



MISO'S RESPONSE TO THE RELIABILITY IMPERATIVE

- D E C E M B E R 2 0 2 0 -

Living Document

MISO is releasing this report as a “living” document which will be updated over time as conditions evolve and as MISO, stakeholders, and states continue to learn about the Reliability Imperative



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A Message from John Bear, CEO

The electric industry is changing in profound ways.

The industry's longtime reliance on conventional baseload power plants is declining sharply, driven by economic factors and consumer preferences for clean energy, among other things.

Meanwhile, the grid is becoming increasingly reliant on wind and solar resources that are available only when the wind is blowing, or the sun is shining.



To be sure, there are upsides and opportunities associated with these trends. But the changes we are seeing also pose a host of complex and urgent challenges to electric system reliability in the MISO region.

Utilities, states, and MISO all have roles to play to address these challenges. MISO calls this shared responsibility the **Reliability Imperative**. We think the word “imperative” is appropriate for several reasons. First, the work we are doing is not optional—to maintain system reliability, we must respond to the unprecedented change we and our members face. Second, this work cannot be put off for months or years—much of it has long lead times, so we need to act now. And third, our stakeholders are counting on us—regulatory agencies, utilities and other entities are looking to MISO to identify problems and find solutions.

This report describes the many interconnected efforts that MISO is pursuing in the realms of markets, operations, and planning to meet that charge. The report is also designed to be “living” so it will be regularly updated and expanded as we learn more and our path forward becomes clearer.

The energy industry and our region are changing in big ways, and MISO is planning for what lies ahead. We hope you will find this report to be engaging and useful as we confront these new challenges and opportunities together.

Thank you,

A handwritten signature in black ink, appearing to read 'JBear'.



Executive Summary

THE REGION IS CHANGING IN BIG WAYS

The electric system is increasingly fueled by wind and solar, driven by favorable economics for energy production, technological advances, state policies, and consumer preferences for carbon-free energy, among other things.

Looking at the marginal cost of energy produced, wind and solar are lower cost than coal, nuclear, or natural gas generation. As a result, the growth of these renewable resources continues to replace the region's conventional baseload resources that constituted the backbone of the region's electric system for decades.

There are many system and societal benefits of these changes. Innovative generation and grid technologies have the potential to reduce customer rates and bring efficiencies to the system. The shift to cleaner fuels will benefit the health of our communities and is key to addressing the risks of a changing climate. With a diverse regional footprint and managing all of the connections with our seams neighbors, MISO is well-positioned to support our members as they transition their fleets.

THESE CHANGES WILL CHALLENGE SYSTEM RELIABILITY

While MISO is policy-neutral on these and other trends, MISO has observed they pose a number of significant challenges for the region's electric system and we must adapt to maintain required and expected levels of reliability. As the independent system operator, MISO has responsibility to maintain electric reliability, which it does by addressing the holistic needs of the system – for example for energy, capacity, resource adequacy, and flexibility.

Each resource type provides a different mix of these capabilities. As the region's resource mix changes, we must understand what capabilities are needed to maintain reliability and ensure that sufficient amounts of those resource capabilities are available when needed.

- Wind and solar resources are not always available to provide energy during times of need.
- Conventional baseload resources that remain in service can be more prone to outages given their changed usage patterns and maintenance cycles, rendering them potentially unavailable when they are needed most.

As the system relies more on renewables, the region is also becoming more dependent on resources connected to local distribution systems or located behind customer meters, as well as



on demand-side resources that currently are only used in emergencies. Generation fleet change and extreme weather are increasing risk across the entire year (not just in the summer). MISO's Renewable Integration Impact Assessment concludes that the complexity of planning and operating the grid increases exponentially beyond 30% of the load being served by wind and solar, requiring more coordination and advanced action to maintain grid stability at higher renewable penetration levels. Already there are areas within the MISO system where local renewable penetration is above 30%.

WE HAVE A RELIABILITY IMPERATIVE TO ADDRESS THESE CHALLENGES

MISO, members, state regulators, and other entities responsible for system reliability all have an obligation to work together to address these challenges. MISO calls this shared responsibility the MISO Region Reliability Imperative because the reliability-enhancing work it requires cannot be delayed. This work will also enable utilities and states in the MISO region to invest in the type of infrastructure that is needed to meet energy needs and policy objectives going forward.

This report lays out MISO's response to the Reliability Imperative. MISO's response is holistic in approach, consisting of numerous efforts and initiatives that are designed to work in concert with each other to mitigate the challenges facing the region. MISO organizes this work into four main categories: (1) Market Redefinition, (2) Long Range Transmission Planning, (3) Operations of the Future, and (4) Market System Enhancements. Below is a brief look at each.

- 1. Market Redefinition:** The initiatives in this category aim to ensure that resources with the types of capabilities and attributes the system needs will be available in all 8,760 hours of the year. This is important because as noted above, the region is increasingly facing reliability risks outside of the summer peak-load months that historically posed the greatest challenges. Specific efforts in this area include providing a longer-term and deeper assessment of system needs across all hours of the year, including required capabilities such as flexibility; shifting to verifying sufficient generation adequacy across all hours of the year; improving how resources are accredited; ensuring that prices accurately reflect market conditions, especially during emergencies; and development of market products that provide the right incentives for resources to maintain system reliability.
- 2. Long Range Transmission Planning:** This effort is designed to identify what transmission the region will need going forward as the electric industry continues to evolve. For example, building additional transmission is especially crucial to support the continued growth of large-scale wind and solar, since those resources are often located far from load centers. A robust transmission plan can also reduce the cost of electricity for consumers by signaling better locations for resource siting that deliver fuel cost savings, decarbonization, and flexibility.



3. Operations of the Future: This effort is designed to ensure that MISO will have the kinds of skills, processes, and technologies it will need to effectively manage both wholesale and retail connected resources. For example, this initiative will leverage artificial intelligence, machine learning and advanced analytics among other tools to help future MISO control-room operators effectively forecast, visualize, and manage grid uncertainty. It will also help MISO to better manage maintenance and “pre-position” the grid ahead of system changes such as weather.

4. Market System Enhancements: This category of work is designed to transform MISO’s historical system—which was built in the early 2000’s—into a more flexible and secure system that will meet the needs for years to come. Current systems and technology are not capable of accommodating the increasing demands for new, reliability-driven market enhancements and fully leveraging the opportunities of new resource types such as storage and residential generation options (like rooftop solar) to meet future challenges. This initiative will employ flexible architecture and analysis to support the evolving resource mix and future-state processes for operating MISO markets.

PURPOSE OF THIS REPORT

The purpose of this report is to provide MISO stakeholders with an organization-wide view of MISO’s plan to address the Reliability Imperative amidst a rapidly changing energy landscape. The goal of this “living” report is to lay out the context for critical Reliability Imperative initiatives, how they fit together, feedback plans and project timing. This “living” report will be updated with accompanying materials as specific plans mature and additional information is gathered.

While grid operators have managed uncertainty for decades, and MISO has continuously pushed to improve and evolve since day one, we are preparing for an unprecedented pace of change. By actively pursuing this strategic collection of coordinated initiatives, MISO will ensure ongoing system reliability while enabling members’ future plans. There is a huge amount of work to do and we will only succeed if we move forward transparently, collaboratively and swiftly.

STAKEHOLDER INPUT IS CRUCIAL

Much of the work cited in this report is already underway. Many of the ideas and proposals in this report reflect a great deal of technical input from stakeholders. For example:



- MISO proposals to assess resource adequacy more than once a year and to improve how resources are accounted for are discussed at the [MISO Resource Adequacy Subcommittee](#).
- Similarly, MISO initiatives for emergency pricing and the Market System Enhancement effort reflect input at the [MISO Market Subcommittee](#).
- Member plans and stakeholder input shaped the MISO Futures planning scenarios over [multiple workshops](#).

Other proposals in this report are not in the stakeholder process because they are in development and not yet ready to be discussed with stakeholders or they are focused on internal MISO processes.

THE RELIABILITY IMPERATIVE DOES NOT REPLACE EXISTING INITIATIVES OR PROGRAMS

This report, and the initiatives it describes, should not be viewed as a brand-new effort by MISO. The Reliability Imperative is not intended to replace existing initiatives that stakeholders are already familiar with. Instead, this report brings together a number of strategic initiatives with the purpose of ensuring more alignment and highlighting the connections.

That said, this report is written from MISO's perspective. Not every proposal and initiative in this report will be supported by every one of MISO's stakeholders, given the range of policy goals, business models, and other interests. MISO welcomes feedback on this report but MISO also recognizes that the Reliability Imperative warrants an immediate response. The time to act is now.



Informing MISO's Response to the Reliability Imperative

MISO's response to the Reliability Imperative has been informed by years of conversations with our stakeholders. Additionally, MISO has performed extensive modeling of the changing risk profile. To review:

MISO Forward 2019: The first of the Forward series described the implications of a changing resource mix, including how the '3Ds' – de-marginalization, decentralization, and digitalization – led to MISO's focus on enhancing Availability, Flexibility and Visibility ("AFV"). You will find these themes in the Reliability Imperative initiatives. These AFV themes have informed much of the following MISO work.



MISO Forward 2020: The MISO Forward 2020 report shows that changes will not be the same across all members, as different states and utilities adopt a range of business models and generation, all of which MISO will support through the Reliability Imperative work.



Renewable Integration Impact Assessment (RIIA): MISO's 4-year initiative to understand the impacts of increasing renewables on the MISO system. The key conclusion is that planning and operating the grid becomes more difficult beyond 30% of the footprint-wide load being served by wind and solar, and that with coordination and advanced action the MISO region could achieve 50% or higher. The workshop materials are available now, and a report will be published in early 2021.



Resource Availability and Need (RAN) Initiative: Ongoing analysis of MISO's changing risk profile and evolving system needs as outlined in five whitepapers. The analysis has informed changes to the value of wholesale load that can respond to the market and plant outage coordination, and development of resource adequacy changes. Because Resource Adequacy must compliment market design and real-time tools/process, the work is central to the Reliability Imperative effort.



MISO Futures: A product of continued collaboration between MISO and its stakeholders, the three MISO Futures provide a set of bookends to explore a wide range of future outlooks. Updated this year with the annual transmission





planning cycle, these forward-looking planning scenarios are being used throughout the organization to prioritize and pace the Reliability Imperative work.

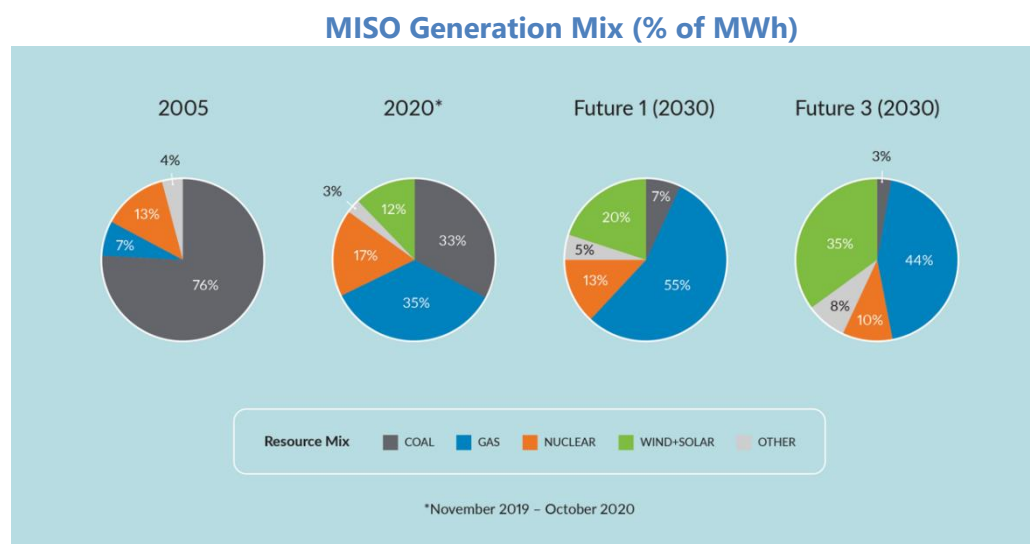
MISO Forward 2021: To be published early 2021, the next report in the Forward series will focus on what changes are needed from MISO as adjacent industries, such as buildings and transportation, evolve how they interact with the electric ecosystem. The Reliability Imperative will remain closely in step with these expectations.

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2021
RELEASE

From this groundwork, we know that there are challenges ahead. But we can also see that there is opportunity for the large, interconnected footprint that MISO provides. We are determined to do the hard work required to ensure all of our members and their end consumers benefit from MISO membership.

The timing of much of the Reliability Imperative work will be impacted by the pace of new generation coming on the system. MISO has multiple views on the future generation fleet and, importantly, the speed of change being set by our members. MISO is currently operating a 25,000 MW wind fleet which, in MISO's most recent 12-month history generated 12% of the electricity mix (solar less than 1%). MISO is preparing for an additional 15,000 MW of renewables (10,000 MW of solar and 5,000 MW of wind) on the system in the next few years.

Beyond that, MISO looks to the [MISO Futures](#) modeling to capture the bookends of resource mix possibilities. The figure below shows 2030 planning scenarios for the conservative pace of change (Future 1) and the more aggressive pace (Future 3):





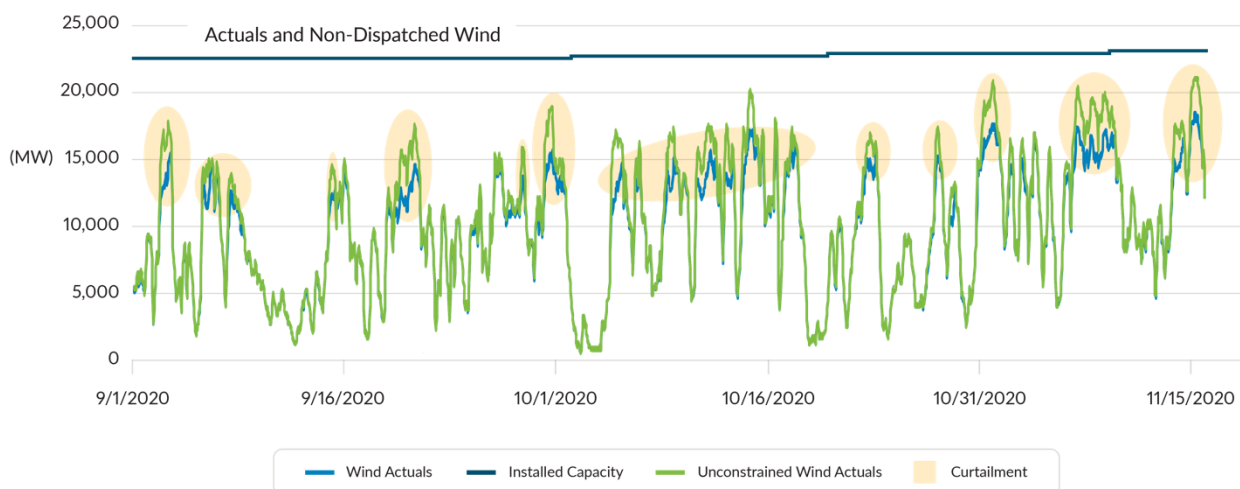
Current Reliability Challenges Will Become More Significant

"We see very little risk of over-building the transmission system; the real risk is in a scenario where we have underbuilt the system. Similarly, across markets and operations, our job is to be prepared."

Clair Moeller, MISO President

Real-time conditions in the last few years have been significantly different than the first 10 years of MISO operations. Power plant retirements, lower overall reserve margins, and increasing outage levels of conventional generation have required MISO to operate with less available capacity than in the past. A growing fleet of renewables that operate differently and, as the graphic below illustrates, can fluctuate on a day-to-day and even an hour-by-hour basis. At times of high wind output, transmission congestion is leading to increased levels of curtailment (highlighted by the orange circles in the chart below). Additionally, non-traditional resources such as load that can respond to system needs and energy efficiency are increasingly being used. And as the climate changes, history becomes a less reliable predictor of future conditions.

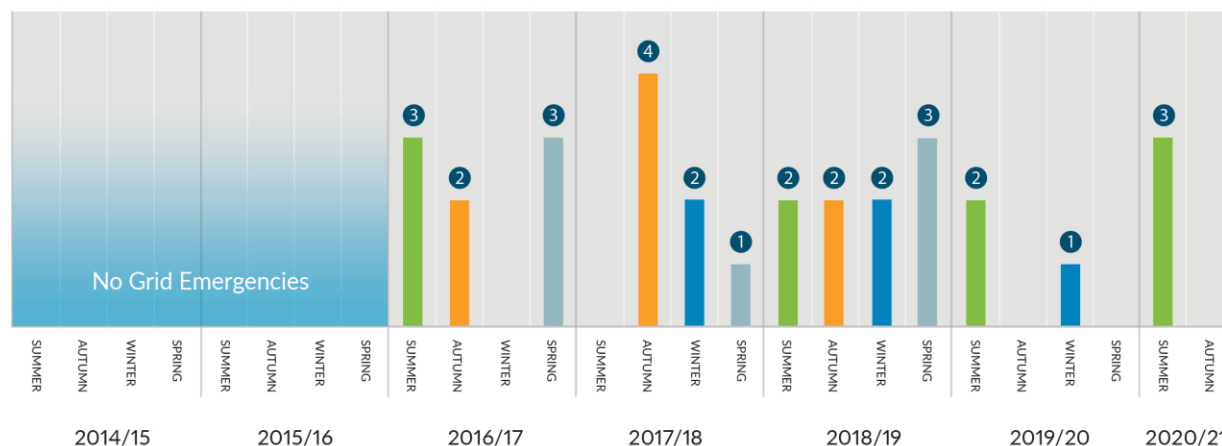
Recent Examples of MISO wind generation variability and curtailment





MISO has declared an increasing number of emergencies since the summer of 2016. While the emergency protocols are a legitimate way for MISO to access additional resources and not a direct indicator of a reliability issue, calling on them more and in non-traditional times are evidence of MISO's changing risk profile.

MaxGen Alerts, Warnings, and Events



Most events are the result of multiple factors happening at the same time. Factors include more planned and/or unplanned generation and transmission outages, high demand conditions, and more extreme temperatures and storms.





Market Redefinition

Generation mix evolution increases the focus on having enough energy for every hour of the year. MISO is addressing this changing risk profile across markets, planning, and future-looking studies. As the generation mix changes, it is important for MISO to provide signals about what will be needed to ensure reliability, and to give the right price incentives when the system is in need. Markets can provide useful signals across multiple time frames.

Resource Assessments: In the investment and planning timeframe, MISO should provide information to all members about the impact of their plans in aggregate. Today, planning is focused on the summer peak hour for the coming year or two. The voluntary Organization of MISO States (OMS) survey looks at several years ahead, but confidence is lower in the later years. Additionally, the OMS survey only focuses on capacity, but increasingly the system will need a forecast of flexibility and other attributes. Going forward, MISO is developing the ability to provide forward resource assessments and long-term resource adequacy reports to better inform future investment and retirement decisions.

Meeting Forecasted Needs: Currently, MISO utilizes both planning requirements and energy market price signals to inform investment decisions and pay resources for providing energy when most needed. Since 2017, the Resource Availability and Need (RAN) initiative has focused on near-term improvements in both planning requirements and energy markets. MISO, and the electric industry in general, are also considering the right balance between planning requirements and energy markets in ensuring energy is available in every hour of the year; for now MISO is focused on ‘no regrets’ modifications for both planning and markets. One important group of changes looks at updating how resources are accredited – including conventional, intermittent, and emergency-only resources.

Resource Adequacy Construct: In the planning horizon, MISO is looking to better reflect the changing risk profile. MISO’s construct was designed around a conventional fleet of resources. In this system, outage risk was concentrated during the summer. Since the early 2000s, the fleet has moved to more renewable resources that are variable and outage risk has expanded beyond the summer months. MISO’s mechanisms must be updated to reflect the changing risk. In the near term, MISO plans to make the Planning Resource Auction a “sub-annual” construct to reflect the changing risks. Importantly, the future Resource Adequacy construct will also need to be adaptable as the portfolio and risk profiles continue to evolve.

Increased Reliance on Energy Market Pricing: MISO is working to update prices to more accurately reflect the value of additional energy during times of system constraints. MISO is in



the process of improving emergency and scarcity prices to more accurately convey system conditions and help incent and ensure reliability in tight grid conditions. MISO will continue to evaluate the changing risk profile to assess the effectiveness of energy market products and pricing and will explore potential new products and approaches.

“Market Redefinition means we need to consider the broad and transformative implications of the rapidly changing risk profile in MISO. This is driving our agenda to re-think the methods by which we assess reliability risk in the planning and operating horizons and the ways in which our markets incent and ensure availability and flexibility.”

Richard Doying, MISO EVP Market & Grid Strategy





MARKET REDEFINITION ACTIONS (BASED ON CURRENT INFORMATION)

| | Explore | Decide | Do | Done |
|------------------------------------|--|---|--|--|
| Resource Adequacy Construct | <ul style="list-style-type: none"> Regional resource assessments of changing reliability risk profile | <ul style="list-style-type: none"> Reliability requirements & metrics Sub-annual construct Accreditation enhancements | | <ul style="list-style-type: none"> Enhanced deliverability for conventional and intermittent capacity resources (Installed Capacity filings) Load Modifying Resources Accreditation |
| Energy Market Signals | <ul style="list-style-type: none"> Uncertainty and variability management Emerging technology participation (e.g. hybrid and Distributed Energy Resources) Optimize transactions at the seams (transmission & distribution interface, and bulk electric system) | <ul style="list-style-type: none"> Improve scarcity pricing and price formation Enhancements for long-lead units and self-commitments Multiple Configuration Resources FERC Order 2222 (Distributed Energy Resource) compliance plan Enhance market-to-market coordination process | <ul style="list-style-type: none"> Enhance emergency pricing Build Short-Term Reserves product FERC Order 841 (storage participation) product | <ul style="list-style-type: none"> Multi-day Operating Margin forecast Distributed Energy Resource Visibility and Communication whitepaper Improvements to MISO-SPP & MISO-PJM market-to-market process |



Long Range Transmission Planning

Renewables such as wind and solar work with the transmission system very differently than conventional power plants. For this reason, the ongoing trend of conventional resources retiring from service as intermittent renewables continue to grow poses significant challenges to the reliability of the transmission system in the MISO region. These challenges are framed up in MISO's Renewable Integration Impact Assessment work.

Fortunately, MISO can leverage its large footprint and resources to ease some of the challenges. One of the keys will be transmission projects that support these new resources in the region.

MISO is doing this through a Reliability Imperative initiative called Long Range Transmission Planning, or LRTP. LRTP is designed to assess the region's future transmission needs, starting from a base of the utility and state plans on where to site and build new resources.

It is important to keep in mind that LRTP does not replace other transmission-planning efforts that have long existed at MISO, such as the annual studies contained in the MISO Transmission Expansion Plan, or MTEP. LRTP will coordinate closely with those efforts, and it will also be a transparent and cooperative part of the MISO stakeholder process.

Futures / Policy Consensus: The LRTP work is grounded in the three robust future scenarios developed over the past year. MISO will prioritize meeting the reliability challenges embedded in Future 1, while ensuring that outcomes do not foreclose Futures 2 and 3. Future 1 tries to reflect current MISO member plans across the footprint and various policy objectives of the states. Futures 2 and 3 reflect increasing levels of electrification (e.g., more electric vehicles) and renewables.

Business Case Development: MISO will help stakeholders assess the business case for LRTP projects by analyzing multiple benefits relative to the costs. The business case should reflect the need for transmission to ensure reliability of the system, in addition to any economic benefits, given the policy and fleet transition objectives of stakeholders. This includes helping stakeholders consider both generation and transmission costs and benefits on a holistic basis, including the value of flexibility that transmission provides. For example, we will need to assess: (1) congestion points that limit energy imports into certain zones; (2) constraints between the MISO South subregion and the North/Central subregions; and (3) energy transfers between MISO and neighboring systems, such as Southwest Power Pool and PJM.

Cost Allocation: A key aspect of LRTP will be to ensure that the costs of new transmission projects are allocated fairly. This means MISO and stakeholders will work together to adjust



existing or develop new cost-allocation methods. The Organization of MISO States (OMS), which represents our state regulatory agencies, has established a working group to focus specifically on transmission cost allocation issues. MISO is committed to working with that OMS group and other stakeholders on this important topic.

LRTP is a comprehensive “transmission roadmap” that will identify and drive investments in transmission projects addressing all needs of the region as the resource fleet continues to evolve. The roadmap will be updated as needed to align with evolving resource fleets and business plans, state energy/environmental policies, and other dynamic factors that affect the region’s transmission needs. As solutions are identified through LRTP, they will be moved into the ongoing MTEP process for final approval by MISO management and Board of Directors. MISO anticipates delivering the first round of suggested LRTP solutions to the Board of Directors in December 2021. Specific projects in the Explore, Decide, Do table will inform recommendations.

“If you love renewables you’d better love transmission.”

John Bear, MISO Chief Executive Officer





LONG RANGE TRANSMISSION PLANNING ACTIONS (BASED ON CURRENT INFORMATION)

| | Explore | Decide | Do | Done |
|-----------------------------------|--|--|---|---|
| Futures / Policy Consensus | | | <ul style="list-style-type: none"> Continue to understand member plans, Integrated Resource Plan trends, state policy objectives | <ul style="list-style-type: none"> Update MISO Futures |
| Business Case Development | <ul style="list-style-type: none"> Study non-transmission alternative solutions Determine increased potential for High Voltage Direct Current (HVDC) lines | <ul style="list-style-type: none"> Conduct special zonal studies Deliver first round of suggested Long Range Transmission Plan solutions to MISO's Board | <ul style="list-style-type: none"> Increase MISO North/South transfer capabilities Enhance renewables integration in the upper Midwest (MWEX-area) Address import / export limitations in Michigan Improve seams via Joint Study with SPP | <ul style="list-style-type: none"> Multi-Value transmission projects Ongoing improvements to the generation interconnection process |
| Cost Allocation | <ul style="list-style-type: none"> Benefits/Cost allocation for identified Long Range Transmission Plan projects | | | |



Operations of the Future

MISO Operations will also be challenged by the different types of resources connecting to the grid including at the residential level. Work is underway to ensure that the people, processes, and technology allow MISO to respond. This work, termed Operations of the Future, is initially focused in the near-term on two large buckets of work – operational planning and situational awareness.

Operations planning improvements can help manage supply and demand variability in every hour. The shift to more weather-dependent, intermittent renewables and distributed resources mean that system peaks and operating risks are becoming less obvious and more difficult to manage in day to day operations. The planning assumption that most days follow predictable load profiles is also being challenged given the rise of demand responding to market prices. With the changes in the system, better forecasting will capture more unknowns into operations and market decisions. Outage coordination will also be enhanced to determine and approve planned maintenance outages, thus providing more windows of opportunity. MISO is further investigating enhanced 'look-ahead' commitment of both generation and demand to capitalize on the flexibility of the grid to meet various system conditions. Finally, MISO is seeking improved methods to position the grid ahead of system challenges such as volatile weather patterns and improve our preparation and management of grid events.

"In the past, most days were the same. In the future, most days will be different and we need the people, process and technology to deal with that variability.





Jennifer Curran, MISO VP System Planning and Chief Compliance Officer

Situational awareness can be improved to turn data into actions. Today, MISO Operations relies heavily on the expertise of its operators. While operators have access to lots of data (e.g., weather, load), they must manually synthesize data into useable information. This has worked well historically, but as the system changes the solution must envision a future with more complex information and less experienced operators. In the future, MISO Operations is looking



to have an integrated toolset for operators that leverages artificial intelligence and machine learning. Techniques to improve how we see and navigate will give operators important information automatically.

OPERATIONS OF THE FUTURE ACTIONS (BASED ON CURRENT INFORMATION)

| |  Explore |  Decide |  Do |  Done |
|--------------------------------|--|--|--|---|
| Situational Awareness | <ul style="list-style-type: none"> • Advanced MISO visualization techniques • Intelligent alarming • Decision support systems leveraging artificial intelligence / machine learning | <ul style="list-style-type: none"> • Smart transmission technologies (e.g. ambient adjusted and dynamic line ratings) • Advance synchrophasor applications | <ul style="list-style-type: none"> • Real time display replacement | <ul style="list-style-type: none"> • Assessment of real-time displays and energy management displays to inform the visualization roadmap |
| Operations Planning | <ul style="list-style-type: none"> • Look-ahead commitment products • Predictive scenario analysis • Outage coordination changes | <ul style="list-style-type: none"> • Enhanced forecasting | | <ul style="list-style-type: none"> • Dispatchable Intermittent Resources forecasting |
| Operations Preparedness | <ul style="list-style-type: none"> • Operations simulation • Reliability product testing | | | |
| Critical Communications | <ul style="list-style-type: none"> • Operations communications • Event/operator logging | | | |



Market System Enhancements

MISO's ability to respond to the Reliability Imperative will be enabled through continued market system enhancements and modeling. Current systems and technology are not capable of meeting the new, reliability driven market improvements and fully leveraging new resources such as storage and distributed energy resources. Even minimal changes to the market systems today require significant resources. The new system will allow more timely improvements to meet MISO's evolving needs.

Today, MISO's legacy system has limitations. Recent upgrades (e.g., MISO's Private Cloud launched in July 2020) will help inform future investments. The Market System Enhancement, or MSE Program, was formed in 2017 to transform our current market platform into a more flexible and secure system. The work is ongoing, but already has reached important milestones including extending the life of legacy systems, improvements to the Energy Management System while the larger upgrade is in-flight, and launching the Readiness Application for the Market User Interface (which will go into production in 2021).

"MISO's Market System Enhancement Program will provide the platform for faster adoption of new technologies into the market and better accommodate the region's changing resource mix to ensure reliable and efficient operations for our customers."

Todd Ramey, VP and Chief Digital Officer



Building on the MSE Program progress, flexible design, advanced data analytics, and model management will help MISO to meet the Reliability Imperative. In contrast to the current legacy technology, the future market platform will integrate technology and systems to better utilize data. Modern architecture means systems that provide flexibility for the evolving needs of the business. Across the various workstreams of the Reliability Imperative, MISO is establishing a portfolio management function to ensure that investments align with the long-term strategy, including meeting the risks of the changing resource fleet.





MARKET SYSTEM ENHANCEMENT ACTIONS (BASED ON CURRENT INFORMATION)

| | Explore | Decide | Do | Done |
|---------------------------------------|--|--|--|--|
| Market System Enhancement | | <ul style="list-style-type: none"> • Real-Time Market Clearing Engine | <ul style="list-style-type: none"> • Market User Interface • Model manager / data governance • Energy Management System (EMS) Upgrade • Day-Ahead Market Clearing Engine | <ul style="list-style-type: none"> • MISO Private Cloud • Extend life of legacy system |
| Technology and Portfolio Needs | <ul style="list-style-type: none"> • Develop and deploy data analytics • External Self-service data • Module E Capacity Tracking (MECT) tool assessment | <ul style="list-style-type: none"> • Update the MISO Communication System (MCS) | | |



Connections Between the Workstreams

The work described here is organized across four main workstreams – market redefinition, long range transmission planning, operations of the future, and market system enhancements. These workstreams are connected and build on each other. Also, success in one area depends on progress in another, so efforts must be coordinated and sequenced.

For example, given the changing resource fleet, providing reliable and economically efficient grid operations requires both new tools and process being developed under the Operations of the Future workstream, and market enhancements being developed under the Market Redefinition workstream. Additionally, the ability to interconnect renewable resources may be constrained by the existing transmission system and therefore dependent on some of the changes being contemplated in LRTP. In a similar vein, the ability for MISO to deploy enhanced situational awareness depends on the quality of our data deployed through MSE.

By documenting our future vision in this report, and outlining next steps across the four main workstreams, MISO is starting an important dialog about how to prioritize different work efforts. As we continue to update this “living” document, we believe the Reliability Imperative will note dependencies and impacts of any future schedule changes. MISO plans to continue the dialog by updating stakeholder committees regularly on the Reliability Imperative.





The Opportunity: Capturing the Value

As described in this paper, MISO sees the challenges of the changing resource fleet. We are facing a Reliability Imperative to prepare for the future, and MISO is hard at work on a number of key planning, operational, and systems efforts.

The fleet change represents not just challenges, but also enormous opportunities for MISO to enable members, states, regulators, and consumers to meet their objectives reliably and affordably.

By listening and taking a system-wide view, MISO can help ensure that all stakeholders have the right information.

By helping forward planning, MISO will help members to develop generation and transmission portfolios that maintain system reliability without over-investing. As member portfolios materialize, MISO markets and operations will optimize energy across the footprint. In addition, MISO will continue coordinating with our neighboring seams partners.

MISO has delivered substantial value to its members since its creation, as demonstrated by the annual Value Proposition calculation. Going forward, additional sources of value will emerge through the sharing of attributes across the diverse resource fleets. MISO is in the early stages of investigating how to calculate these new sources of value in an evolved, future-looking Value Proposition. Given changes to fleet, grid, market, and operations, it is more important than ever that the MISO region work together so that each member continues to realize the substantial benefits of our regional structure.

“MISO has the opportunity to help its States and Members reach their own policy goals in the most cost-effective way while also ensuring the reliable delivery of electricity to end-use customers.”

Wayne Schug, MISO VP Strategy & Business Development



Working Together to Address the Reliability Imperative

This is a report written from MISO's perspective. It lays out MISO's proposals to address the challenges associated with the region's changing resource mix. As an independent, FERC-approved system operator, MISO is responsible for the reliability of the Bulk Electric System and has the authority to act.

But the responsibility for the Reliability Imperative is certainly not MISO's alone. Utilities, electric cooperatives, and other load-serving entities serve the load and own the region's transmission lines, generating units, and other infrastructure. State regulatory agencies also play an important role in overseeing how load-serving entities carry out their responsibilities.

Internal and external input

While this report focuses on MISO's ideas and proposals, it was heavily informed by technical and policy-related input we received from our members and other entities described above. Much of that input came from the formal MISO stakeholder process and its committees, which have expertise in markets, operations, and planning. MISO also received input from industry trade groups, consultants, and other entities with insights into the challenges that are facing our region.

MISO is committed to working closely with its stakeholders as we identify, design, and implement the Reliability Imperative. We believe that by doing so, we can continue to operate the system reliably and efficiently while also working with the differing utility business models and state energy policies in our region.



A Message from Clair Moeller, President

Utilities, states, and other stakeholders in the MISO region differ widely in terms of their policy goals, business models, and other interests. MISO knows that not all stakeholders will support every view, recommendation, and initiative that MISO lays out in this report. Concerns are sure to be raised in the stakeholder process, and perhaps beyond it as well.



That's OK. That's how it should work. That's how important issues like these should be debated. Our region is facing some very difficult and complex challenges, and no single entity—MISO included—has the perspective, experience, and wisdom to fix them singlehandedly. Everyone should be invested in the outcome. Everyone should offer up their ideas and their proposed solutions.

This report represents MISO's initial contribution to that effort—but it does not represent the last word on the subject. MISO welcomes stakeholder feedback on the proposals described in these pages, and if stakeholders have different ideas altogether, we want to hear them. Will we agree on everything? No. But that should not—and must not—stop us from working together to meet the obligations of the Reliability Imperative.

We also recognize that we will need to adjust our approach going forward as industry conditions and the needs of our stakeholders continue to evolve. We are committed to working cooperatively with all of our stakeholder sectors to address these long-term challenges. In the meantime, we will continue to address incremental enhancements needed to maintain reliable and efficient operations.

This report is a current, snapshot-in-time look at how we see the Reliability Imperative today, but we will revise our approach as we learn more.

The time to act is now – the industry is changing, and MISO members are poised to drive exciting, necessary changes over the coming years. Given the regional Reliability Imperative, MISO must act quickly and deliberately to ensure that the planning, markets, operations, and systems keep pace with our members' plans.

Let's get to work,

A handwritten signature in black ink, reading "Clair Moeller". The signature is written in a cursive, flowing style.