressive resource development. Solar installations have continued to trend upward, representing 69% of new entries and new wind development has shown a reversal of a downward trend from the prior year. Once the additional requests received in the latest queue cycle were validated, the total volume of active queued projects had reached 756 projects representing 113 GW.

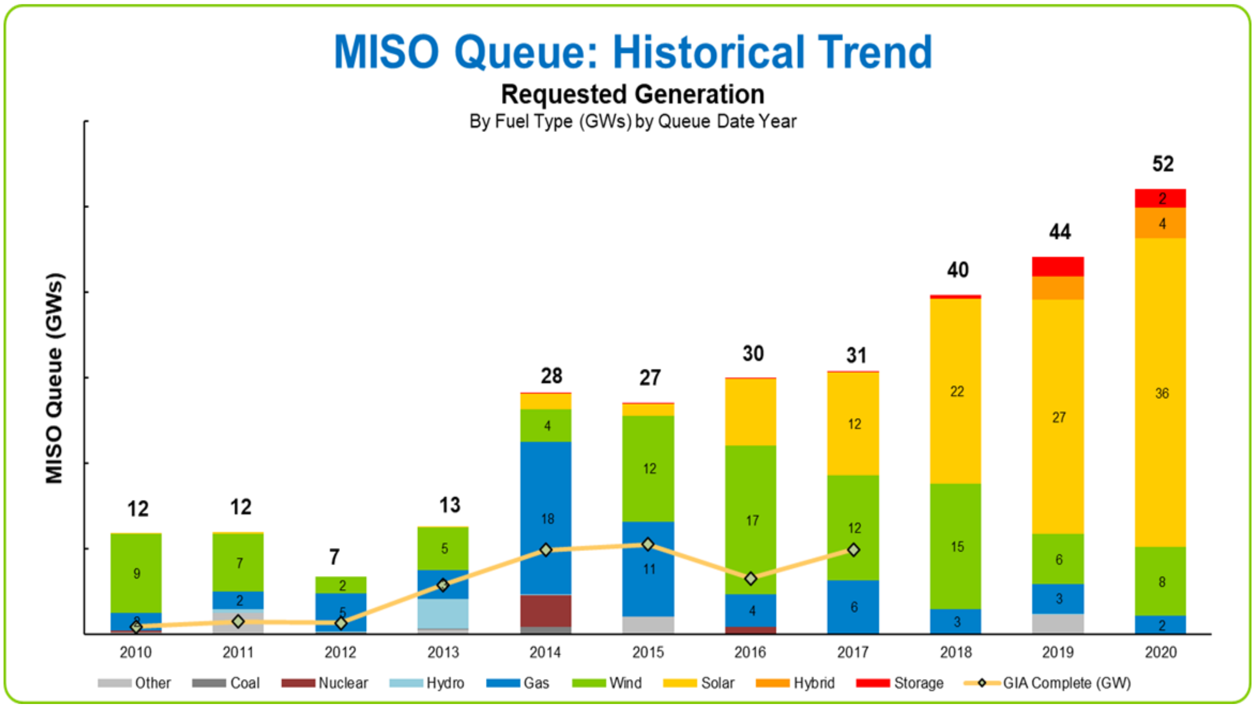

Figure 2.2-1 GI Queue by Fuel Type over the last ten years

As of September 21, the current state of the queue has 719 projects representing 108 GW of total capacity. The drop from our historic peak of 113 GW was mainly driven by the August decision point in the South Region where Interconnection Customers can withdraw from the queue before committing additional milestone payments. Renewables represent over 80% of the remaining capacity. The figure below is updated monthly on the MISO website under the GIQ Web Overview link on the Generator Interconnection Queue page. A list of all active projects can also be reviewed on the page. The five study regions in the GI queue currently have 13 active cycles in various stages of the process from the start of the DPP to GIA negotiations.

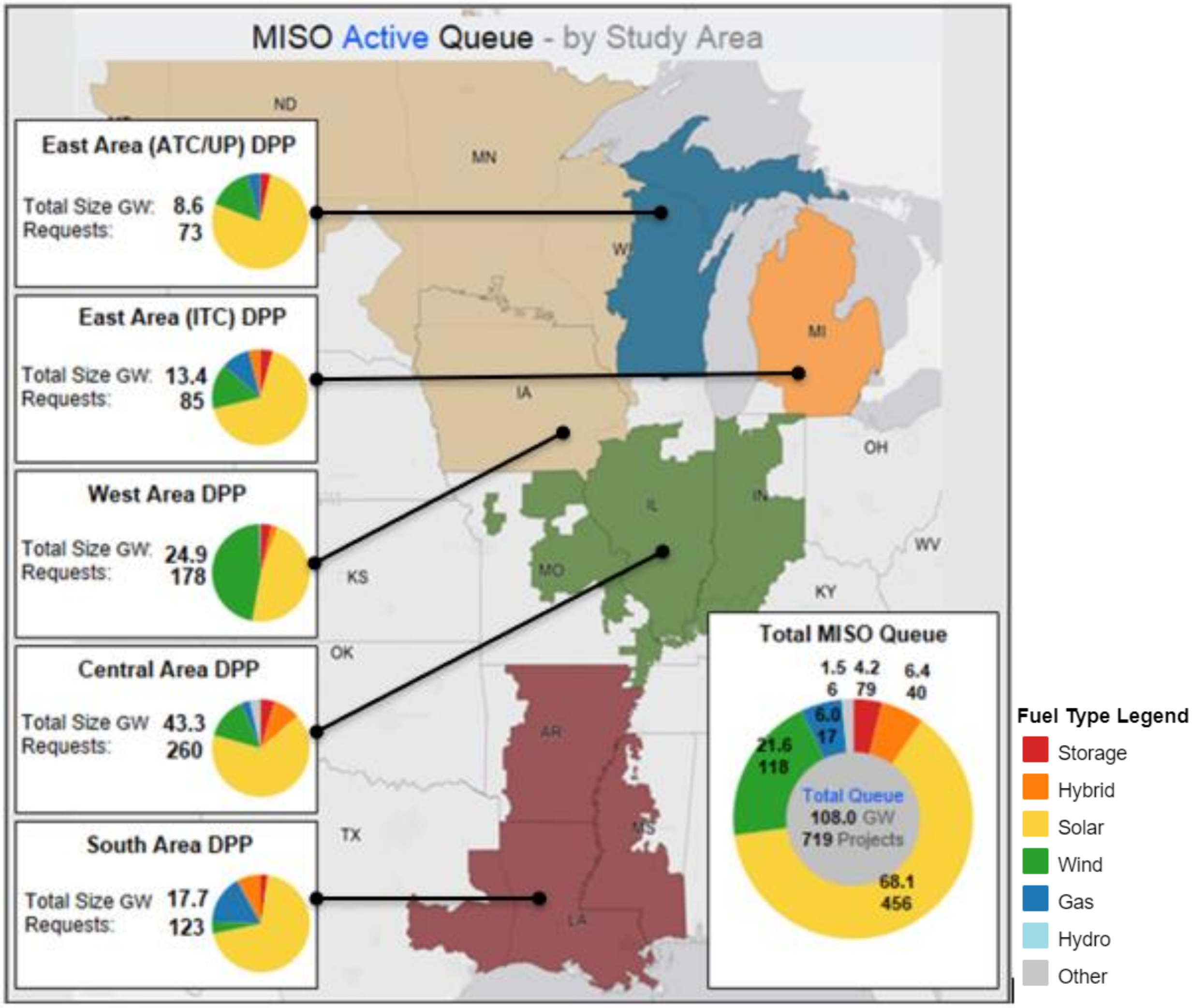

Figure 2.2-2: MISO Active Queue by Fuel Type as of 9-21-2020

2.3 The Cost of New Transmission to Integrate Generation is Changing and Impactful

In the past, the MISO Multi-Value Project (MVP) Portfolio facilitated new renewable resource development that delivered regional benefits by enabling access to lower cost energy. This broad regional approach to transmission planning recognized the benefits of a regional plan that would result in the most cost-effective transmission investment rather than an incremental build-out resulting from the generation interconnection process. Over the last decade, the continued interconnection of new resources has fully utilized the additional capacity provided by the MVPs resulting in the need for more network upgrades to support ongoing interconnection requests.

The continued growth of remotely located renewable resources has resulted in the need for major transmission upgrades with a significant increase in transmission costs incurred for resource interconnections. As the industry transitions away from traditional central station generation to more dispersed and variable energy resources, transmission investment will be needed to facilitate the change and support continued reliability. A comprehensive approach to system planning and resource interconnection recognizes broader benefits of transmission investment while facilitating resource evolution in a timely manner.

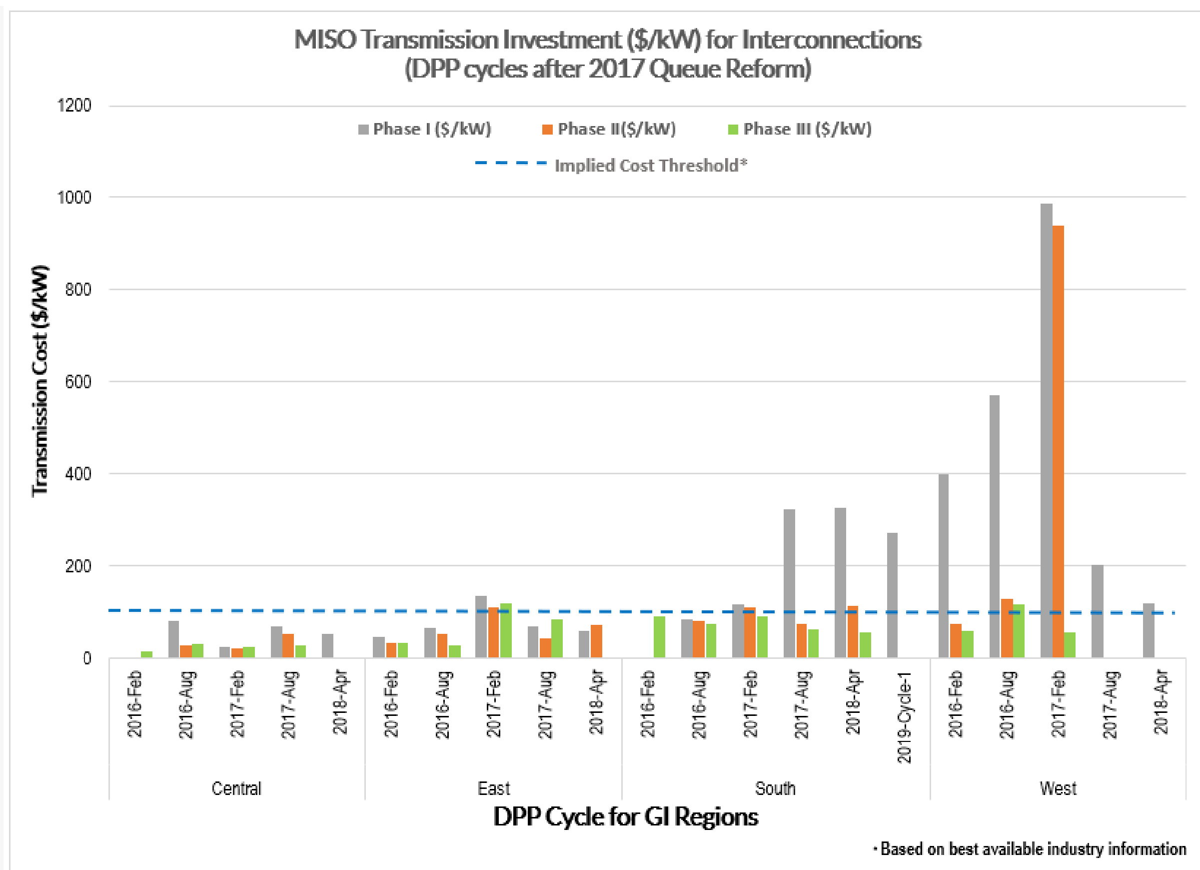

Figure 2.3-1: DPP Cycle Transmission Cost for each Planning Region

2.4 Current Generation Fleet Must Continue to be Deliverable to Load

MISO performs generator deliverability analysis as a part of the annual MTEP process to ensure continued deliverability of existing generating units with firm service, including Network Resource Interconnection Service. The generation deliverability analysis results in the identification of projects which mitigate transmission system constraints that restrict generation output below the established network resource amount. Results of the assessment are determined on an analysis of near-term (five-year) summer peak scenario.

Observed constraints that restrict generation beyond the established Network Resource amounts require mitigation.

A total of two projects, and a special protection scheme (SPS) were identified to alleviate identified congestion.

MTEP20 Constraints

In MTEP20, constraints are due to major construction efforts in the area. Two MTEP19 projects were identified to mitigate these constraints which restrict generation beyond the established network resource amount (Table 2.4-1). These projects, along with alternatives, were reviewed by stakeholders in the MTEP19 planning process and were approved for construction.

Overloaded Branch	Area	Mitigation MTEP19 ID	Notes
John Junction – Morris 115 kV circuit 1 Ortonville – John Junction 115 kV circuit 1	OTP	17006	Mitigated by an Appendix A project in MTEP19. MISO identified thermal overloads on the John Junction to Morris 115 kV circuit 1, and Ortonville to John Junction 115 kV circuit 1 during the MTEP19 Deliverability Analysis
Big Stone – Browns Valley 230 kV circuit 1	OTP	16965	Mitigated by an Appendix A project in MTEP19. MISO identified thermal overloads on the Big Stone to Browns Valley 230 kV circuit 1 during the MTEP19 Deliverability Analysis
Crossroads – Clarksdale 115 kV circuit 1	EMBA/CLECO	NA	Mitigated by Crossroads SPS which will trip one of the Crossroads units to provide relief

Table 2.4-1: Projects identified to alleviate MTEP20 constraints that limit deliverability of network resources

2.5 Planning for the Future

Due to the long lead time of constructing new transmission infrastructure (identification of project, design, regulatory approval, construction, and energization), effective transmission planning must occur nearly 10 years prior to a significant transmission need, in most cases. To address this, MISO has developed a process to prudently plan transmission over a 10 - to 20-year period that captures a wide array of potential resource fleet changes and conditions due to political, economic, technological, industrial, commercial, and consumer trends. This process utilizes multiple planning scenarios, or "Futures" to bookend the spectrum of potential changes before they happen.

MTEP20 Future Scenarios

The MTEP20 cycle included four Futures. These four Futures include only slight modifications from those developed in MTEP19. The minimal updates to the Futures for MTEP20 include updates reflecting interconnection queue activity, retirements, additions, as well as an updated unit/resource dataset from ASEA Brown Boveri (ABB), the Swiss-Swedish multinational corporation that maintains the PROMOD simulation tool and data.

The four MTEP20 Futures are:

- Limited Fleet Change (LFC)
- Continued Fleet Change (CFC)
- Accelerated Fleet Change (AFC)
- Distributed and Emerging Technologies (DET)

The goal of MTEP Futures is to bookend uncertainty by defining a wide range of potential plausible outcomes.

The Regional Resource Forecasting (RRF) process uses the assumptions defined within each Future to economically identify the least-cost portfolio of new supply-side and demand-side resources. Base data assumptions in the associated ABB PowerBase database are presented in Appendix E along with fuel forecasts, new unit construction costs, emissions constraints, retirement assumptions, renewable energy assumptions and regional demand and energy projections. The resulting resource additions and retirements from the MTEP19 regional resource forecasting process are shown in Figure 2.5-1.

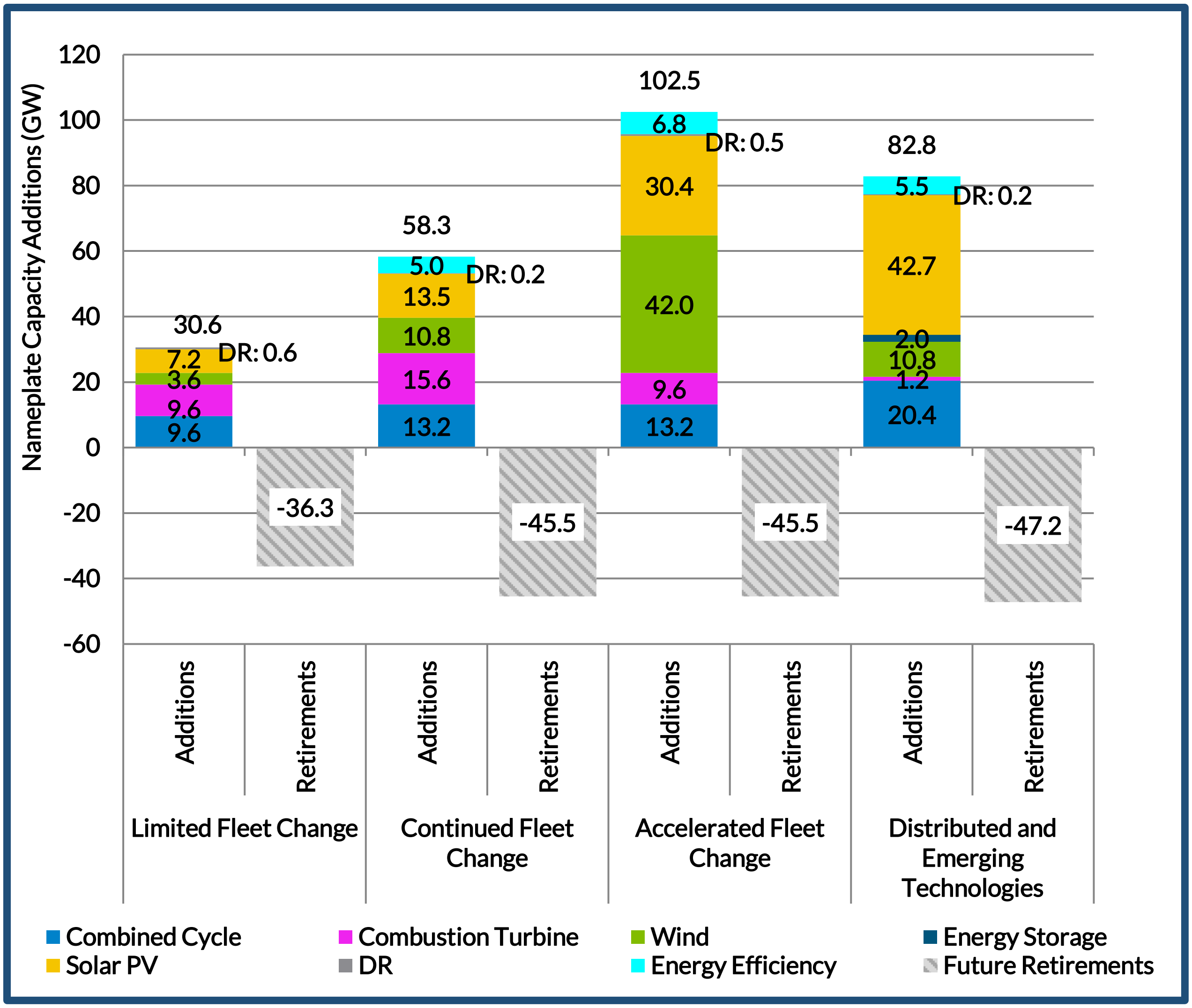

Figure 2.5-1: MTEP20 Futures- Resource additions and retirements by 2033

To produce the capacity mix in 2033 for each Future, the retirements and new resources identified from the regional resource forecasting process must be applied to the existing generation fleet (Figure 2.5-3).

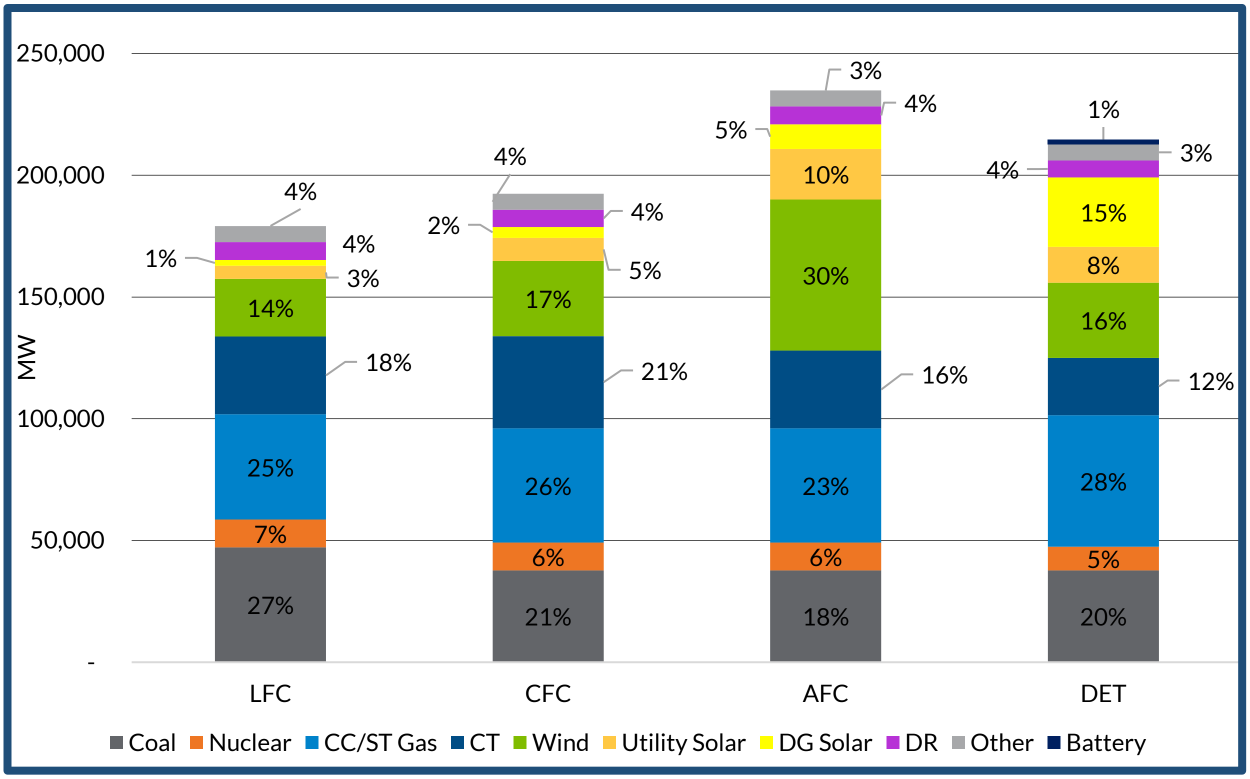

Figure 2.5-2: MTEP20 Futures-MISO 2033 Futures nameplate capacity mix by resource

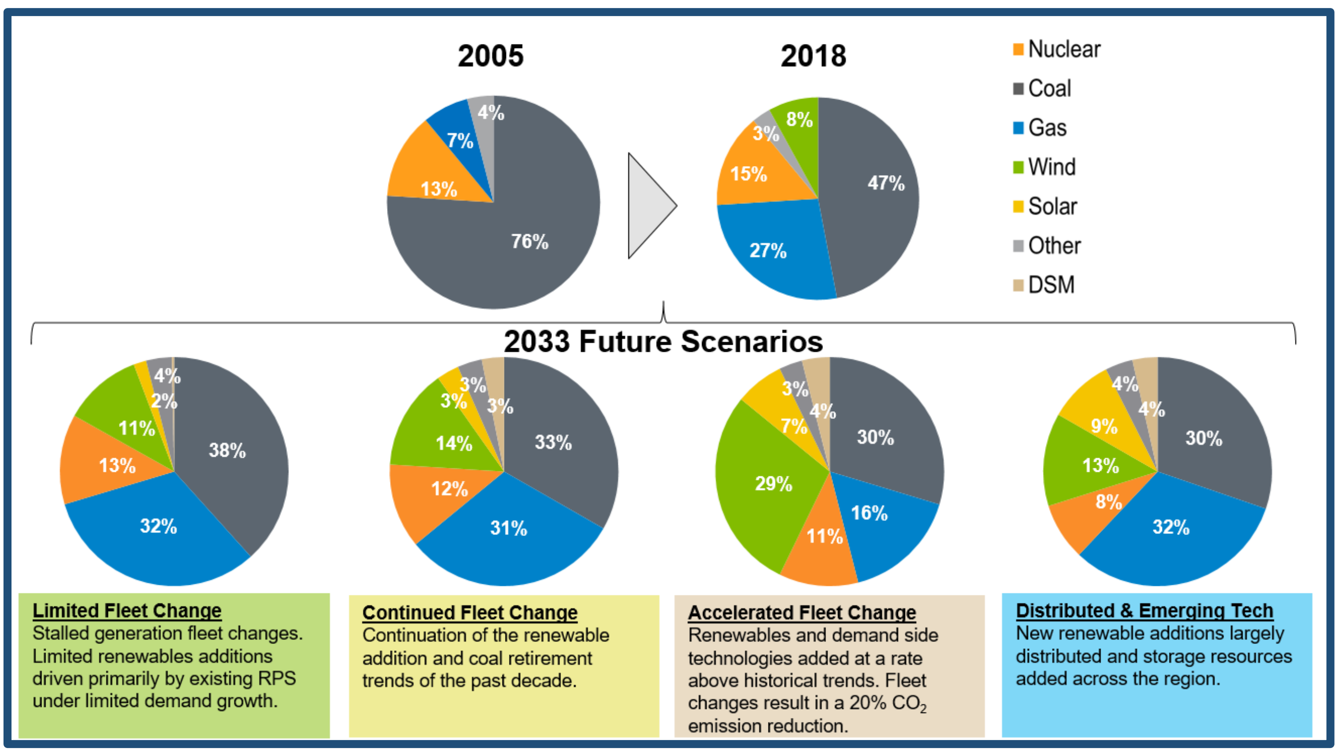

Figure 2.5-3: MTEP20 Futures - MISO 2033 Futures energy utilization mix

The results from the regional resource forecasting (RRF) process identify the type, size and installation date of new resources. However, they do not specify where these units should be located within the MISO footprint. Therefore, new resources identified in the regional resource forecasting process must be sited within the economic production cost model. The Futures siting process is based on stakeholder-agreed-upon rules and criteria detailed in section 4 of Appendix E (Figure 2.5-4).

Additional details regarding Futures development, resource forecasting, and siting processes are in Appendix E of this report.

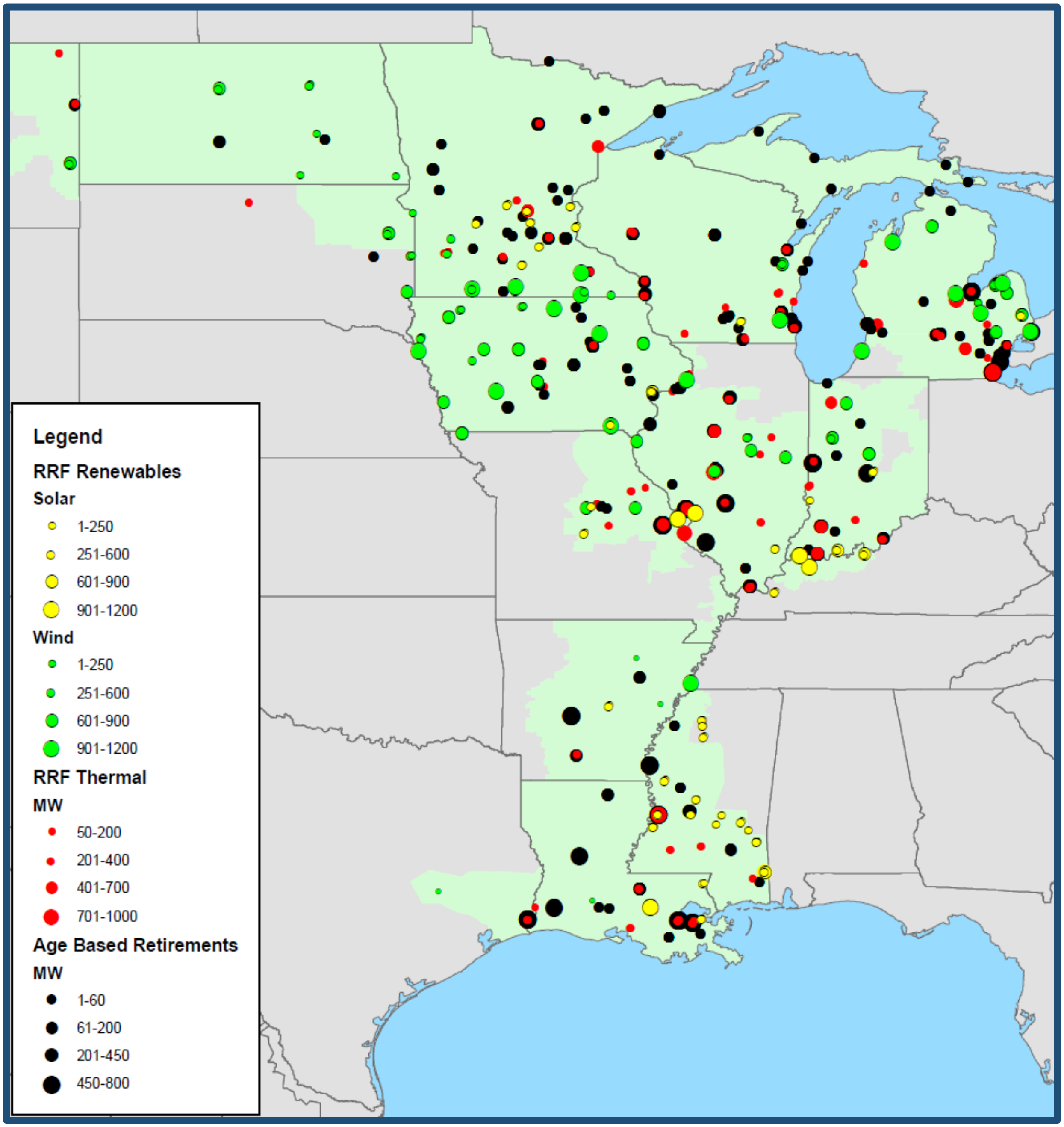

Figure 2.5-4: MTEP20 Futures -MISO Future supply-side resource siting results

2.6 Resource Outlook

The fleet has been steadily changing over the past 10-15 years. Initially this was due to forces such as state Renewable Portfolio Standards, environmental regulations, and fuel competition from historically low natural gas prices. This portfolio evolution continues now to greater levels of renewables and new levels of battery storage based on public interest and support for less reliance on fossil fuels, and historically low costs of renewables. As this change continues, focus on maintaining adequate resources is imperative and becoming increasingly difficult.

The MISO region will have adequate, but tighter, reserve margins for 2021, and continued action will be critical to ensure resource adequacy into the future. For 2021, MISO will have surplus resources to meet the regional resource requirement. In most of the MISO region, load-serving entities with oversight by the applicable state or local jurisdiction are responsible for resource adequacy. Though the 2021 peak demand forecast decreased 300 MWs from last year's survey, the five-year regional demand growth rate is up from 0.2 percent to just under 0.35 percent this year. On the supply side, the 2020 OMS-MISO Survey indicates that increasing resource adequacy risk can be avoided by firming up the commitments of additional potential resources.

The potential for significant generation fleet transformation has prompted MISO to evaluate how system needs will change and how MISO might adapt its planning, markets and operations to maintain reliability with aging and retiring units, higher penetration of intermittent resources, and new load consumption patterns. The MISO membership is rapidly transitioning the resource mix in the footprint.

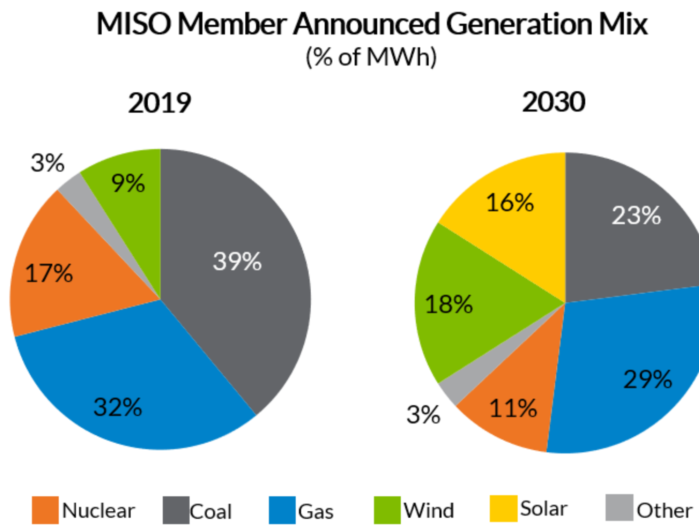

Figure 2.6-1: Member announced energy mix (as of September 2020)

Resource adequacy planning that focuses on summer peak alone will no longer suffice. Resource adequacy analysis will likely need to reflect patterns across the year in order to capture the magnitude of risks.

Effective dialogue amongst stakeholders will be key to this transformation – identifying needs and working with MISO to develop solutions that work across the footprint. MISO will leverage the forums where discussions are already underway on transmission planning, MISO's resource adequacy construct, and pricing enhancements.

The 2020 OMS-MISO survey indicates that the MISO region will have adequate, but tighter, reserve margins for 2021, and that continued action will be needed to ensure resource adequacy in the extended outlook.

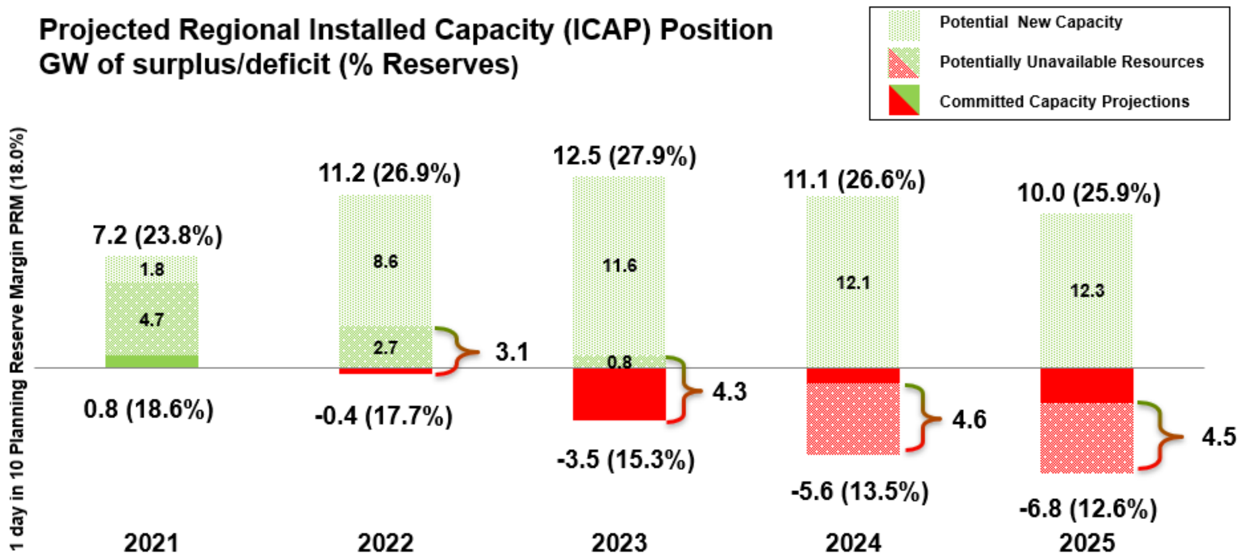

Figure 2.6-2: 2020 OMS-MISO Survey 5-year Results

This year's OMS-MISO survey shows MISO will have 0.8 gigawatts of surplus committed resources beyond the regional requirement, representing a reserve margin of 18.6%. If all potential resources materialize in 2021, there could be as much as 7.2 gigawatts of surplus generation resources, which would result in a reserve margin of 23.8%.

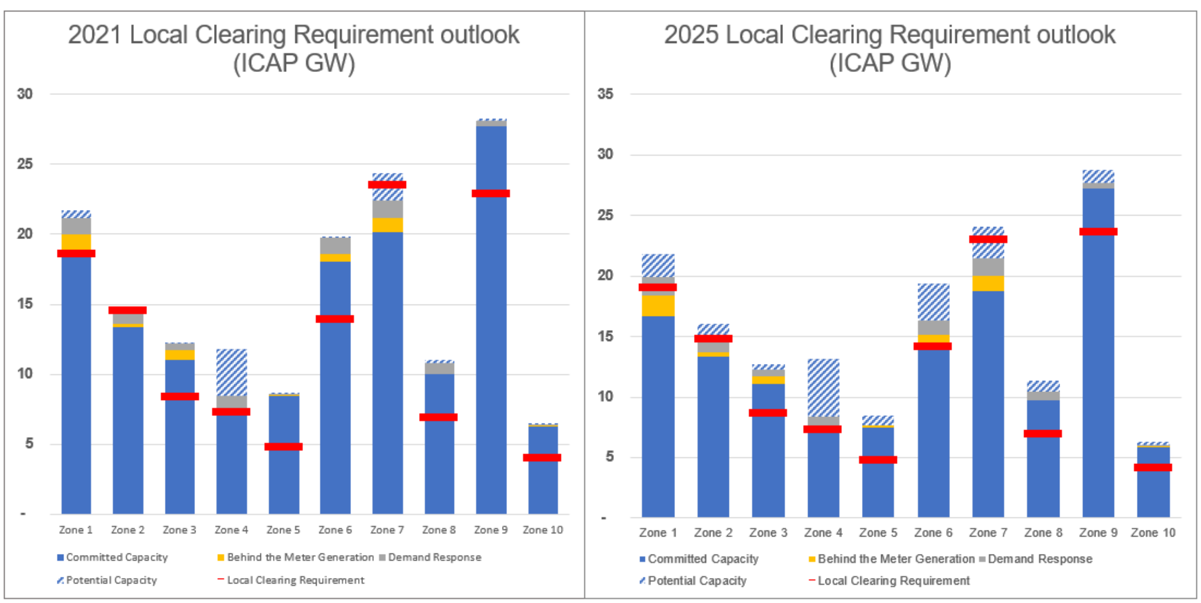

Figure 2.6-3: Potential new generation and retirements, within each zone

Compared to last year, these committed resource reserve margins are lower for both the first year and the full five-year period of the survey, which translates into increased reliance on less certain resources to ensure resource adequacy going forward.

The OMS-MISO Survey shows fleet changes in the next 5-10 years shifting heavily toward renewables. As queue additions are not submitted much beyond 2025, the impacts observed are due more to unit retirement decisions. The increase in battery and hybrid units from zero percent today to two and three percent respectively by 2025 indicates a changing dynamic in the MISO generation fleet. One emphasizing more flexibility and energy-shifting versus traditional fossil-based resources.

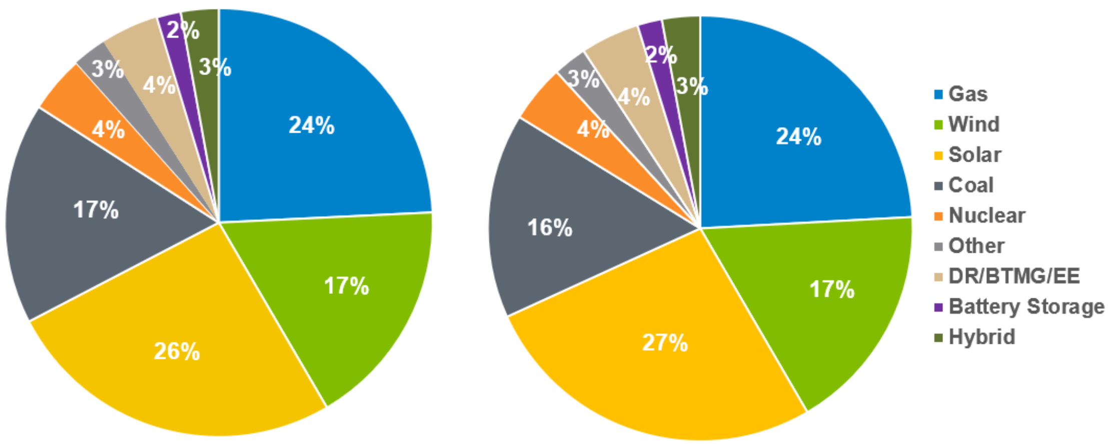

Figure 2.6-4: 2025 and 2030 OMS-MISO Survey Fleet Mix by Nameplate MW

2.7 Continued Future Scenario Development

Looking ahead as it began the MTEP20 cycle, MISO saw increasing momentum in fleet development and many stakeholders noted how new generation could outpace the Futures bookends within the planning horizon. With the accelerated pace of fleet change in mind, MISO initiated conversations to redevelop the Futures with stakeholders in 2019 with the goal of developing a new set of MISO Futures by the end of 2020. These new Futures will bookend a wider range of possibilities and seek to further embed the plans that MISO's members are developing for themselves. The new Futures compounded annual growth rate assumptions and scenario definitions are represented in Figure 2.7-1.

Future 1	Future 2	Future 3
• The footprint develops in line with 100% of utility IRPs and 85% of utility announcements, state mandates, goals, or preferences. • Emissions decline as an outcome of utility plans.	• Companies/states meet their goals, mandates and announcements. • Changing federal and state policies support footprint-wide carbon emissions reduction of 60% by 2040.	• Changing federal and state policies support footprint-wide carbon emissions reduction of 80% by 2040.

Figure 2.7-1: New Futures CAGR assumptions and descriptions.

In Future 1, the MISO footprint evolves as members' plans are substantially met, carbon emissions decline 40% from 2005 levels, and current trends of electric vehicle adoption persist.

In Future 2, members' plans are met or exceeded, carbon emissions decline 60%, and energy increases over the 20-year study period driven by electrification, including increasing adoption of electric vehicles.

Future 3, members' plans are met or exceeded, carbon emissions decline 80%, energy increases over the 20-year study period driven by electrification, and renewable penetration levels reach a minimum of 50%.

These three Futures allow MISO to further study some of the insights identified in the MISO Forward documents such as the impacts of decentralization and demarginalization; they also support MISO's vision "to be the most reliable, value-creating RTO.

2.8 Long Range Transmission Planning

MISO has the responsibility and perspective to provide for the enablement of transmission needs determined by the long-range expectations of load and the evolution of the resource portfolio. Transmission system needs and requirements have been and will continue to be driven by Federal and State policy, economics for the MISO region and sub-regions, and driven by the future plans of industry and utilities.

Long Range Transmission Planning (LRTP) takes a long-term view of system development to ensure the values of more near-term solutions are robust in the long-term under a range of Futures, and account for 20- to 40-year benefits.

LRTP is a cornerstone for future operations, but the foundation has many pieces that must work well together:

- Long term resource adequacy that respects the Resource Availability and Need (RAN) program aligning resource availability and need with the changing reliability requirements due to resource evolution;
- Activity in the Interconnection Queue that offers a short- and long-term view of possible future resource siting and identification of sub regional, regional, and interregional transmission limits;
- Interregional reliability and economic planning with MISO neighbors and other entities in the Eastern Interconnect. While MISO's first priority is our members and our footprint it is essential to work together with bordering systems to best develop a nationwide system that supports and works reliably and efficiently together.

LRTP will ensure an optimized regional and interregional system for the changing portfolio across short- and long-term horizons. Regional planning must ensure the system is planned to be reliable, secure, resilient, and efficient over the entire planning horizon; address differences across the MISO region, and holistically incorporate reliability and economic planning with future resource needs/expectations.

The MTEP21 LRTP initiative will build off of the MTEP20 targeted and interregional analyses discussed in Chapter 3 of this report and other identified near term issues developed with stakeholders. LRTP work under MTEP21 will begin identifying the transmission solutions needed to enable the new MISO Futures starting with Future 1 in the MTEP21 transmission planning cycle. Future 1 and MTEP21 will lay the groundwork for continuing efforts with Futures 2 and 3 in MTEP 22 and beyond.

LRTP will seek to establish a transmission road map for the long-term horizon that will be the foundation to drive future investment decisions. Once complete, the LRTP transmission road map will be periodically reviewed and updated over time with select transmission projects pulled into Appendix A as business cases for those projects become robust for impending needs. Some transmission projects may be identified for Appendix A as early as MTEP21.