Highlights

• The generation interconnection queue continues to provide a steady pipeline of new projects seeking interconnection to enable ongoing fleet evolution

• Significant transmission investment will be needed to support continued integration of remotely located resources

• Coordinated system planning promotes timely and cost-effective resource integration to serve future energy and capacity needs
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Executive Summary

This report is a compilation of data from MTEP Futures analysis and Generation Interconnection Queue information which examines future resource expansion and ongoing trends in resource interconnections. It is intended to provide an informative look at projected queue activity and the related challenges that exist in system planning.

The MISO 2020 Interconnection Queue Outlook provides insight into future resource integration challenges

In light of dramatic changes in the projected resource mix, MISO’s strategic vision is focused on the three key trends that influence this transformation: de-marginalization, decentralization and digitization. The MISO Resource Availability and Need (RAN) program was established to address the operational and planning impacts of these trends and to identify solutions that enhance the availability, flexibility and visibility of resources to serve system needs. To gain further understanding of the resource transition, MISO examines trends in new resource development to produce a forecast of future queue activity. The Interconnection Queue Outlook is a projection of future volume and composition of interconnection queue activity derived from a range of outcomes in the MTEP Futures scenarios and reflects the emerging trends in technology and the impact of distributed resources. While the forecast of queue activity helps shed light on the relationship between transmission costs and resource integration, the amount of actual interconnection queue capacity that secures interconnection service will ultimately determine the transmission investment needs. The Interconnection Queue Outlook does not represent how Market Participants are planning to meet their Resource Adequacy obligations but gives an indication of how resource development will take shape to serve those needs. Market Participants provide a snapshot in time of their five-year plans as part of the OMS MISO survey. In effect, the OMS MISO survey snapshot provides a “true up” of the Queue Outlook.

The trends in generation interconnection queue activity indicate robust interest in development of new interconnection projects that will adequately support future resource needs. Spurred by the declining cost of renewable technologies, tax incentives and favorable industry policy, wind resources comprised a large portion of the interconnection queue volume over the last decade while solar resources have emerged more recently. The continued growth of these remotely located renewable resources has consumed much of the available transmission capacity resulting in the need for significant transmission upgrades to support further growth. An integrated system planning approach for transmission investment and resource interconnection recognizes broader benefits of transmission investment while facilitating resource evolution in a timely manner.
Historical Trends in Resource Retirements

The MISO resource fleet continues to experience a shift from predominately coal-fired generation to renewable and gas-fired technologies as a result of customer preference, regulatory policy and economic drivers (Figure 1). The increase in demand-based resources and recent developments in technology and environmental policy have converged to stimulate interest in distributed energy resources as potential market resources. As solar and wind resources continue to become operational and comprise a growing portion of the resource mix, their variable nature combined with increased uncertainty of demand-side resources will require additional transmission investments to address reliability issues caused by shifting flow patterns across the system.

![Figure 1 - Changing resource mix due to increased renewables and greater use of demand response and external resources](image-url)

**Figure 1 - Changing resource mix due to increased renewables and greater use of demand response and external resources**
The retirement of conventional generation resources has historically been driven by age and economics with new capacity additions coming from gas and renewable resources. In recent years the marked increase in resource retirements has been driven largely by increased environmental regulations, low natural gas prices, and growing interest in renewable energy.

The capacity of coal and gas-fired generation continues to decline year over year (Figure 2).

**Figure 2 - Cumulative historical retirements**
Trends in New Resource Interconnections

Wind resource development has historically maintained steady growth, but a significant expansion in renewables will occur in the next few years as new resources enter commercial operation. While past queue cycles have delivered a substantial amount of wind resources, the emerging growth in solar appears to be the trend for the near future. Furthermore, non-traditional resources, such as Load Modifying Resources, will continue to be a growing component of the resource mix.

![New Resource Interconnections](image)

New gas resource development remains steady while renewable generation resources make up a growing share of the projects that become operational (Figure 3).

![Non-Traditional Resources](image)

Non-Traditional Resources including External Resources and Load Modifying Resources (LMR) are increasingly being used for capacity obligations (Figure 4).
Forecasted Resource Expansion

Future queue activity forecasts are based on the MTEP Futures assessment

The MTEP Futures reflect a range of detailed scenarios of the future resource mix needed to meet energy and demand requirements under varying assumptions that include economic and policy impacts. The forecasted expansion influences generation interconnection queue cycle activity and indicates expected volume. The growth in interest in solar and storage technology revealed in recent queue cycles is reflected in the current queue forecast. Table 1 shows the future capacity additions from the MTEP20 Futures assessment for the Distributed and Emerging Technology scenario which provides the basis for the current queue forecast. This future is characterized by increased solar, growing interest in battery storage and slightly higher growth in demand and energy as electric vehicle adoption occurs with development of gas-fired resources expected in later years. As details emerge from the next cycle of Futures development, adjustments to the forecasted resource expansion will reflect the assumptions in the company announced plans scenario.

Table 1 – MTEP20 Futures - Distributed and Emerging Technology (MISO Capacity Additions - GW)

<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
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<th>2024</th>
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<td>2.4</td>
<td>3.6</td>
<td>1.2</td>
</tr>
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<td>6</td>
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<td>3.7</td>
<td>6.1</td>
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The MTEP Futures reflect a range of detailed scenarios of the future resource mix
Generation interconnection queue projections are developed using MTEP20 Futures to identify the long-term resource requirements.

The baseline expansion represents the MTEP20 Distributed and Emerging Technology Future yearly capacity additions to meet the long-term resource requirements and reflects current industry trends (Figure 5). The range encompasses the other MTEP20 Futures scenarios.

The baseline expansion represents the yearly capacity additions and reflects current industry trends.
Forecasted Queue Volume

The queue forecast is a five-year moving average that reflects a multi-year project development effort and the progression of the most recent queue cycle. Since the queue forecast is developed from the MTEP Futures, a range of uncertainty is included to reflect the broader set of outcomes that result from the differing assumptions contained in the various scenarios in the MTEP Futures Assessment.

Table 2 – MTEP20 Forecasted Queue Volume (GW)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Gas</td>
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<tr>
<td>Storage</td>
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<td>0.4</td>
<td>0.6</td>
<td>0.4</td>
<td>0.5</td>
<td>0.7</td>
<td>0.9</td>
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<td>1.5</td>
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</tr>
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</table>

A multi-year rolling average of the estimated annual queue capacity is used to account for the extended development cycle of interconnection projects.

The resulting forecast volume is distributed over the years leading up to the year of need (Figure 6).

The range of uncertainty is determined by the different outcomes that result from the various MTEP20 Futures.

Figure 6 - Forecasted Queue Volume
Transmission Investment

Over the last several years, the Multi-Value Project (MVP) portfolio has delivered regional benefits by enabling access to lower cost energy.

In the past, regional transmission expansion planning studies identified transmission investments that provide broad benefits of lower cost energy to the MISO market. The Multi-Value Project (MVP) Portfolio provided the transmission expansion needed to integrate large amounts of renewable resources while allowing states to meet their renewable energy goals. 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. MVP investments focused on the large-scale regional power delivery needs while allowing local upgrades to be identified the generation interconnection process. Over time, the additional transmission capacity provided by the MVP portfolio has been utilized by newly installed generation resources, and current interconnection queue studies have shown an increase in MISO network upgrade costs (excluding Affected Systems upgrades) in some sub-regions (Figure 7).

Figure 7 - Trend in cost of transmission upgrades required for interconnection queue projects
In some sub-regions, significant transmission investments will be needed to support continued reliability as growth of renewables significantly alter the resource mix. Recent interconnection studies for new generation resources in MISO’s West sub-region have indicated the need for network upgrades exceeding $3 billion to accommodate the initial queue volume, and a similar trend is expected to occur in other areas with high wind and solar potential, including MISO’s Central and South sub-regions.

The traditional approach to interconnection planning may not fully consider the interdependency between resource interconnection needs and transmission expansion. With project success closely tied to the cost of transmission reinforcements, coordinated planning efforts help ensure that transmission investment enables the development of adequate resources to support future needs. The transformational changes observed in the future queue will bring more uncertainty to the planning process and require robust planning practices that can quickly respond to the needs of the industry. A comprehensive approach for long range transmission planning and generation interconnection planning provides the best opportunity for successful system planning by recognizing the broader benefits of transmission reinforcements and enabling integration of new resources to support specific policies and goals of stakeholders in the different sub-regions.
Summary

Queue forecasting presents a broad view of the changing resource picture and provides an opportunity to prepare for the impacts of the incoming activity.

MISO generation interconnection queue forecasts are determined by the expansion scenarios identified in the MTEP Futures Assessment. While future needs and trends in past queue cycles serve as the basis for the forecast, other external factors such as tax incentives and financing arrangements often influence the outcome of the individual interconnection projects. Further refinements in queue forecasting continue to explore the changes in assumptions in MTEP Futures development and other industry data sources to better reflect the impacts from these other factors on project success. Coordinated system planning recognizes the interdependency of generation interconnection and transmission expansion and enables the timely integration of new resources. A holistic approach promotes the most cost-effective transmission investments to serve the needs of diverse stakeholder interests and produces more predictable outcomes for both resource planning and long-term transmission planning.