

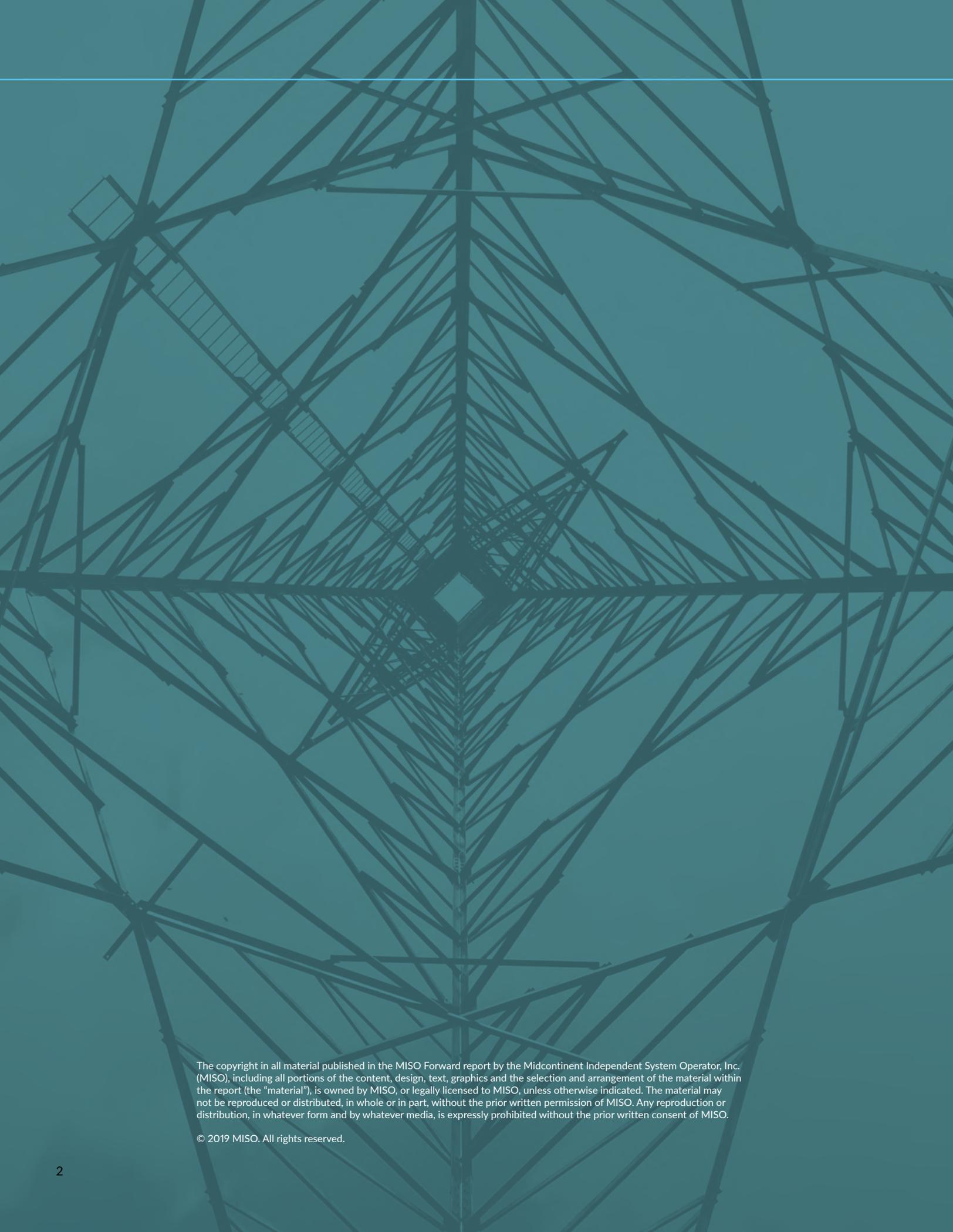
MISO FORWARD »



MARCH 2019



Delivering Reliability and Value in a 3D Future



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Acknowledgement

MISO would like to thank the MISO Board of Directors for its initiation and leadership in setting the direction for this report. We appreciate the partnerships with stakeholders, industry experts, and researchers as we generate insights and explore solutions. We would also like to thank the Regulatory Assistance Project for their assistance in the preparation of this report.

A Message from John Bear, CEO

Dear Friends of MISO,

Meeting critical needs in partnership with our stakeholders is at the heart of our vision and mission. Understanding how needs change with an evolving energy landscape informs the work in this report.



Being the most reliable, value-creating RTO is at the core of why we come to work every day. Our mission is to work collaboratively and transparently with our stakeholders to enable reliable delivery of low-cost energy through efficient, innovative operations and planning.

MISO serves 42 million end-use customers in a \$29.9 billion energy market — a responsibility we take very seriously. We are very proud of our [Value Proposition](#) that we work to grow each year with the input and collaboration of our stakeholders. In 2018, the efforts of MISO and our members provided more than \$3.5 billion in regional benefits, driven by: enhanced reliability; more efficient use of the region's transmission and generation assets; and a reduced need for new assets. All of this takes place in a very dynamic environment.

At the end of 2017, MISO recognized the seismic changes affecting our industry and I tasked our Executive Vice President, Richard Doying, to lead our work assessing and laying the foundation for how to prepare for these changes. I'd like to thank Richard and his team for their diligent work as well as to recognize our stakeholder community that worked closely to advise on the trends, challenges, opportunities and needs, and then make recommendations for the way forward. This new report represents the fruit of all that labor. We remain grateful for your support as we continue our work together to deliver on the promise of being the most reliable and value-creating RTO.

Sincerely,

A handwritten signature in blue ink that reads "J. Bear". The signature is stylized and fluid.



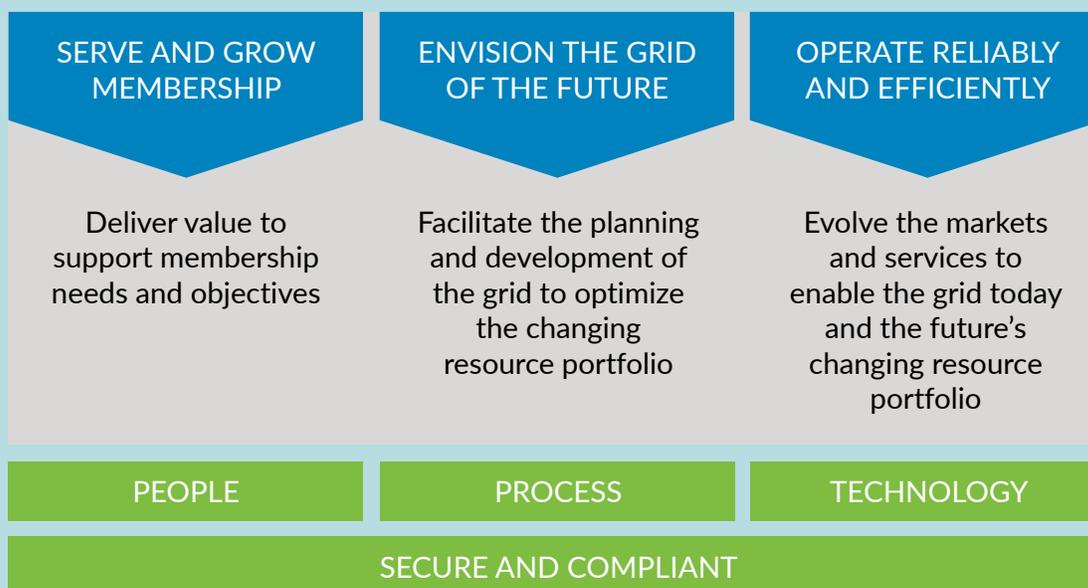
OUR VISION

To be the most reliable, value-creating RTO

OUR MISSION

Work collaboratively and transparently with our stakeholders to enable reliable delivery of low-cost energy through efficient, innovative operations and planning

MISO CORPORATE STRATEGY



Executive Summary

MISO, like other regions, is facing profound changes that have re-shaped its markets in recent years. MISO must consider the dramatic transformation of the resource mix in MISO's footprint over this period and the likelihood that similar changes in the energy mix will continue into the foreseeable future. The exploration of these changes has led MISO to focus on three over-arching trends that are transforming and will continue to transform the industry and the MISO region, referred to as the "3Ds":

De-marginalization, Decentralization, and Digitalization.

With change comes opportunity. As the energy paradigm evolves under the 3Ds, the region is well-positioned to leverage the value of markets, regional transmission planning, resource planning, and footprint diversity.

DE-MARGINALIZATION

De-marginalization refers to the modified set of resources that can provide the next needed, or "marginal," increment of energy at zero additional costs (e.g., renewables), or very low additional costs (e.g., highly efficient gas-fired generation).

DECENTRALIZATION

Decentralization involves the shift away from large, central-station power plants to smaller, often variable resources that are located on local, low-voltage electricity distribution networks, or "behind the meter" at homes and businesses.

DIGITALIZATION

Digitalization refers to the revolution in information and communication technologies and platforms that will continue to disrupt nearly everything in our economy, including energy services.

Over the course of 2018, MISO cast a wide net gathering insights from its own analysis and operating experience, members, utilities, states, and federal policy initiatives, vendors, national laboratories, academia and other regional grid operators. This report, as a result, reflects insights gained from a broad cross-section of members, stakeholders and industry leaders, including participants at the MISO Market Symposium held in August 2016 and August 2018. Among the most important insights gained during the course of this report's development was validation from every corner of the MISO region of both the direction (the 3D key trends) and velocity (faster, not slower) of changes underway.

*MISO interviewed
utilities that serve
80% of end-use
customers across
all regions.*

These insights reveal three major opportunities and challenges:

- 1) Increased variability and uncertainty of both generation and demand;
- 2) More coordination required with seams partners, stakeholders, advanced technology providers, and distribution system operators; and
- 3) Market products, incentive structures, and planning processes that are increasingly misaligned with efficiency and future reliability needs.



To address these opportunities and challenges, MISO has identified three key needs:

- 1) Availability is the ability of transmission and energy resources to meet requirements at all hours;
- 2) Flexibility is the ability to anticipate and adapt to frequent, significant changes in generation output and demand; and enable new sources of flexibility; and
- 3) Visibility is the ability to see and coordinate relevant resource, demand, and power flow attributes in operations and planning horizons.

Addressing these needs will take time and internal functional coordination from system planning through grid and market operations. Most importantly, it will require a high level of stakeholder collaboration, new partnerships with advanced technology providers, and new coordination with distribution operators in order to innovate holistic solutions to ensure reliability and create value for end-use consumers.

Three Identified Key Needs



The report first summarizes the meaning of the key trends and then identifies emerging opportunities, challenges, and resulting needs. In addition, this report puts forward a specific framework and recommendations to address these needs falling into three distinct stages: **Explore, Decide** and **Do**.



MISO is uniquely positioned to partner with stakeholders to enhance products, services, operations and planning approaches around availability, flexibility, and visibility. MISO will continue to work with stakeholders on directly related and important initiatives like Resource Availability and Need (RAN), queue improvements, integrated roadmap improvements, market system enhancement, and security improvements. Conversations will continue across the footprint to learn more and work to understand the needs of MISO's stakeholders and their customers.

What Are the 3Ds?

Trends driving change

DE-MARGINALIZATION

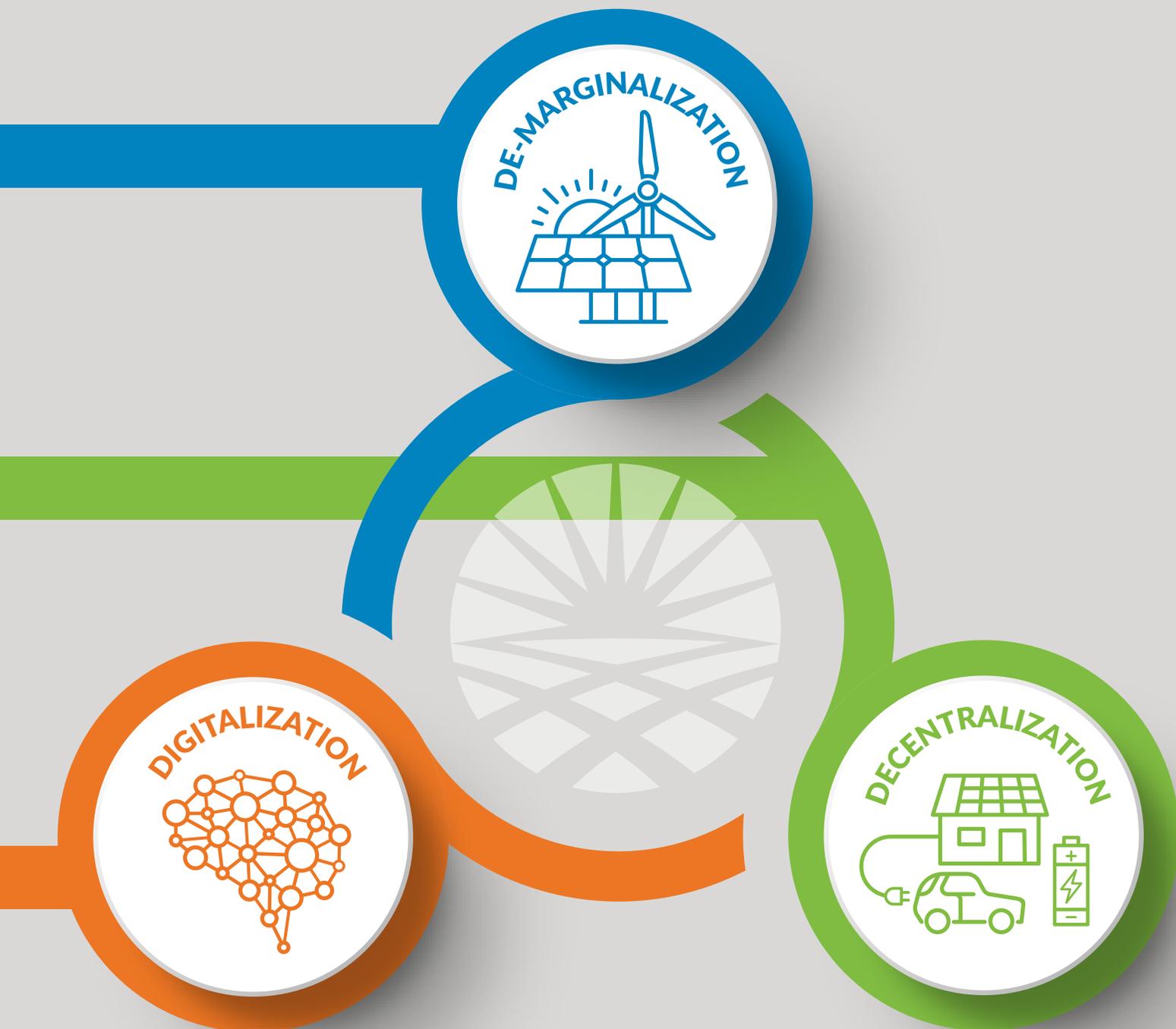
De-marginalization refers to the modified set of resources that can provide the next needed, or “marginal,” increment of energy at near zero additional costs (e.g., renewables), or very low additional costs (e.g., highly efficient gas-fired generation). An implication of this trend is an increase in the value of flexible resources while market revenues for those resources decrease. This points to a need to re-visit the attributes being priced in MISO’s market so that scarcity and the value of energy, reliability, and flexibility services are fully and accurately reflected in various market prices. Further this has implications for planning and transmission investment – notably how MISO can leverage its scale for the region’s benefit.

DECENTRALIZATION

Decentralization involves the shift away from large, central-station power plants to smaller, often variable resources that are located on local, low-voltage electricity distribution networks, or “behind the meter” at homes and businesses. Unlike traditional system resources, many distributed energy resources – from generation to demand management – may be less visible or invisible to MISO system operators. This can increase system risk significantly. At the same time, MISO can help enhance and leverage the full value of these resources through regional diversity, optimization capabilities and system flexibility. All of this is enabled through regional transmission planning. But realizing those opportunities will require new cooperation and collaboration between MISO, its members, stakeholders, and others. Decentralization also presents new opportunities to align the roles of state and federal regulation overseeing the grid.

DIGITALIZATION

Digitalization refers to the revolution in information and communication technologies and platforms that will continue to disrupt nearly everything in the economy, including energy services. This revolution has been a key enabler of the decentralization of generation and demand management resources, but its implications extend far beyond. The emergence of the “internet of things” opens up entirely new ways for consumers to become an active element within the energy system. The accompanying proliferation of data also represents an opportunity to understand and respond to changing consumer preferences more quickly and efficiently. And, importantly, it also presents new challenges to safeguarding the security of the power system while respecting the privacy rights of MISO members and their end-use customers.



Emergence of the “3Ds”

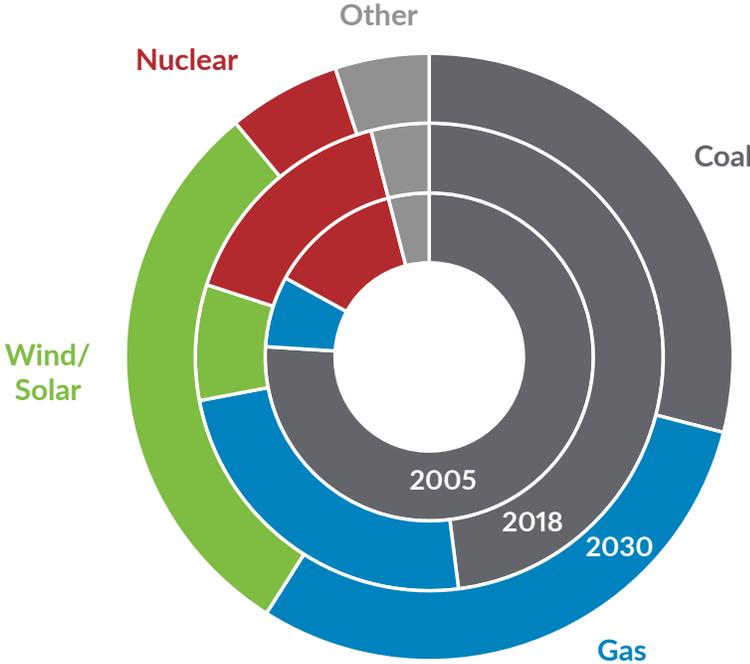
Profound Changes to Continue in the Region

In 2005, nearly 80% of the MISO region's total energy was generated from coal, with just 7% coming from natural gas, and only a negligible amount from renewables.

Today, less than half of the region's total energy comes from coal, while the amount coming from natural gas is about 26%. Additionally, the region now gets about 7% of its total energy from wind with much more renewable energy on the way.

Rapidly decreasing costs, state and federal policies, and interest in decarbonization continue to drive investment in wind and solar. Abundant natural gas supply and lower gas-prices are also driving the transition. MISO expects this portfolio evolution to continue over the next decade, which will align with the MISO Transmission Expansion Plan scenarios of Accelerated Fleet Change and Distributed Energy Technology.

**MISO Energy Mix Transition (GWH) from 2005 to 2018 to 2030
(Based on Utility Announcements and State Integrated Resource Plans)***



*Chart reflects ratios of generation.



The energy landscape is transforming, fueled by customer and community expectation, a drive for cleaner energy and advancements in technologies. We see more participation in the market – utilities, IPPs, and developers with access to capital and incented to move aggressively.



Bob Frenzel
Executive Vice President and Chief Financial Officer,
Xcel Energy





MISO is already experiencing the effects of de-marginalization, which can exacerbate other challenges of the evolving portfolio. Lower energy prices, combined with environmental considerations and an aging fleet, have contributed to significant retirements of traditional units. MISO had 14% capacity beyond planning reserve margin in 2013, which has declined to 2% in 2018. Resource availability gaps have emerged periodically when variable resources are at low output levels. The frequency of emergency operations has increased significantly over the past two years. De-marginalization is a trend in portfolio evolution that changes the risk profile for planning, resource adequacy, markets, and operations.

The growth of low- to no-marginal cost energy resources on the grid continues to change the economic and reliability characteristics of the system. This trend and the corollary growth of resources having variable output presents a two-pronged challenge. First, the energy prices that encourage generation to follow MISO's commitment and dispatch are declining. Second, the growth in variable generation requires increased and more dynamic capabilities in other resources, not only to complement the variability of these resources but also to help manage the associated uncertainty. For example, the direction and magnitude of ramp need will change for morning and late afternoon as the renewable portfolio grows.

This "D" has implications for existing resources and investment decisions for new resources. Increased variability and uncertainty will become more acute when these resources grow in prevalence, as energy markets may not appropriately compensate dispatchable resources for the availability, flexibility, and other attributes they provide. There may be ways to access required services through the dispatch of renewable resources and utilization of emerging technologies like energy storage and advanced demand controls. Given an increase in variable resources, there may be ways MISO can further leverage its scale and diversity for the region's benefit through regional transmission planning and investment.

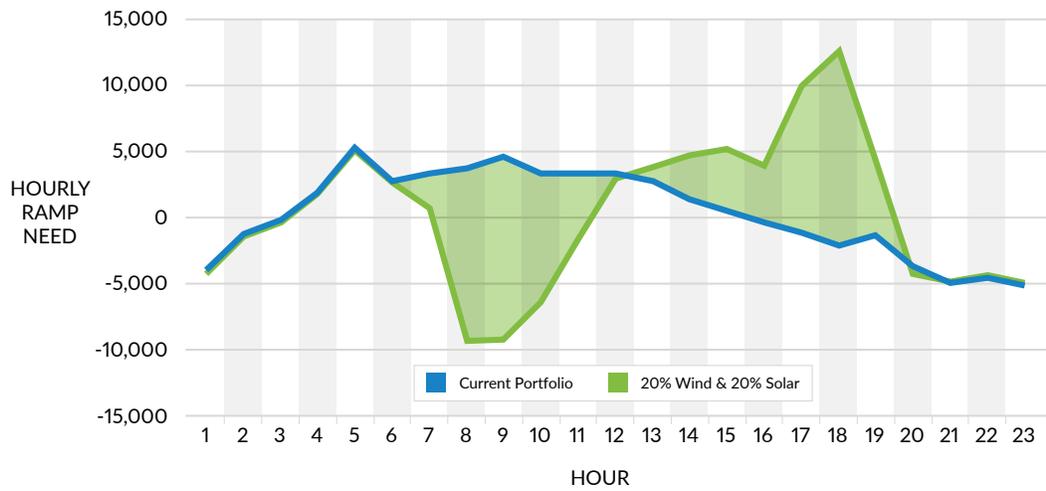


Our goal to be 50% renewable by 2030 is economically driven and consistent with what our customers expect from us. We want to be relevant and competitive to the markets we serve. Renewable energy helps on both of those fronts.



Jon Brekke
VP & Chief Power Supply Officer,
Great River Energy

The Evolving Portfolio Requires Increased and More Dynamic Ramp Capabilities



- Higher variability within an operating day - more peaks/troughs and steeper ramps
- Higher overall level of required up/down ramp
- Higher variability to be compounded with higher uncertainty



The MISO region has a long and successful track record of providing electricity to homes and businesses via the traditional industry model of central-station power plants, high-voltage transmission lines, and local distribution systems. Transitioning towards a model with a higher penetration of distributed energy resources (DERs) is likely to present challenges as well as opportunities for innovation for the region's generation and transmission owners, distribution operators, states, other stakeholders, and for MISO.

DERs will be smaller, less visible to MISO, and located on the distribution system. DERs may include distribution connected utility-scale solar, wind, and storage projects or behind-the-customer-meter resources such as rooftop solar, demand controls, storage, etc. Innovative solutions are developing at the grid edge, where the lines are blurring between transmission and distribution, federal and state jurisdiction, and suppliers and consumers of electricity.

As cost barriers fall for DERs, new types of resources are joining the energy mix. The decentralization trend will leave two needs in its wake. First, without any intervention, the physical state of the grid and the resources impacting that state will become less visible to the grid operator. Second, DERs, including rooftop and utility-scale solar, will have a variability that is distinctly different from traditional demand patterns. Traditional one-way power flows may become more bi-directional in nature when resources on the distribution system provide power to the local grid. These patterns will be less static and fluctuate frequently. Changes in net demand patterns, combined with potential reductions in visibility, will raise the need to operate the grid with greater flexibility.

DERs can be deployed more rapidly than those traditional assets like coal plants, gas plants, and transmission lines. This rapid deployment leads to a shortening of the time allowed for planning and developing supportive infrastructure, services, and transmission that enable the coordinated, reliable, and efficient use of these new resources.

MISO can leverage footprint diversity and regional planning approaches to support and enable DERs. MISO must conduct research, investigate options, and engage stakeholders to develop the best approaches to maintain or increase value with an increasing penetration of decentralized resources.



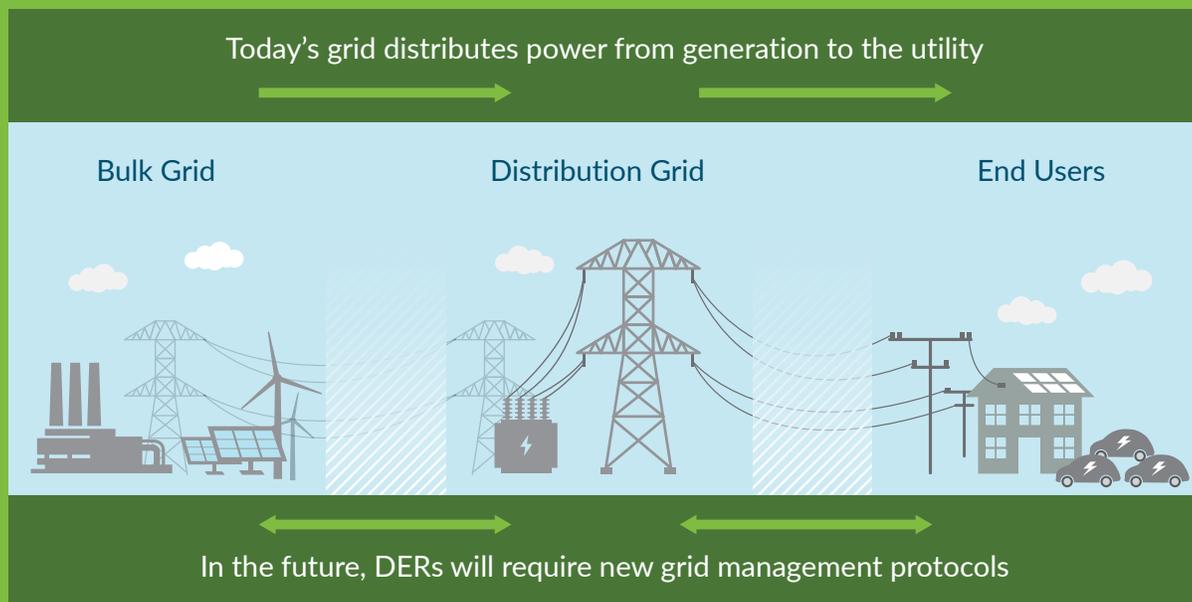
DECENTRALIZATION



We can put solar on any distribution system and save them money.



Duane Highley
President and CEO,
Arkansas Electric Cooperative Corporation (AECC)



Right now, in some communities in Iowa, 50% of peak load is met by distributed generation, rooftop solar.



Joe McGovern
Director Strategic Engineering,
Alliant



Digitalization changes all businesses. It changes the manner in which businesses interact and transact across the energy value chain and obscures the line between producers and consumers, people and machines. It influences and shapes decentralization and de-marginalization trends by providing opportunities for enhanced information and controls.

Twenty years ago, utilities had meter reading departments with employees who visited and recorded each meter in the service area. Today, metering data may be transmitted across the internet. Utility personnel only travel to the meter if a problem arises. Rapid advances in sensors, control systems, industrial software, and artificial intelligence are opening new ways of driving value gains from existing operations and enabling new, more flexible business and operating models such as harvesting customer insight through smart devices.

The emergence of digitalization both in the energy sector and the broader economy, represents key challenges and opportunities around all three needs: availability, flexibility, and visibility. Digital devices might be the key to unlocking flexibility from a historically inflexible demand for energy. It might also, however, represent new and unpredictable demand growth in the form of electric vehicle charging, if done in significant quantities in the absence of grid coordination and if misaligned with grid value signals.

As digital electronics integrate throughout the value chain, the ability to translate data into useful information becomes key. Data analytics will be critical in wholesale and retail operations because of the increased complexity, amount of data, and rapid rate of change. New security approaches are needed that delineate and respect privacy and ownership of data and information.



DIGITALIZATION



We are investing to improve reliability on the distribution system. These upgrades include automation, which provides flexibility for future DER integration.

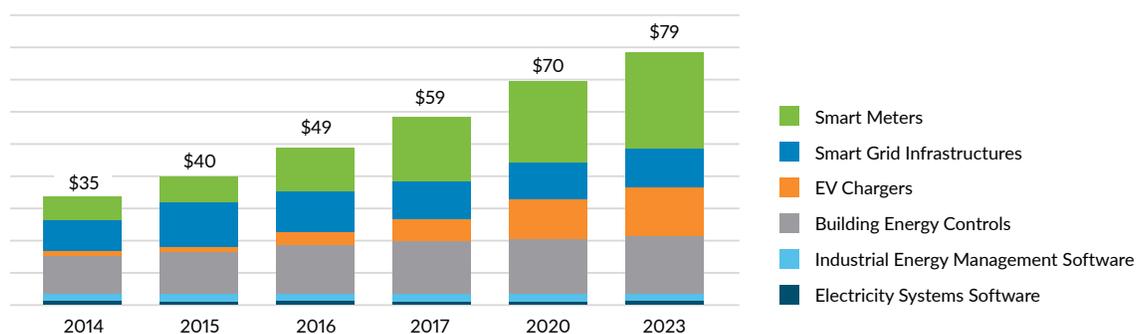
Investments to improve system reliability may help set the stage for a distribution-level market in the future.



Shawn Schukar
President and Chairman,
Ameren Transmission Company



Forecasted Growth of Digital Investments (\$ Billion, USD)



Graph Courtesy: Mordor Intelligence

Opportunities and Challenges Spanning the 3Ds

Each of the 3Ds suggests current and future implications, opportunities, and challenges for MISO and its stakeholders. Many of the opportunities and challenges are interrelated and span the 3Ds. Each “D” is moving at its own pace. Advances in digitalization may spur advances in decentralization or de-marginalization. In considering MISO’s vision to be the most reliable and value-creating RTO, three main categories emerge.

INCREASING VARIABILITY AND UNCERTAINTY

De-marginalization and decentralization present new challenges due to increased variability and uncertainty impacting generation, demand, and transmission and require evaluation of potential risk to reliability and cost. These challenges will be more pronounced within any given day and across multiple days. There is an opportunity to evaluate existing tools, products, and planning approaches and make changes to leverage the region's diversity and capabilities. Demand patterns are changing due to digitalization and distributed energy resources (DERs) with end users able to schedule their demand. The pace of digitalization may contribute to how quickly variability and uncertainty grow but also may provide new possibilities for managing change. Adding to the complexity of increased variability and uncertainty is the blurring of the transmission and distribution interface due to the decentralization trend.

MORE COORDINATION REQUIRED

MISO and local utilities share the task of integrating DERs through planning and operations. A comprehensive integration approach, or individual approaches that are strongly aligned, is needed to ensure DERs enhance the overall grid rather than harm it. Coordination is required in long-term forecasting, interconnection, data sharing, communication, and resource optimization. Alignment at the transmission and distribution interface and among neighbors will become increasingly important. Divergent approaches and policies across the MISO footprint will complicate efforts to design rules and systems at MISO in this changing environment. MISO is working closely with its states and stakeholders to help shape beneficial approaches.

INCENTIVE STRUCTURES AND PLANNING MISALIGNED WITH FUTURE RELIABILITY NEEDS

Various experiences worldwide show that reliability needs with high renewable penetration will be different. For example, changes are needed to account for significant increases in inter-day and intra-day variability and related uncertainty. Incentive structures and planning should evolve for the changing needs. Inverter-based technology responds differently to disruptions in the grid than rotating technology. Additional research and discussion are needed to define the future reliability needs, align planning processes, and identify ways to improve incentive structures. Incentive structure policy considerations include alignment between wholesale and retail prices.

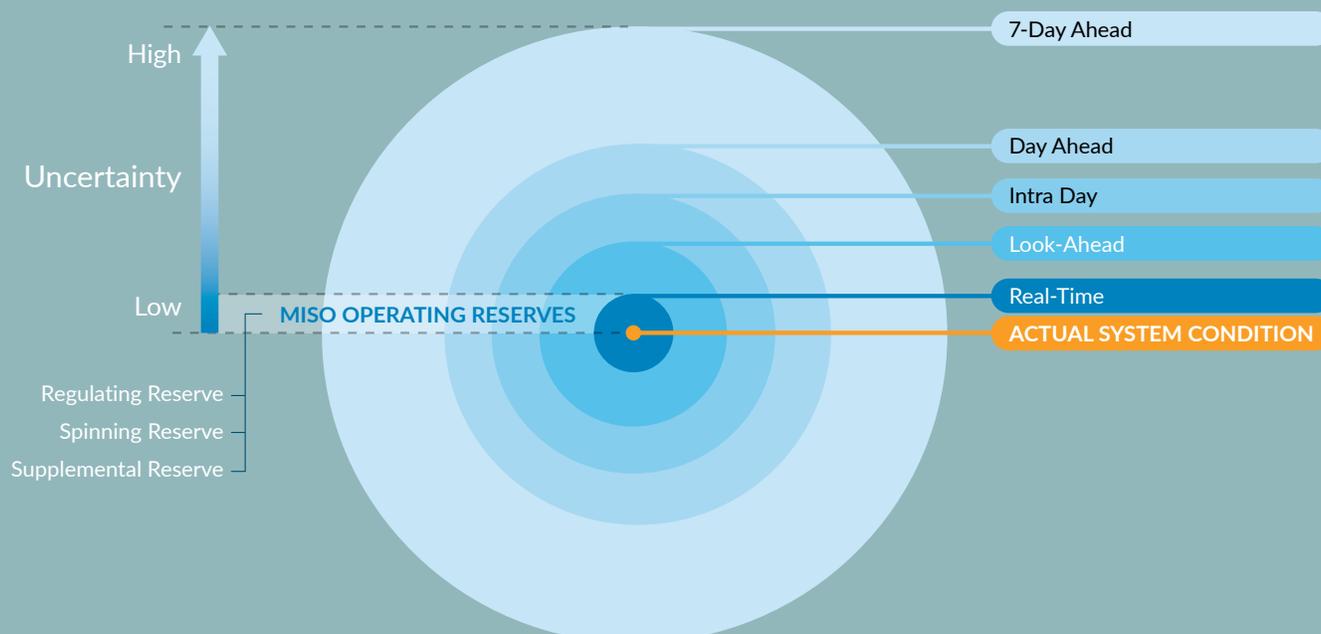


Right now, most of the generation is connected to the transmission system, and the transmission system is almost bullet proof. In the future, with significant growth in distributed energy resources connected to the distribution system, it won't be the same; you'll be wondering if that supply will be available when a storm rolls through. It's going to be a different animal we haven't seen before.



Tim Sparks
Vice President of Electric Grid Integration,
Consumers Energy

Level of Uncertainty Varies Significantly Across MISO Processes and Time



Methodology

MISO recognizes there is an opportunity to create more value for the regional footprint by innovating now to prepare for the impact of the 3D industry trends. As such, MISO leverages its insights-driven strategy with the goal of improving MISO capabilities and reducing time-to-market for enhanced products and services. Assessing both upside opportunities and downside risk for existing and potential future solutions helps inform prioritization of research, design, and development efforts. This report provides a longer-range view for the integrated roadmap with additional breadth for related technology and tools, similar to the way the MISO Transmission Expansion Plan (MTEP) process takes a holistic look at transmission planning. Both efforts are tightly coordinated.



Explore, Decide, Do is an insights-driven framework that starts with higher levels of abstraction and works to develop concepts through to concrete enhancements. Each phase results in additional insights, forming critical feedback loops to the framework. The transition between each phase serves as an evaluation point before moving to the next phase. Factors considered before a new phase include the probability for economic value creation/destruction and operational impact.



EXPLORE

MISO gathers insights from a variety of sources with the goal of understanding what new opportunities and challenges are identified and what new capabilities will sustain and enhance MISO's Value Proposition. MISO has discussions with members, vendors and policy makers, including leadership and expert staff, conducts its own studies through data analysis and simulation, and participates in research efforts with industry experts and national laboratories.

DECIDE

Using gained insights, MISO works with stakeholders to refine ideas to a more clearly defined approach or conceptual design. MISO leverages these insights to conduct studies and analyses to guide economic and reliability decisions. For major market enhancements, MISO works with stakeholders through the Integrated Roadmap prioritization process to help inform both "Decide" and "Do" priorities that align with MISO's Market Vision and Guiding Principles.¹ For planning enhancements, MISO works with the Planning Advisory Committee and Planning Subcommittee to help inform both "Decide" and "Do" priorities.

DO

At this point a solution is clear and the only question remaining is priority relative to other "Do" needs and their timing. For market enhancements, this phase often requires decisions about sequencing and ease/complexity of integration with software systems and platforms. Other "Do" actions may focus on targeted education or consensus building with stakeholders that could then result in a need to explore new solutions for later implementation, creating a feedback loop. As an example, MISO has been working with stakeholders on four Resource Availability and Need (RAN) goals: 1) improve outage scheduling, 2) link Load-Modifying Resource accreditation and requirements, 3) align Planning Resource Auction commitments with energy needs all year, and 4) ensure flexible resource availability.

1. <https://www.misoenergy.org/markets-and-operations/market-roadmap/>

Looking Ahead: MISO Needs for the Future

The 3D framework gives MISO the structure to give a critical look ahead to the challenges and opportunities for its markets, operations, and planning. MISO will continue to innovate and adapt to deliver reliability and create value for its members and stakeholders. As MISO looks ahead, three key themes stand out: availability, flexibility, and visibility.

AVAILABILITY

The de-marginalization and decentralization trends suggest that a significant portion of resources in the future will operate based on external drivers such as wind and sun. This differs from the current and historical scenario of scheduled resource availability in both maintenance and energy production. In the future, entirely new external drivers may also influence grid conditions, such as charging patterns with electric vehicles. The emerging dominance of forecasted, rather than scheduled, resources will put a premium on planning and signaling the value of resource availability. These resources deliver specific reliability services at specific times to fill probabilistic forecast gaps that emerge with new resource types. The challenges of assuring not only availability of generic resources, but also those with key service capabilities like inter-day and intra-day flexibility, are likely the most important availability need identified so far. Market incentives and planning approaches to address this gap need to be decided.

Availability will also be enabled by more proactive and effective coordination among the diverse regions and assets across MISO's large footprint. This is most apparent in the regional solutions MISO can provide by delivering to its members a more flexible, yet cost effective, bulk power system. MISO must work proactively with stakeholders, including state and federal policy makers, to identify future needs and to develop coordinated solutions. Recent work with stakeholders includes Resource Availability and Need (RAN), Short-term Reserves, and queue process improvements.



MISO's weekly operating reserve market would be very effective in sending the right price signals and help with scheduling outages and managing our hydro storage



David Cormie
Wholesale Power and Operations Director,
Manitoba Hydro



AVAILABILITY ACTIONS

AVAILABILITY

The ability of transmission and energy resources to meet requirements at all hours.

Explore

- How does MISO define reliability and security requirements as risks change and what are the needed adjustments to associated standards, metrics, products, and services?
- How does MISO develop a regional business case assessing the need for long-range transmission projects?
- How should processes involving contingencies and congestion in operations and planning be enhanced?

Decide

- Pursue [Resource Availability and Need \(RAN\)](#) (continued improvements, enhanced availability mechanisms or constructs, seasonal approach)
- Continued reforms to improve scarcity pricing and price formation
- [Evaluate potential of a 15 minute Day-Ahead Market](#)
- Future queue improvement (strengthen site control and milestone payment structure)

Do

- Reform [Resource Availability and Need \(RAN\)](#) (near-term Load Modifying Resource (LMR) and outage reforms)
- Design [Short-term Reserves](#)
- Improve queue process

MISO makes recommendations for product and service enhancements that, first, put a requirement and price on the value of the right attributes being available at the right times. From there, market participants will be able to choose how much of those capabilities they wish to own to meet their own needs for all hours. This will be balanced with potential operational efficiency associated with acquiring these services from the markets at times to fill availability gaps in their portfolio. The specific recommendations in this table represent the highest priority actions.

FLEXIBILITY

The 3Ds and the associated growth of variable generation will transform MISO in many ways. The common denominator in how MISO can continue to deliver reliability and value in the face of these trends is increased flexibility. The rapid growth in variable production in MISO's footprint will raise the value of resource flexibility and transmission system flexibility. The portfolio of dispatchable generation resources is undergoing and will continue to undergo major shifts in value, with flexible generation increasing in value and less-flexible generation losing value. Recognition and action to incent flexibility is critical, as it will need to inform investment choices by MISO and its members.

MISO is well-positioned to help its members manage through this shift in ways that deliver value and safeguard reliability and security. Doing so, however, will require the development of new products, services, and planning approaches that leverage footprint diversity to improve MISO's sources of flexibility. A critical lever in mitigating inefficient impacts will be the ability to mobilize the emerging flexibility of demand, especially with the opportunities presented by digitalization and grid-integrated electrification of less traditional uses like transportation.

Flexible demand and other generation resources have the potential to benefit the region by opening up a new source of flexibility at a time when increased flexibility is needed. The growing volume of flexible demand raises the question of whether MISO and its stakeholders should jointly re-examine how they define and quantify "reliability". The traditional approach to calculating loss of demand through Loss of Load Expectation (LOLE) requires an update. Customers will, directly or through service providers, acquire greater capabilities to shape how and when they use energy services and gain a greater interest in doing so. Matching generation to demand at all times in all places will become more of a two-way street, and may not be best reflected in legacy reliability metrics. Transmission infrastructure may need to evolve to support dispersed generation and dispersed flexible demand. This will have implications for MISO's interactions with its members. MISO will work with its members to transition from the traditional model of incremental changes to demand forecasting to a more dynamic forecasting process that better captures the demands on the wholesale system of more active consumer engagement with the electricity system.



With as much renewables as are expected to come online, you're going to need even more flexibility. When are we going to get compensated for that flexibility?



Jim Compton
CEO,
Cooperative Energy in Mississippi



FLEXIBILITY ACTIONS

FLEXIBILITY

The ability to anticipate and adapt to frequent and significant changes in resource output and demand, including the enabling of new sources of flexibility.

Explore

- What market products, operational approaches, and planning methods will enable and encourage flexibility (intra-day, inter-day)?
- How best to plan for energy, reserves and ramp along with capacity?
- What is the best way to securely leverage data and digital technology to prepare for uncertainty and variability?
- What is the best way to integrate new types of flexible resources?
- How can MISO leverage information sharing and diversity of its neighbors' footprints to decrease uncertainty and variability?

Decide

- How to improve [storage integration](#) (Phase II)?
- How to model smart inverters in planning?

Do

- Implement [Fast First Automatic Generation Control](#)
- Implement [Enhanced Combined Cycle](#)
- Improve reserve deliverability

MISO makes recommendations for product and service enhancements that first put a price on the value of different emerging flexibility services being available at the right times. From there, market participants will have improved ability to choose how much they wish to own to meet their own flexibility needs versus acquiring these services from the markets to fill flexibility gaps in their portfolio. The specific recommendations in this table represent the highest priority actions.

VISIBILITY

As availability and flexibility increase in importance, increased visibility up and down the value chain will become a critical factor in MISO's ability to efficiently manage reliability and, in turn, deliver value to its members. This is especially true for new resources on the distribution systems that might contribute to two-way power flows with impacts to the bulk power system. Interconnection policy needs to evolve in response to the options available to the new energy resources whether connected to the transmission or distribution systems. Access must continue to be non-discriminatory, reflect costs, and support optimal grid development through sufficient visibility both vertically (up and down the grid infrastructure) and horizontally (in collaboration with regional seams partners). At the same time, it will be important to avoid the unintended consequence of high barriers to MISO's bulk power grid as it may encourage resources to find ways to bypass interconnection and "disappear" behind the transmission-distribution interface.

MISO's partnership with its members needs to evolve in ways that increase collaboration regarding what they see on their local distribution systems. This is important for managing reliability and maximizing the value possibilities of decentralization and digitalization.



Even one energy storage unit could be a problem on the distribution system if MISO dispatches it and it creates distribution-level issues.



Irene Dimitry
Vice President Business Planning & Development,
DTE



VISIBILITY ACTIONS

VISIBILITY

The ability to see and coordinate relevant resource, demand, and power flow attributes in operations and planning horizons

Explore

- How can MISO increase effective collaboration, coordination, and planning across the region and with its neighbors?
- How does MISO provide better transparency on future resource needs?
- How best to securely leverage data and information to enhance situational awareness, readiness, and real-time decision making?

Decide

- How will MISO expand collaboration with distribution operators related to distributed energy resource (DER) challenges?

Do

- Advance collaboratively developed DER priorities with stakeholders, beginning with educational workshops and technical preparation
- Improve long-term planning forecasts for load

MISO, in this report, makes recommendations for product, service, and planning enhancements that will facilitate situational awareness for all market participants to coordinate operations with particular regard to variable generation operational forecasting and DERs. From there, market participants will then have improved foresight into system needs and increased ability to plan for and operate during all hours of the year. The specific recommendations in this table represent the highest priority enhancements to provide this increased situational awareness and support the needed increase in visibility and coordination.

Next Steps: A Note from Richard Doying, Executive Vice President

The "3Ds" – de-marginalization, decentralization, and digitalization – will carry MISO, its stakeholders and the electricity end-users into a future that is increasingly different from the past. This report introduces the framework and methodology that will allow MISO to prepare for the future. Customer insights will continue to be invaluable to our research into how major trends affect our region.



Our footprint diversity includes varying end-use customer needs and preferences, natural resource availability, utility business models, and customer sectors. Collaboration across all of these entities is what has gotten us here and helped us achieve 99.99% system reliability and efficient market outcomes as reflected in MISO's value proposition.

This report has been guided by common themes we have heard during stakeholder discussions on what the 3Ds mean to their companies and customers, as well as what it means for what they need from MISO as the regional grid and market operator.

Going forward, we see an even greater need for collaboration and enhanced coordination in light of industry trends to carry out our vision and mission. MISO is uniquely positioned to develop approaches to address the need for enhanced availability, flexibility, and visibility. MISO can also help its members capture the value of regional diversity, increasing the utilization of members' capital assets and providing clear economic signals as members consider future resource investment choices. MISO will continue to pursue the identified explore, decide, and do items, as well as Market System Enhancement and security improvements, providing updates via stakeholder forums and reports.

We look forward to continuing conversations across our footprint to learn more and work to understand the needs of our stakeholders to help synthesize and innovate effective solutions for the future of energy.

Sincerely,

Richard



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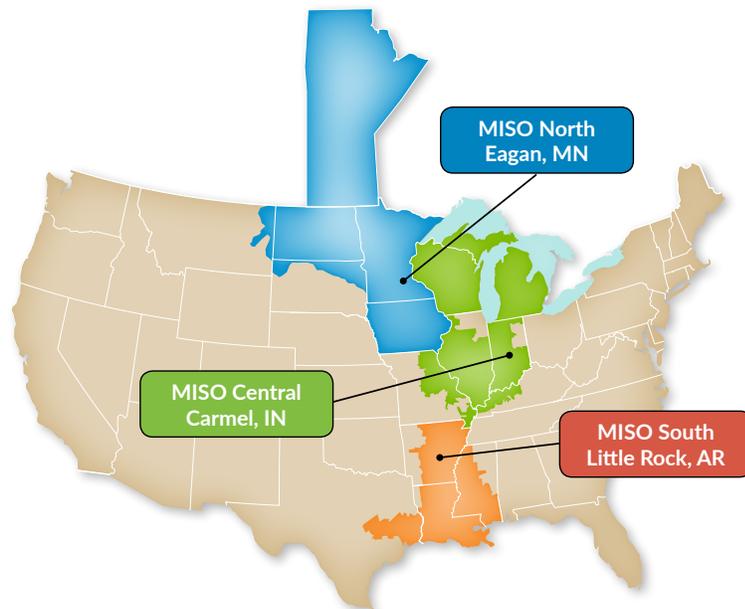
“Going forward, we see an even greater need for collaboration and enhanced coordination in light of industry trends to carry out our vision and mission.”

About MISO

The Midcontinent Independent System Operator (MISO) is a 501(c)(4) not-for-profit organization with responsibility for ensuring the reliability of the high-voltage electric transmission system to deliver low-cost energy. MISO began providing reliability coordination and other services in December 2001, and is one of the ten Independent System Operators (ISOs) in North America.

MISO manages the largest power system in North America in terms of geographical scope, serving about 42 million people across all or parts of 15 states, stretching from the Canadian border to the Gulf of Mexico. MISO's energy markets are among the largest in the world, with more than \$29.9 billion in annual gross market charges. MISO also serves as the reliability coordinator for MISO entities in these 15 states and one Canadian province.

Currently, the MISO region contains about 66,000 miles of high-voltage transmission assets with an aggregate value of approximately \$38 billion, as well as 175,000 megawatts of electricity-generating capacity. MISO does not own any of these assets. Instead, with the consent of its asset-owning members and in accordance with its FERC-regulated tariff, MISO exercises functional control over the region's transmission and generation resources with the aim of managing them in the most reliable and cost-effective manner possible.



MISO's reliability footprint and locations of regional control centers.



KEY FACTS

5-minute dispatch

\$29.9 billion gross market charges (2018)

More than 450 market participants

42 million end-use customers

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