When we meet with the major corporates in our territory, they are willing to talk with us and share their aspirations in this space. They are willing to give us time to be part of this solution. There is going to be a point when they say you are not doing enough and go off to solve it on their own. We need to be responsive. We are trying to meet their needs directly and by working with MISO. We need MISO to help de-risk some of the paths forward with, for example, timing of renewables buildout.

Steve Greenly
Senior Vice President of Generation Development
CenterPoint Energy

Contents

A Message from John Bear, CEO ........................................... 2
Executive Summary ..................................................... 4
The energy ecosystem is evolving .................................. 6
Game Changers ......................................................... 8
Adjacent industry sectors ............................................ 10
Utilities are accelerating decarbonization ...................... 12
MISO’s Reliability Imperative is heightened by decarbonization 14
Innovation is critical to addressing changing risks .......... 16
Innovation is changing the nature of demand ................. 18
Insights and collaboration across sectors can help navigate uncertainty 20
Insights point to further exploration ............................ 22
Action Plan Highlights ................................................. 24
A Note from Richard Doying, Executive Vice President ..... 26
About MISO ................................................................. 28

Acknowledgment

MISO would like to thank the MISO Board of Directors for its initiation and leadership in setting the direction for this report. MISO appreciates the partnerships with stakeholders, industry experts, and researchers as it generates insights and explores solutions.
A Message from John Bear, CEO

One year ago in early March, days after we published the 2020 MISO FORWARD report on utilities of the future, we closed our offices to non-essential workers. Like other companies, we rolled our risk management plans and made adjustments. As our lives changed and many of us worked from home, we experienced significant shifts in load patterns. In the fall, our operators and members leveraged extensive training and drills to manage the grid throughout a series of devastating hurricanes.

Resilience and reliability are at the core of MISO. While none of us forecasted 2020 to play out the way it did, we were able to better navigate sudden changes by being prepared in advance for emergencies. Communication plans, designated teams, redundant operations in multiple control rooms, staff training and more enabled us to be nimble and focus on critical decisions.

At a broader level, gathering insights from across the energy ecosystem allows MISO to better understand what risks — both upside and downside — might be on the horizon. We can use these as we work through multi-year efforts to redefine markets, upgrade our platforms, enhance tools for our operators and develop robust transmission plans.

In the 2020 MISO FORWARD Report, we heard from members across our footprint that major drivers for decarbonization were customer preferences. In looking closer at end-user needs in this year’s report, the imperative is even more pronounced for MISO to address changing member needs by advancing our Reliability Imperative initiatives, including redefining markets and updating the approach for transmission cost and benefit sharing.

Learning from what we share and what makes us unique will continue to increase the collective value of the diversity in the MISO footprint. By being proactive and collaborative, we will establish a wide funnel for ideas and a narrow filter to advance durable solutions. These solutions will need to provide flexibility across a range of scenarios as we prepare for an uncertain future. We look forward to working together as we move forward.

Sincerely,

John Bear

Learning from what we share and what makes us unique will continue to increase the collective value of the diversity in the MISO footprint. By being proactive and collaborative, we will establish a wide funnel for ideas and a narrow filter to advance durable solutions.
Executive Summary

ENERGY ECOSYSTEM EVOLUTION

MISO has an imperative to grow and adapt in response to industry transformation and its members’ evolving needs, driven largely by decarbonization of the electric sector. MISO’s Reliability Imperative report explains the ramifications of these changes across MISO and the far-reaching efforts underway to prepare the organization to meet its members’ needs and fulfill its mission of providing reliable and efficient operations. In prior MISO Forward reports, MISO explored these industry trends in detail and the specific areas it must focus its efforts under the Reliability Imperative. In this report, MISO explores one major driver of member decarbonization goals, customer preference, and how the rapid growth of decarbonization goals by MISO members creates additional needs and opportunities for MISO to provide value.

Following the 2020 MISO Forward Report, we explored four key topics that can help unlock the value of the diversity of utilities of the future: establishing future reliability criteria, redefining markets, updating the investment approach for transmission and enhancing communication and coordination. For 2021, MISO continues its focus on member needs by gathering insights on how adjacent industries are changing how they interact with the energy ecosystem. Electrification, sophisticated demand response, and increased bi-directional power flows are some of these changes. What does this mean to MISO’s members? How can MISO leverage these insights to better serve its membership?

INDUSTRY SECTORS ADJACENT TO THE ELECTRIC SECTOR

To gather insights around the ways adjacent industry sectors are evolving their relationship with the electric sector, MISO worked with West Monroe Partners to conduct research and interview large national and multi-national companies with multiple sites throughout the MISO footprint. Cross-functional teams at MISO collaborated to translate changes coming into implications for MISO’s planning, markets and operations. With that foundation, MISO engaged in dialog with member companies to help turn industry findings into value-add opportunities to explore. These are included in an updated action plan.

MISO’s research and company interviews found that across sectors, major companies publishing sustainability reports rose from 20% to more than 90% over the past decade. Increasingly, these included clean energy goals that became more ambitious and accelerated each year. Energy goals are often one aspect of broader decarbonization initiatives that look across the supply chain, Transportation, manufacturing and industrial processes provide opportunities for fuel switching to electricity. Such changes often involve more precise control and flexibility around electricity use and the ability to proactively schedule greater amounts of demand to align with low-carbon energy goals.

THE CHANGING NATURE OF DEMAND

In many ways, these changes present significant opportunities for MISO members. As both power plants and transmission infrastructure ages, buildout of wind and solar plants with lines to carry power helps end-customers meet their goals. Customer-side investments in smart charging, onsite generation and energy controls can shift demand to when desired supply attributes, such as low carbon, are available. Increased demand elasticity has the potential to transform energy markets while also providing grid operators an expanded toolset to manage real-time conditions. This transition to a more symbiotic nature carries substantial implications. However, the exact timing for each degree of change is highly uncertain, making it critical that MISO monitor change and maintain the ability to adapt quickly to respond to member needs.

MANAGING RISK AND ENHANCING STAKEHOLDER VALUE

To mitigate some of the risk related to that uncertainty, MISO heard two priorities repeatedly: broader collaboration and increased transparency into wholesale markets and market outcomes. These themes are core to the elements of the Reliability Imperative as well as five newer opportunities for exploration identified by MISO stakeholders and members:

1. Enhance coordination with members on flexible load for markets and operations
2. Gather a broader range of insights to understand potential future needs resulting from increased electrification and impacts to transmission planning and cost allocation
3. Share more granular predictive data on future resource availability attributes (locational, 1+ years, hourly rolling data – including estimates for energy, flexibility, power quality support, emissions intensity, etc.) to address the gap between MISO’s Operating Margin Forecast and Planning Resource Auction timeframes and beyond
4. Offer time and location emissions data as a service, similar to how MISO publishes actual energy price data
5. Develop distributed energy resource (DER) participation models that enable the value realization of local and transmission-level support capabilities

Many of these items are already included in some form in the Reliability Imperative and the Integrated Roadmap. An updated Action Plan on pages 24-25 of this report highlights how MISO will explore these customer-identified needs and direct efforts to develop solutions.
The energy ecosystem is evolving

**ADJACENT INDUSTRY SECTOR DEFINITIONS FOR THIS REPORT:**

**BUILDINGS:** In this look at the buildings sector, the focus is on companies with the ability to manage or influence decisions around energy for large volumes of buildings for end-use corporate customers. With the greater economies of scale, this perspective offers an early adopter indication of where the broader industry could move in the future. The building sector overlaps considerably with other sectors in this report.

**RETAIL:** For the retail sector, the focus is on large multi-site retailers that have the capabilities of scaling the value of minor energy improvements to achieve meaningful combined value. Large retailers are also large employers with notable voice in advocating with policy makers for decarbonization and other electric industry policies.

**INDUSTRIALS:** In addition to consumer products sold through retailers, the industrials sector is diverse, including agricultural processing plants, chemical and material manufacturing and heavy metals processing.

**FOSSIL RESOURCES:** Fossil resources include oil, as well as coal and gas — key upstream resources in the value chain for electricity. In this sector, the focus is on oil majors that have the investment appetite and scale to transform. As these companies shift closer to the electric sector, they are able to leverage their expertise in infrastructure and strong customer brand awareness in new ways.

**TRANSPORTATION:** In the transportation sector, the focus is on vehicle manufacturers, electric vehicle charging infrastructure companies and fleet operators, including ride sharing platforms.

**HIGH-TECH:** In the high-tech sector, global electric demand is increasing significantly due to the growth of data centers, which can be 200+ MW of demand in a single location or campus. This sector also provides technology solutions to utilities, grid operators and end-users, and is active in energy policy advocacy at state and federal levels.

Adjacent industries are moving closer, expanding both their needs for electricity and their capabilities of providing services from/to the electric sector.

[Size of bubble illustrates relative demand for electricity; Source: West Monroe Partners]
Change is far from homogenous, however. Each industry sector has unique capabilities and needs over varying timelines amid complex regulatory structures faced by multi-site companies. Different innovative approaches to meeting goals are under exploration. These approaches reinforce core elements of MISO’s Reliability Imperative and also present new opportunities to meet emerging member and stakeholder needs.

Source: Governance and Accountability Institute Flash Report S&P 500 2020

90% of S&P 500 Index and Fortune 200 Companies Published Sustainability / Responsibility Reports in 2019

The Greenhouse Gas (GHG) protocol categorizes a company’s GHG footprint into three different scopes: Scopes 1, 2 and 3.

GHG emissions can be translated to CO2 equivalents to have total emissions represented by one number – carbon emissions.

As companies seek to reduce their Scope 2 emissions (including emissions from purchased electricity), the growth rate of wind and solar procurement contracted through power purchase agreements is accelerating. Companies are also participating more in energy markets and utility programs to leverage flexible onsite resources, such as battery storage, electric vehicles and smart meters. On-site generation of clean electricity has increased six-fold since 2009. Across sectors, companies are exploring ways to generate their own electricity on-site not only to help achieve clean energy goals and manage price volatility, but also to improve resilience during extreme weather conditions.

Source: BSR

As priorities are shifting to include sustainability in the bottom line, companies are seeking strategic partnerships, mergers, or acquisitions to align their portfolio and capabilities with their goals.

Companies are increasingly looking for ways to reduce their Scope 1, 2, & 3 Greenhouse Gas emissions and reporting their efforts to third-party tracking organizations.

As companies seek to reduce their emissions, electrifying their fleet or operations is becoming a key strategy.

Companies are looking for ways to further engage – either directly or more often via utilities or aggregators – in retail and wholesale electricity markets to extract additional value from their assets through demand response and other load flexibility programs.

Companies across all sectors are looking to fulfill their energy supply needs with clean sources of electricity, including wind and solar.

Multiple drivers are leading governments, businesses and consumers to change the way they interact with the energy sector. An increasing number of states, utilities and businesses are pledging to be carbon-free. Among major corporations, the vast majority have sustainability and decarbonization goals in place. These often include investments and advocacy for change in the following areas:

- **CLEAN ENERGY PROCUREMENT**
- **EMISSIONS REDUCTION / DECARBONIZATION**
- **ELECTRIFICATION**
- **LOAD FLEXIBILITY**
- **PARTNERSHIPS AND ACQUISITIONS**

Corporates are pursuing increasingly advanced methods to achieve decarbonization goals

Multiple drivers are leading governments, businesses and consumers to change the way they interact with the energy sector. An increasing number of states, utilities and businesses are pledging to be carbon-free. Among major corporations, the vast majority have sustainability and decarbonization goals in place. These often include investments and advocacy for change in the following areas:

- **CLEAN ENERGY PROCUREMENT**
  - Companies across all sectors are looking to fulfill their energy supply needs with clean sources of electricity, including wind and solar.

- **EMISSIONS REDUCTION / DECARBONIZATION**
  - Companies are increasingly looking for ways to reduce their Scope 1, 2, & 3 Greenhouse Gas emissions and reporting their efforts to third-party tracking organizations.

- **ELECTRIFICATION**
  - As companies seek to reduce their emissions, electrifying their fleet or operations is becoming a key strategy.

- **LOAD FLEXIBILITY**
  - Companies are looking for ways to further engage – either directly or more often via utilities or aggregators – in retail and wholesale electricity markets to extract additional value from their assets through demand response and other load flexibility programs.

- **PARTNERSHIPS AND ACQUISITIONS**
  - As priorities are shifting to include sustainability in the bottom line, companies are seeking strategic partnerships, mergers, or acquisitions to align their portfolio and capabilities with their goals.

As companies seek to reduce their Scope 2 emissions (including emissions from purchased electricity), the growth rate of wind and solar procurement contracted through power purchase agreements is accelerating. Companies are also participating more in energy markets and utility programs to leverage flexible onsite resources, such as battery storage, electric vehicles and smart meters. On-site generation of clean electricity has increased six-fold since 2009. Across sectors, companies are exploring ways to generate their own electricity on-site not only to help achieve clean energy goals and manage price volatility, but also to improve resilience during extreme weather conditions.

Change is far from homogenous, however. Each industry sector has unique capabilities and needs over varying timelines amid complex regulatory structures faced by multi-site companies. Different innovative approaches to meeting goals are under exploration. These approaches reinforce core elements of MISO’s Reliability Imperative and also present new opportunities to meet emerging member and stakeholder needs.

As companies seek to reduce their Scope 2 emissions (including emissions from purchased electricity), the growth rate of wind and solar procurement contracted through power purchase agreements is accelerating. Companies are also participating more in energy markets and utility programs to leverage flexible onsite resources, such as battery storage, electric vehicles and smart meters. On-site generation of clean electricity has increased six-fold since 2009. Across sectors, companies are exploring ways to generate their own electricity on-site not only to help achieve clean energy goals and manage price volatility, but also to improve resilience during extreme weather conditions.

**Source:** Governance and Accountability Institute Flash Report S&P 500 2020

**90% of S&P 500 Index and Fortune 200 Companies Published Sustainability / Responsibility Reports in 2019**

The Greenhouse Gas (GHG) protocol categorizes a company’s GHG footprint into three different scopes: Scopes 1, 2 and 3.

GHG emissions can be translated to CO2 equivalents to have total emissions represented by one number – carbon emissions.

As companies seek to reduce their Scope 2 emissions (including emissions from purchased electricity), the growth rate of wind and solar procurement contracted through power purchase agreements is accelerating. Companies are also participating more in energy markets and utility programs to leverage flexible onsite resources, such as battery storage, electric vehicles and smart meters. On-site generation of clean electricity has increased six-fold since 2009. Across sectors, companies are exploring ways to generate their own electricity on-site not only to help achieve clean energy goals and manage price volatility, but also to improve resilience during extreme weather conditions.

**Source:** BSR

As companies seek to reduce their Scope 2 emissions (including emissions from purchased electricity), the growth rate of wind and solar procurement contracted through power purchase agreements is accelerating. Companies are also participating more in energy markets and utility programs to leverage flexible onsite resources, such as battery storage, electric vehicles and smart meters. On-site generation of clean electricity has increased six-fold since 2009. Across sectors, companies are exploring ways to generate their own electricity on-site not only to help achieve clean energy goals and manage price volatility, but also to improve resilience during extreme weather conditions.

**Source:** BSR

As companies seek to reduce their Scope 2 emissions (including emissions from purchased electricity), the growth rate of wind and solar procurement contracted through power purchase agreements is accelerating. Companies are also participating more in energy markets and utility programs to leverage flexible onsite resources, such as battery storage, electric vehicles and smart meters. On-site generation of clean electricity has increased six-fold since 2009. Across sectors, companies are exploring ways to generate their own electricity on-site not only to help achieve clean energy goals and manage price volatility, but also to improve resilience during extreme weather conditions.
Adjacent industry sectors are transforming what is possible

BUILDINGS
How energy is consumed and how portfolios of buildings use energy collectively is changing as technology advancement continues in clean energy, smart buildings, electric vehicle parking, the Internet of Things and 5G. Combined with the adoption of sustainability targets in this sector, the business case for energy-related investments and the business model for energy services is changing. As building customers look for more options to purchase 100% clean energy that help achieve sustainability targets, many investors and commercial developers see onsite clean energy enhancing their brand. Onsite options are critical for hospitals, for example, where a power outage can have a significant impact in a short period of time. Controlled islanding solutions are becoming more diverse and include microgrids, co-generation, energy storage and solar power. Onsite capability can help mitigate energy price volatility in some areas and have nearer-term returns in high-risk areas.

RETAIL
Retail chains often have extensive diversity in energy uses, such as refrigeration, heating, cooling, kitchen exhaust fans, lighting, and fast charging stations in customer parking lots. Increasingly, these can be sub-metered and controlled individually from a central location. Many retailers also have large vehicle fleets, including refrigerated trucking and forklifts. Retail decarbonization goals can include carbon-free energy targets, onsite solar goals, supplier energy initiatives, thermal load, and plans to convert to carbon-free fleets. Options are open on how to achieve some of these. With respect to vehicle fleets, for example, both green hydrogen and electric vehicles are possible options.

INDUSTRIALS
Today only a subset of large industrial end-users participate in MISO’s markets, often offering in emergency demand response capabilities. Collectively, many companies in this sector are evolving their operations and what they need from the energy ecosystem. Given the importance of electricity in terms of reliability, price and power quality to the industrial sector, much of the lower-hanging fruit in terms energy efficiency improvements have been made, and many companies have onsite energy resources. As these companies pursue their publicly announced decarbonization goals with increased automation, robotics and electrification, their electric demand could substantially increase. Innovation efforts for many companies in this sector focus on ways to create new, breakthrough technologies to reduce emissions across the value chain, from operations to products and solutions. This sector designs products ranging from energy-efficient building envelope materials to smart appliances for consumers.

FOSSIL RESOURCES
In addition to partnering with industrials on electrification of energy intensive processes, some oil majors are making multi-billion dollar investments each year in electric vehicle charging, distributed energy resources, smart building automation, on/off-shore wind, solar and hydrogen. While electrification of passenger vehicles is dominated by batteries, companies in this sector also view hydrogen as offering a potential path forward to decarbonize heavy-duty fleets and aviation. Green hydrogen that uses clean energy to power the electrolysis of water can also be used for week-long electricity storage. This would be highly beneficial to managing grid operations in a future with high wind and solar buildout. However, green hydrogen will need to achieve economies of scale to be economically feasible, along with access to low-cost, clean energy to meet the increased electric demand of electrolysers.

TRANSPORTATION
High electric vehicle penetration may hinge on sufficient buildout of vehicle charging infrastructure and related investments at the transmission and distribution level to support increased energy demand. Early adopters are fleet operators for short-haul deliveries, busses and others in the public sector. Fleet charging profiles can vary widely by commercial purpose. Current business models for charging are changing from a more passive use of utility rates that encourages customers to react to price signals toward more active control where automakers, utilities or aggregators manage charging on behalf of the customer. Once matured, aggregated and anonymized data can increase visibility of demand patterns to grid operators. Bi-directional Flows could be possible. Dealer lots with hundreds of vehicles, for example, could be used as grid assets. Advancements in telematics currently being piloted enable vehicle charging to align with customer objectives, such as economic benefits from peak shaving or intervals with high wind.

HIGH TECH
To meet the high and growing demand for energy, companies in this sector are global leaders in clean energy offtake agreements. While early adopters of direct wind and solar procurement, examples of more recently announced decarbonization goals include net-zero emissions by 2030 and matching data center energy use to carbon-free energy generation output on an hourly basis. To achieve these goals, companies are piloting emerging energy technologies such as green hydrogen and long duration battery storage for onsite backup generation. They are investing significantly in ways to improve data center energy efficiency, optimizing computationally intensive activities and approaches to cooling, leveraging core competencies in machine learning, artificial intelligence models and cloud computing, companies in this sector work with hundreds of utilities on end-user smart energy solutions and demand response programs. This includes multi-billion dollar annual investments in Internet-of-Things and intelligent edge use for energy related industries.
As a result, many utilities are accelerating energy transition plans for decarbonization

In the past five years, the percentage of end-users in MISO’s footprint served by utilities with 80% or higher decarbonization plans has grown from almost zero to more than 80%. Customers are also expecting more choice, control and convenience from their provider. Utilities are responding with increasing buildout of wind and solar plants, along with distributed energy resource (DER) products and programs. Costs for clean energy technologies are continuing to decrease, strengthening the business case for these investments.

This energy transition carries both reliability and financial risks, not all of which are incorporated into cost sharing for transmission or clearly reflected in current wholesale energy prices. MISO recently published two papers that explore these risks in more detail: Renewable Integration Impact Assessment (RIIA) and Redefining Energy and Ancillary Services Markets. RIIA identifies five areas of risk as the system integrates more wind and solar: 1) stability risk, 2) shifting periods of grid stress, 3) shifting periods of energy shortage risk, 4) shifting flexibility risk, and 5) insufficient transmission. The markets report focuses on how markets must adapt to the changing resource mix and explicitly account for a range of possible outcomes and optimize amidst increasing uncertainty. This includes managing uncertainty to address risk, enhancing resource models to improve flexibility, addressing locational constraints to enhance availability, and advancing coordination to gain sufficient visibility.

Shifting risks are the major driver for MISO’s Reliability Imperative. The next section outlines efforts to help de-risk paths forward to ensure the system has sufficient availability, flexibility and visibility in the future as members pursue decarbonization goals.

Utility Decarbonization Goals by Year Announced show that over the past three years many utility goals have been replaced shortly with more aggressive goals.

We want to make sure that we incorporate the adjacent sectors, both within our industry as well as those that we rely upon, early on and engage them around broader discussions of system needs. We will need them to integrate more in terms of knowledge and transparency so they can continue to understand the importance of reliability to the utility and ISO. We all need to be in this together, and we each have a role and a responsibility. As a load-serving entity, we are focused on ensuring reliability for our customers and members. We are going to need to be able to see more of what’s happening at every level within our industry. We want these adjacent sectors involved and for them to know what it takes to be a part of the system.

Priti Patel
Vice President & Chief Transmission Officer
Great River Energy

We have a good mix of demanding customers on our system including paper mills and other industrial customers. We need to make sure we can meet their needs not only for energy but also power quality. We have a strong partnership with the industrial world to explore the effects of the changing resource mix on their needs. There could be a need for MISO to have market products for resources that can provide dynamic var and short circuit capability in sub-regional locations.

Mike Pullen
Chief Operating Officer
Big Rivers Electric Corporation
MISO’s Reliability Imperative is heightened by accelerated timelines for decarbonization

Transparency will be key to unlocking the potential from changing utility resource fleets and adjacent sectors to provide the major grid needs identified in previous MISO FORWARD reports: availability, flexibility and visibility. These needs helped inform MISO’s Reliability Imperative, which is a continuation and broadening of the Action Plan laid out in previous reports. Multiple initiatives are designed to work in concert with each other to mitigate the challenges facing the region. These are organized into four categories:

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 the region increasingly faces 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.

LONG-RANGE TRANSMISSION PLANNING
This effort is designed to identify what transmission the MISO 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.

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 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.

MARKET SYSTEM ENHANCEMENTS
This category of work is designed to transform MISO’s historical system — which was built in the early 2000s — 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. Innovation efforts throughout the energy ecosystem and adjacent sectors will create new opportunities for addressing changing risks and require coordination around integration.

Xcel Energy is leading the clean energy transition with a plan that will reduce carbon emissions 80% by 2030 in pursuit of our vision to deliver 100% carbon-free electricity by 2050. Key to this strategy will be identifying and building new transmission infrastructure that can ensure we meet these goals while also maintaining reliability, affordability and safety for our customers and communities. We’ll work with MISO and other stakeholders throughout the region to develop plans that meet the system’s real-time demands and also enable the new carbon-free energy that will help energy providers throughout the country meet our shared goals.

John Welch
Vice President, Commercial Operations
Xcel Energy
Innovation is critical to addressing changing risks and meeting the reliability imperative

In addition to significant buildout of wind and solar, decarbonization efforts include innovation on both supply and demand side resources. Understanding the role of emerging technologies in the grid will require collaboration across the energy ecosystem, with adjacent sectors, with research partners in academia, think tanks, national labs and others. Continued investigation, analysis and pilots are integral to MISO’s initiatives addressing the Reliability Imperative. This section highlights emerging resources MISO members and adjacent sectors are investing in and how they offer new ways of providing grid needs and managing uncertainty.

**ELECTRIC VEHICLES**
To meet the transportation sector’s near-term needs, charge management and the dispatch of demand is a priority for cross-sector collaboration. Without advancements in telematics and coordination, unmanaged charging in a future with widespread electric vehicle adoption could create significant risk for the transmission system in terms of unpredictable and volatile load patterns. Learning in this area can guide more complicated decisions related to vehicle to grid dispatch and market optimization in the future.

**ENERGY STORAGE**
Buildout of energy storage resources is lower in the mid-continent than other regions. However, as additional wind and solar facilities are constructed, storage can provide both grid services and mitigate congestion risks. Hybrid plants can participate more closely to a traditional gas plant, depending upon the configuration.

**FLEXIBLE DEMAND**
This includes leveraging onsite generation or storage, smart building management systems and sophisticated residential demand programs.

**GREEN HYDROGEN**
While facing near-term cost hurdles, economies of scale and diversity of end-uses (electricity, transport fuel, industrial heat, etc.) could improve the business case for this technology. Many developers and utilities are investing in green hydrogen pilots and converting existing gas plants to be capable of running on green hydrogen. NREL estimates that green hydrogen could economically provide one-week duration storage as early as 2025.

**ADVANCED TRANSMISSION TECHNOLOGIES**
These include real-time topology optimization, advanced power flow controllers and dynamic line ratings. Leveraging many of these emerging technologies would require a detailed analysis of impacts to related systems and further enhanced coordination with asset owners.

**HVDC MACROGRID**
Advancements in HVDC conductor cables and Voltage Sourced Converters can improve security of supply, provide grid services and increase flexibility. The macrogrid concept, which connects regional grids, is a core component of ESIG’s Transmission Planning for 100% Clean Electricity report.

**SMALL MODULAR NUCLEAR**
Early in the pilot stage of development, SMRs are smaller and more economic than large nuclear plants while offering carbon-free, base-load energy.

“Digital transformation and sustainability are increasingly at the top of the agenda for every business. As part of our own 2030 goal of running entirely on carbon-free energy at all times, we are more closely knit with the electric industry than ever before. Collectively, the more dialog and runway we give ourselves, the more collaborative, proactive, and transformational we can be together.”

Raiford Smith
Energy, Analytics and Markets
Google

“We are planning for an increasingly uncertain future, one full of opportunities and challenges. New tools, planning frameworks, market and regulatory mechanisms, and technologies must be deployed to address evolving customer needs, to navigate the transition towards a lower-carbon economy, and to continue to ensure that we balance affordability, reliability, and sustainability. We are partnering with industry experts on new and evolving technologies, with our customers to help them meet their reliability and climate-related goals, and with MISO to ensure that appropriate rules and market-based instruments are in place to ensure that the electric grid is capable of meeting those opportunities and challenges in a manner that is equitable and beneficial to all customers.”

Elizabeth Adams
Vice President Enterprise Planning
Entergy
Innovation is also changing the nature of demand with implications across industries

Consumer preference and sustainability goals are driving adoption of emerging technologies and will carry significant implications for what is needed from the grid. Despite the uncertainties around the timing and nature of change, considering possible outcomes is essential to risk management.

**Electrification** /// **Increase in demand** — Some innovations could be more than a decade away, such as the electrification of intensive steam processes like crackers used to make base chemicals. Other innovations are occurring today in the electrification of industrial fleets; motors such as pumps, compressors and elevators; passenger vehicles; and space and water heating. Achieving the decarbonization objective of near- and long-term investments will require the ability to rely on the supply of low-carbon energy from the grid. Electric demand could be further amplified by the buildout of green hydrogen. Customers will continue to need reliable and affordable electricity. As such, both transmission infrastructure and energy resource planning efforts must consider what would be required to meet these future needs.

**Digitalization** /// **Increase in elasticity of demand** — As investments in advanced energy controls and clean energy are made, commercial buildings, homes, data centers, industrial plants and fleets have the potential to become valuable and flexible resources to the grid. Active demand management, such as light dimming, pre-cooling, water heating and vehicle charging, can be scheduled to align with grid forecasts for wind and solar output to optimize the use of weather dependent energy. Flexible demand is transforming to be more active and load capable of five-minute dispatch is growing.

**Integration of newer energy technologies** /// **Increase in need for data and coordination** — The characteristics, capabilities and constraints of grid resources differ by resource type. Availability of fuel source, minimum run time, start-up time, speed of ramp, ability to respond quickly to signals, foresight needed to optimize operations and other factors can all vary substantially depending on the resource technology. In addition to refined resource participation models, enhancing data transparency on the supply and demand side will be needed to improve coordination to efficiently manage risk.

**Emission reporting** /// **Increase in need for emissions data services** — Many utilities in MISO’s footprint with decarbonization goals need to report on their own fleet emissions as well as the emission factors for energy purchased through MISO’s markets. Many large corporates also report on emissions and often face painstaking data collection processes to gather input from sometimes hundreds of different utilities given the companies’ geographic spread. Enhanced data transparency on grid emissions factors from a more centralized source like MISO was one of the top requests MISO heard in its research interviews for this report. This was important to stakeholders for energy resource planning, emissions reporting and aligning operations with low carbon energy output.

Preparing for a range of potential outcomes will require close collaboration with MISO stakeholders.

Today, our energy portfolio is 50% renewable. Our steel customers see their product as the greenest steel you can buy in the world. But they also don’t want to be the most expensive because they compete at a global level. ‘What does the future grid look like, so we can participate in that?’ That’s what they want to know. We are planning now for a future where they can make their operations more variable and they can participate to keep their costs lower. To date, adjusting operations for the flexibility of the grid hasn’t been attractive enough for them to participate to complement emerging renewables. That could be the biggest market impact we could see. Electrification is a big element of that. A lot of their operations currently run on other fossil fuels that could be replaced and run in part or in whole by electricity. Unfortunately the value proposition isn’t there for them yet, because investing in operations for demand response isn’t valued the same way as a generation resource.

Daniel Gunderson
Vice President Transmission and Distribution
Minnesota Power
Insights and collaboration across sectors can help navigate uncertainty in transition

Far from all companies across adjacent industry sectors are game changers in terms of how they see their interaction with the electric sector evolving. Now more than ever, the future is hard to predict and the changing nature of demand comes with many questions. How much, when and where will we see change? While the answers to these questions are still coming into focus, outlines can be seen in the actions of early movers.

Continuing to foster discussion, engage in workshops and explore the art of the possible across the energy ecosystem will be essential to bringing needs and potential solutions into clearer focus. The diversity across the energy ecosystem in MISO’s footprint provides significant shared value. Continuing to gather and synthesize insights on what’s needed as end-user needs evolve enables MISO to create enduring value for members and their customers.

Broader collaboration and increased transparency were among the pain points MISO heard from both its member utilities and stakeholders in adjacent industry sectors. A high priority is for speed in building out transmission to support new wind and solar generation. In many discussions, key themes were reinforced: the need for carbon goals and electrification to be considered in transmission planning, reduced interconnection process timelines, more comprehensive price signals that better reflect the costs and value of resources, and greater transparency around future needs and constructs. Members are looking to MISO to help mitigate both price and reliability risk during the energy transition as they work to meet aggressive decarbonization goals of their own and the often-accelerated timelines of their customers.

In the next section, we will explore some of these potential next steps.

Many of the same pain points and needs arose multiple times throughout conversations with companies across adjacent industries

<table>
<thead>
<tr>
<th>Pain Point</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of Reliable, Affordable, Clean Electricity 24/7</td>
<td>9</td>
</tr>
<tr>
<td>Improved Incentives to Participate in Exchanges</td>
<td>8</td>
</tr>
<tr>
<td>Lack of Carbon Intensity Data</td>
<td>7</td>
</tr>
<tr>
<td>Lack of Visibility into Transmission Access</td>
<td>6</td>
</tr>
<tr>
<td>Inadequate End Customer Engagement</td>
<td>5</td>
</tr>
<tr>
<td>Lack of Forward Data Transparency and Granularity</td>
<td>4</td>
</tr>
</tbody>
</table>

Our country’s future energy security and sustainability depends on a strong transmission system to enable the transition from coal to renewable energy. The ability for us to expedite this process quickly and efficiently is paramount in terms of how the utility industry is evolving with the commercialization of digital technologies and electrification. Ameren, MISO and other industry partners must be able to pivot and accelerate this energy transition with a sense of urgency. If we can’t respond with agility to provide critical solutions based upon our customers’ ambitious targets, they will look elsewhere. MISO’s quick response helps drive the facilitation of a low-carbon energy future that will meet customer expectations, optimize operations and cultivate investments in our nation’s energy system.

Shawn Schukar
Chairman & President
Ameren Transmission Company
Insights point to further areas to explore as MISO advances its Reliability Imperative

In gathering insights on an ongoing basis, MISO is able to identify new areas of exploration that can help guide some of these initiatives or eventually develop into new elements of MISO’s roadmap. In listening to our members and adjacent sector industries, five key issues surfaced for further exploration.

**ENHANCING COORDINATION WITH MEMBERS ON FLEXIBLE LOAD** for markets and operations. Building on work with the Resource Availability and Need Program, as well as the 2020 Redefining Energy and Ancillary Services Markets Report, MISO will focus on stakeholder engagement throughout 2021 to further define and prioritize what is needed for Markets of the Future. In addition to topics covered in earlier reports, further understanding the potential to integrate flexible load in market constructs will be important to consider across these efforts.

**GATHERING A BROADER RANGE OF INSIGHTS** to understand potential future needs resulting from increased electrification and impacts to transmission planning and cost allocation. In the most recent MISO Futures, the Future 2 scenario shows a 30% increase in energy demand for 2040 while Future 3 shows a 50% increase. MISO’s Electrification Insights Report explores what this means for transmission planning. The Renewable Integration Impact Assessment Report also looks at implications for transmission development for futures with high wind and solar buildout.

**SHARING MORE GRANULAR PREDICTIVE DATA** on future resource availability attributes (e.g., locational, 1+years or hourly rolling data that includes estimates for energy, flexibility, power quality support, emissions intensity, etc.) to enhance developer siting of new resources and buildings/data centers. In addition, it can address the gap between MISO’s Operating Margin Forecast and Planning Resource Auction timeframes and beyond (e.g., predicted ELCC values for future years). Five years ago, this might have seemed impossible. With advancements in data analytics and cloud/fog computing, it could be valuable to explore the feasibility of potential approaches to provide this as a service.

**OFFERING TIME AND LOCATION EMISSIONS DATA** in a similar way to how MISO publishes actual energy price data to provide a streamlined source of data and enable market participants to understand emissions factors for wholesale energy transactions. This is a newer area for MISO to consider. It will be valuable to explore this issue further with stakeholders to better understand both what is possible and what is needed.

**DEVELOPING DISTRIBUTED ENERGY RESOURCE (DER) PARTICIPATION MODELS** that enable value realization of support capabilities. MISO’s Distributed Energy Resource Program jointly with the Organization of MISO States has hosted a series of workshops to cultivate discussion with MISO members and other stakeholders across the transmission and distribution interface related to planning, markets and operations. These will continue throughout 2021. MISO will continue to work closely with stakeholders as it develops a compliance plan for FERC Order 2222 on DER participation in wholesale markets.

These areas of exploration and progress on initiatives identified in earlier MISO FORWARD reports are included in MISO’s Action Plan.
### ACTION PLAN HIGHLIGHTS

Additional details on these initiatives can be found in [MISO's Reliability Imperative](#) and the [Integrated Roadmap](#).

<table>
<thead>
<tr>
<th>AVAILABILITY</th>
<th>FLEXIBILITY</th>
<th>VISIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Gather insights from a broader range of stakeholders on future needs from electrification, impacts to transmission planning</td>
<td>- Extend market definition work to provide an outline of Markets of the Future</td>
<td>- Offer emissions data along with the energy price data MISO currently provides</td>
</tr>
<tr>
<td>- Understand benefits/cost allocation for identified Long Range Transmission Plan projects</td>
<td>- Enhance coordination with members on flexible load for markets and operations</td>
<td>- Share more predictive granular data on future resource availability attributes</td>
</tr>
<tr>
<td>- Study non-transmission alternative solutions and increased potential for High Voltage Direct Current (HVDC) lines</td>
<td>- Develop distributed energy resource (DER) participation models that enable value realization of local and transmission level support capabilities</td>
<td></td>
</tr>
<tr>
<td>- Develop long-term regional resource mix assessments of changing reliability risk profiles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AVAILABILITY</th>
<th>FLEXIBILITY</th>
<th>VISIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Decide on integration of smart transmission technologies (e.g. ambient adjusted and dynamic line ratings)</td>
<td>- Develop Multiple Configuration Resources (previously titled Enhanced Modeling of Combined Cycle Generators)</td>
<td>- FERC Order 2222 Compliance</td>
</tr>
<tr>
<td>- Enhancements for long lead units and self-commitments</td>
<td>- Build Short Term Reserve product</td>
<td>- Enhance Market-to-Market coordination processes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AVAILABILITY</th>
<th>FLEXIBILITY</th>
<th>VISIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Improve emergency and scarcity pricing</td>
<td>- Build Storage Phase 1 market participant model (FERC 841)</td>
<td>- Continue Market System Enhancement</td>
</tr>
<tr>
<td>- Develop alternatives to the current annual resource adequacy construct</td>
<td></td>
<td>- Improve seams via Joint Study with SPP</td>
</tr>
<tr>
<td>- Enhance resource accreditation</td>
<td></td>
<td>- Continue Customer Relationship Management System</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Host distributed energy resources stakeholder workshops jointly with the Organization of MISO States</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AVAILABILITY</th>
<th>FLEXIBILITY</th>
<th>VISIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>- MISO’s Response to the Reliability Imperative</td>
<td>- FERC approval for solar generation to register as Dispatchable Intermittent Resources</td>
<td>- Updated tariff language for Aggregator of Retail Customers (ARCC) participation</td>
</tr>
<tr>
<td>- RRA Report</td>
<td></td>
<td>- Improved Relief Request Algorithm Used for Market-to-Market Seams</td>
</tr>
<tr>
<td>- Electrification Insights Report</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A Note from Richard Doying, Executive Vice President

Dear Friends of MISO,

Looking forward, we are beginning to see a shift in the paradigm of how different industry sectors interact with the electric industry. Large companies in the buildings, retail, industrial, fossil fuels, transportation and high-tech sectors are evolving into a more symbiotic relationship in terms of what they need and can provide the electric sector. New needs and capabilities are being driven by decarbonization goals and by opportunities enabled with the decentralization and digitalization trends that we’ve covered in previous MISO FORWARD reports. In many cases, those needs translate to new demands on or opportunities for MISO members. MISO can help members meet some of those needs by understanding how to serve members as they evolve.

In last year’s report, we highlighted how the future energy ecosystem will be increasingly diverse and that MISO can help members leverage that diversity to create shared value. We outlined how utilities of the future may look not only different from today but different from each other. From our utility members, we heard that customer preferences were a major driver for the choices they were making for the future. With this in mind, this year we listened to large end-users at the forefront of change to help us understand what we need to prepare for in order to best meet our evolving member needs. Because preparing for these changes is multi-faceted, these insights are a key aspect of risk management. They offer foresight to prepare for changes that could entail multiple years of research, development and collaboration with stakeholders throughout our footprint.

For that reason, we continue our efforts to gather insights on needs for the future to support MISO’s broader Reliability Imperative. We identify new areas to ‘Explore’ to feed a wide funnel. As we learn more, that funnel narrows. Initiatives that are prioritized move to ‘Decide’ and eventually to the ‘Do’ phase of our development framework. This year, in our listening tour across adjacent sectors and a broad range of MISO stakeholders, five common themes emerged as opportunities for MISO to further ‘Explore’:

1. Enhance coordination with members on flexible load for markets and operations
2. Gather a broader range of insights to understand potential future needs resulting from increased electrification and impacts to transmission planning and cost allocation
3. Share more granular predictive data on future resource availability attributes (locational, 1+ years, hourly rolling data – including estimates for energy, flexibility, power quality support, emissions intensity, etc.) to address gap between MISO’s Operating Margin Forecast and Planning Resource Auction timeframes and beyond
4. Offer time and location emissions data as a service in a similar way to how MISO publishes actual energy price data
5. Develop distributed energy resource (DER) participation models that enable value realization of local and transmission level support capabilities

Many of these align well with work already underway at MISO, such as DER Program initiatives and our electrification study. Others, such as emissions data as a service, are newer. For all of them, we will need to work closely together with our members and research partners to create additional value for our stakeholders.

Sincerely,

Richard
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 10 Independent System Operators (ISO) 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 $22 billion in annual gross market charges in 2020. 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 184,000 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.

KEY FACTS

- 5-minute dispatch
- $22 billion gross market charges (2020)
- More than 450 market participants
- 42 million end-use customers