MISO and DER

Ensuring Grid Reliability Through Visibility and Communication

MISO works collaboratively with stakeholders to understand the implications of Distributed Energy Resource (DER) growth, including the exploration of reliability coordination, planning, resource adequacy and market effects.

Why is DER Visibility Important?

- Reliable operation of the regional transmission grid requires continuous monitoring of flows on the grid. MISO Operations has very limited visibility into activity on the distribution system; this includes real-time changes to load and energy generated behind the MISO meter or at a commercial scale, which affects transmission flow.

- Reliably balancing supply (capacity) and demand (load) for electric power requires detailed and accurate forecasting. Distributed generation, which supplies power to load directly, masks the need for wholesale power when distributed power is unavailable.

- Operation of the electric grid involves complex modeling to maintain reliability, inform resource/infrastructure investments, and administer wholesale energy and ancillary services markets.

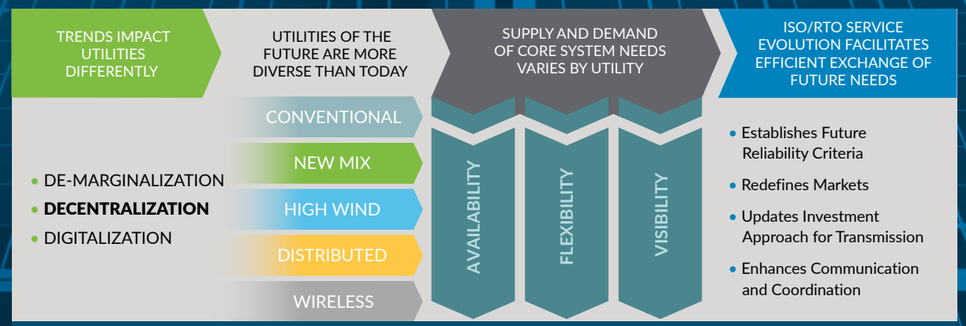
MISO

misoenergy.org

De-marginalization

Decentralization

Digitalization



Insights inform strategic action plans focused on cultivating a reliable and efficient ecosystem of exchange for utility needs

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The DER Visibility report addresses enhanced communication and coordination, which was identified as necessary for an exchange of future needs in the 2020 MISO FORWARD report.

Executive Summary

MISO's vision to be the most reliable, value-creating Regional Transmission Organization (RTO) requires understanding the shifting resource mix; examining existing market products and effects; and enhancing its capabilities to meet the needs of its members and stakeholders as they enable the energy future.

The 2019 MISO and DER framing report details the paradigm shift to decentralization. This paradigm shift entails more small-scale generation resources, demand response resources, and storage (all forms of DER) being added to local distribution systems, with reliability implications of increased real-time variability and uncertainty, changing net load patterns, limited visibility and ability to forecast, as well as potential two-way power flows.

Today MISO has more than 11.5 GW of DER in the form of demand response and behind-the-meter generation that participates as emergency only resources. The latest Organization of MISO States (OMS) DER survey indicates an additional 3.8 GW of installed DER capacity in MISO's footprint. For assets that don't participate in the day-ahead and real-time market, MISO has no direct mechanism to monitor the performance, scheduling or capabilities of these units or their effect on transmission system flows. The processes and systems MISO uses to ensure reliability must be updated to more accurately assess the power flows on the entire electric system, including the DER impact on the bulk transmission system. For those DER megawatts of resources in MISO's markets, it means understanding where these assets are located, how they operate, and what drives increases or decreases in output.

FERC Order 2222 (September 2020) requires RTOs to enable full participation of Distributed Energy Resource Aggregators (DERAs) in MISO's markets. The DER program team at MISO, in conjunction with the OMS and MISO's stakeholder community, has been investigating DER visibility since 2018, well before the FERC Order 2222 was published. Increasing the visibility of DERs requires investigating new methods of communication across the transmission/distribution boundary, collaborating with partners to understand the state of the industry, and examining MISO's systems and markets.

MISO's DER strategy prioritizes ensuring reliability and maturing foundational capabilities to meet the evolving grid within operations, markets and resource planning. This strategy is aligned with MISO's Reliability Imperative, which seeks to mitigate challenges and leverage opportunities that are presented by the changes transforming the region.

MISO'S DER STRATEGY

Ensure

Address identified issues with existing markets, tools and processes to ensure continued reliable and efficient operations.

Enhance

Support reliability and market efficiency by updating existing markets and processes for DERs including Demand Response (DR), Aggregators of Retail Customers (ARC), Load-Modifying Resources (LMR) and supply resources (such as storage or behind-the-meter solar). Jointly investigate both near- and long-term communication and visibility needs; and evaluate solutions.

Enable

Prepare for the future by identifying additional enhancements to enable the capabilities of DERs to support grid reliability and participate in wholesale markets.

To better understand visibility needs and potential models, there are three key areas of research that inform this report: first gathering customer insights, then investigating integration models and conducting solution brainstorming workshops, combined with evaluating evolving policies across the region.

UTILITY INSIGHTS

MISO developed and deployed a survey to gather MISO utility members' thoughts about DER communication as the penetration grows in the MISO footprint. Most utilities surveyed believe increased communication with MISO about DER performance is necessary to protect the reliability of the Bulk Electric System (BES). Overall, MISO members and market participants are still learning, monitoring participation and gathering information as DER grows.

INTEGRATION MODELS

MISO examined four alternative integration models to identify potential changes to functions and processes to ensure continued reliable and efficient operations given higher levels of DERs. These models also identified the potential needs for new visibility, communication and coordination between MISO, current stakeholders and new DER-related entities. This exercise is not intended to propose a solution; rather, MISO utilizes this type of evaluation to shape future workplans and stakeholder engagement.

VISIBILITY/COMMUNICATIONS POSSIBILITIES BRAINSTORMING

In early 2020, MISO held brainstorming workshops with 10 different potential technology partners and vendors to explore the state of the industry and a range of potential solutions. What is possible in terms of data monitoring, metering, communication, quality, latency, security, etc., is more advanced than even five years ago.

KEY TAKEAWAYS

The research that MISO has completed thus far will be helpful as it begins to consider its response to the recently released FERC Order 2222. MISO's vision of being the most reliable, value-creating RTO will remain on the forefront and enhanced visibility will be critical. Through utility insights, examination of potential integration models and solution brainstorming with vendors, the following key insights emerge:

- DER information must be incorporated into development of planning models
- Significant DER deployment changes forecast assumptions
- Communication between members and MISO will evolve as DER grows
- Integration models exist that can help MISO and stakeholders understand potential relationships between MISO, utilities and other parties who operate DERs
- While a single solution for a multi-state RTO does not currently meet all visibility needs, options do exist to improve situational awareness

NEXT STEPS

MISO will continue to collaborate with stakeholders to ensure states and utilities are aware of the opportunities and challenges with DERs to better understand changes needed to policies, market rules and planning processes.

The discussion of DER will involve policy conversations, technical coordination, and education for MISO and stakeholders. Workshops on the topic of DER will continue to explore these issues.

MISO's Reliability Imperative and DER Problem Statement

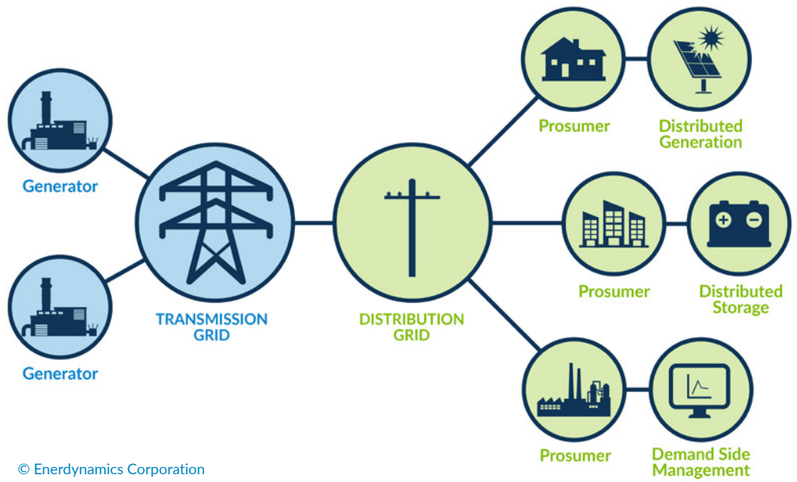
MISO is responsible for ensuring Bulk Electric System reliability. It is important that MISO have an accurately modeled system and understanding of the changing power flow across the transmission and distribution interface.

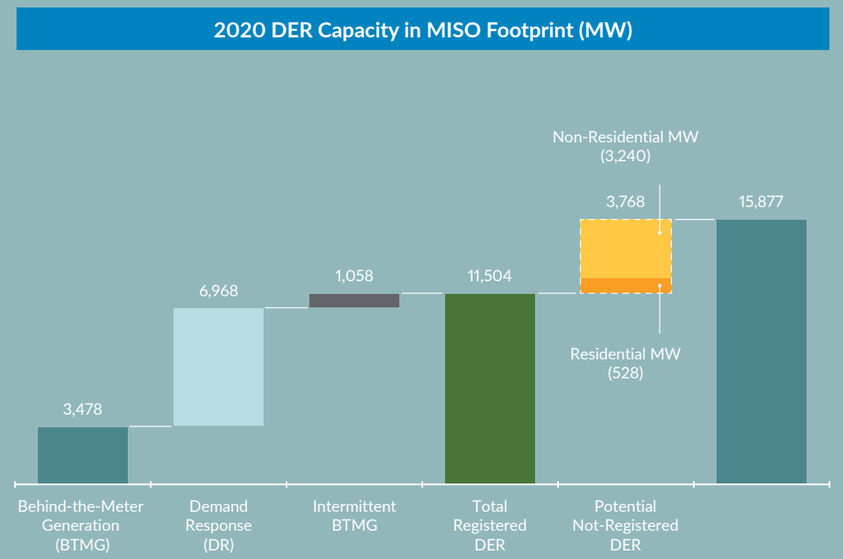
As the characteristics of both generation and demand for power undergo significant transformation, the dynamics of the system change as well. Historically, large central-station fossil, nuclear and hydro-electric generation were dispatched to match demand. Power flowed in a largely one-way direction onto the transmission grid and then to the distribution system. This central generation and transmission system has been telemetered and monitored to provide visibility into system flow and to manage reliability. Now, many wholesale generators are aging. Newer utility-scale wind and solar plants on the transmission system are telemetered, monitored and modeled, yet add increased variability and uncertainty on the supply side which have to be managed. The growth of DER contributes to changes in net load demand patterns, further increasing variability and uncertainty and contributing to forecast error at the RTO level. To help counter these increased risks, some DERs may be capable of providing key flexibility services for both distribution and transmission. The RTO and transmission operators will need sufficient visibility in order to forecast the impacts of changing weather patterns and be prepared to reliably serve load under all conditions.

Improved coordination and communication can help prepare both MISO and distribution operators to more reliably and cost-effectively manage these emerging risks. At the same time, there is not a single solution but a variety of approaches, and each has its pros and cons. This report helps focus the conversation on what risks need to be managed, the different roles that can be impacted, and how to do so as effectively as possible for the current situation and MISO's future resource mix.

Existing communication protocols for transmission-system-connected resources may be too costly for smaller distributed resources. Emerging technology also plays a substantial role as smart inverters and metering, which are becoming more cost effective, can enable more efficient integrations to the grid.

With these system changes comes a need for upgraded communication and visibility tools across the transmission and distribution interface to help manage emerging risk.





Source: MISO registration data and OMS 2020 Annual DER Survey results

Two-Way Communication Critical to System Reliability

MISO operates a part of the Bulk Electric System comprised of local utilities serving more than 42 million end-use customers. Those customers are choosing a variety of grid-edge devices, installed at homes and businesses, to change their energy usage and production. Direct communication from MISO to individual devices is unlikely, but aggregators and utilities will be increasingly able to use sophisticated control systems and signals provided from the wholesale market to shape demand, making decisions to direct energy usage based on market information.

Communication between the BES and utilities and aggregators may include cloud interaction, direct signal gathering and price signaling for future price responsive demand. It could also include using statistical methods to forecast asset performance and load patterns, as well as modeling these effects in both power flows and wholesale market transactions.

In parts of Europe, DER information is transmitted, in anonymized fashion, into a common cloud, where a number of energy market participants are able to access data to operate the market, develop bids and forecast demand. Identifying a communication approach that meets the needs for both MISO and its stakeholders will help the control room operators with efficient decision making by having improved visibility on the system.

While DER can provide value to the wholesale markets, there will continue to be many more DERs installed that operate only in the retail market. The capabilities, location and performance of these assets are still critical to ensuring reliable system operations, especially as installations grow. MISO is exploring methods to facilitate information exchange about the growth of DERs or ways to estimate installation to determine impacts to the Bulk Electric System.

Visibility also has an important role to play in transmission planning and operations. Transmission owners and local balancing authorities will need visibility into growing residential and commercial DER to keep their load shed plans, incident plans and protection schemes relevant for the increasing penetration of DER. Sharing DER information with MISO will help inform the evolution of MISO's markets, reliability operations and transmission planning.

Utility Insights Highlight Security and Reliability Drivers for Enhanced DER Communications Investments

Early in 2020, MISO worked with member utilities to identify opportunities and challenges regarding communications and understand reliability drivers for additional coordination to protect the BES. Utilities stated that if the aggregate total of DERs online had an impact on the transmission system, coordination may be necessary to curtail dispatchable generation on the transmission system.

Coordination and communication have roles both in planning and real-time operations, but with important distinctions. Planning improvements can help identify increased DER penetration and potential system impacts on the bulk electric system. Closer to real-time, technological and/or market changes can provide value where there is a desire for wholesale market participation. For example, larger-scale installations such as solar PV systems that could back feed into the substation should be required to have protection capabilities to maintain reliability and address islanding. These larger-scale solar PV systems may also have a future impact on how load shed plans are developed and implemented.

Outages or abnormal system conditions at the localized distribution level could impact DER availability for wholesale market participation. MISO would need to see whether DER capability is offline; if MISO is counting on power generation or frequency regulation to be there to support the grid, knowledge about units which are offline due to distribution system constraints is critical.

The diversity of MISO's footprint – in terms of organization type, impact of state-specific regulations, and the prevalence of DERs – present a challenge among RTO's and is reflected throughout MISO's learning process. Not surprisingly, organizations with large volumes of DER in their system have more detailed plans for how to manage them and will be key voices as lead users or influencers as MISO plans integration efforts. Further, utility member customers agreed that with DER growth, more extensive communication capabilities and coordination with MISO will be required.

METHODOLOGY

MISO sent a DER Communications and Visibility questionnaire to 70 companies that had previously participated in MISO and OMS joint DER stakeholder workshops. Twenty-nine unique organizations provided responses and there were 40 total respondents, representing 41% of organizations polled.

RESPONDENTS

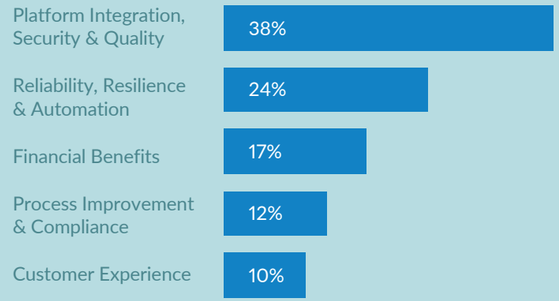
Earlier this year, MISO worked with member utilities to learn more about their plans for maintaining system reliability as DER continues to grow.

- All three MISO regions are represented in the results.
- Respondents are predominately directors, managers, professionals or in technical roles.

Top DER Communication Opportunities and Challenges Identified by Utilities in MISO Survey

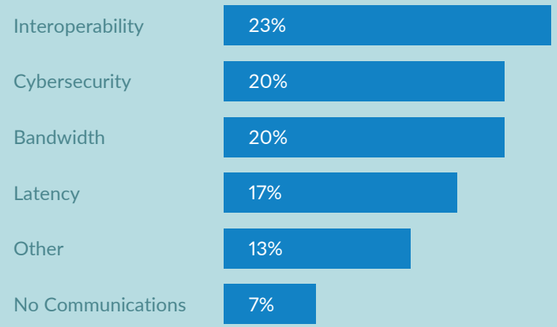
OPPORTUNITIES

Key drivers for investment in communications technologies



CHALLENGES

Limitations to current DER communication



Customer Insights Show Need for Coordinated Communication

Most utilities surveyed believe increased communication with MISO is necessary to protect system reliability

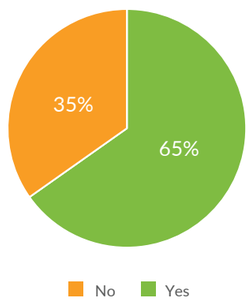
The insights from the survey will give MISO a new understanding of current and future communication needs. Sixty-five percent of the utility respondents believe that increased or coordinated communication will be required between DER assets, distribution system operators, or with MISO to deliver reliability. Within the next five years, more than 50 percent believe that coordinating communication specifically with MISO will be necessary to protect the BES.

Respondents identified several reliability drivers that would necessitate coordinated communications with MISO. While these drivers are monitored today by many respondents, they are not at critical levels requiring coordination.

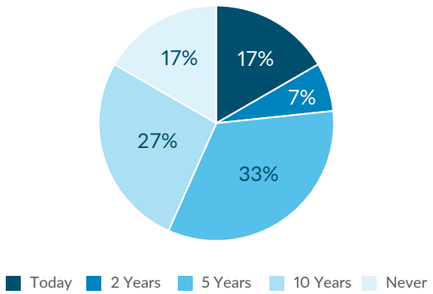
High DER penetration or large DER (either in size or via aggregation) is a key theme that would require increased coordination, as are reliability issues involving either the BES or the transmission and distribution systems. Reliability issues specifically mentioned by respondents include reverse power flow onto the transmission system and DER without ride-through capability.

Market participation for DER, as detailed by FERC Order 2222, will also require increased communication and coordination.

Need for increased or coordinated communication to provide reliability services



Timeframe for the need to coordinate communication with MISO as DER grows



Today, approximately one-third of respondents do not require customers to provide DER energy generation or consumption information. One reason is that currently, many existing DER are controlled by interconnected customers directly.

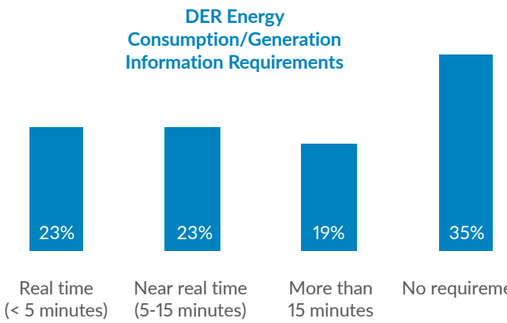
While requirements differ depending on state tariffs and service agreements, many respondents explained that larger DER have information requirements, often with a size threshold between 500 kW to 1 MW. Larger DER are also more likely required to respond in real time, although that threshold requirement varies by organization.

In addition to size, some respondents indicated that LMR registration of DER creates a requirement for receiving operating instructions. Furthermore, the emergence of interruptible loads, as well as utility-implemented and administered DR efforts, have presented new needs to control and monitor implementation.

While many respondents indicated that DER penetration is not high enough to warrant inclusion in incident management plans, they did note that increased coordination is likely in the future.

Insights from this research have helped MISO more deeply understand members' perspectives about DER and frame solutions, including potential integration models.

DER Energy Consumption/Generation Information Requirements



> A demand response program is included in incident management plans. However, grid modification investments are not. The deployment (penetration) of DERs on our own system is in its infancy. DER on our system is small but we expect it to grow significantly and it will have to be incorporated into incident management plans.
>
> Kevin Van Oirschot
> Market Regulations Director
> Consumers Energy

COLLABORATIVE EXPLORATION

- 650+ ATTENDEES
- 13 STAKEHOLDER WORKSHOPS
- 29 UTILITIES RESPONDED TO DER COMMUNICATION SURVEY
- BLACK & VEATCH CONSULTED ON INTEGRATION MODELS
- 10 VENDORS PARTICIPATED IN BRAINSTORMING WORKSHOPS

MISO and OMS Actively Collaborate on Visibility Needs

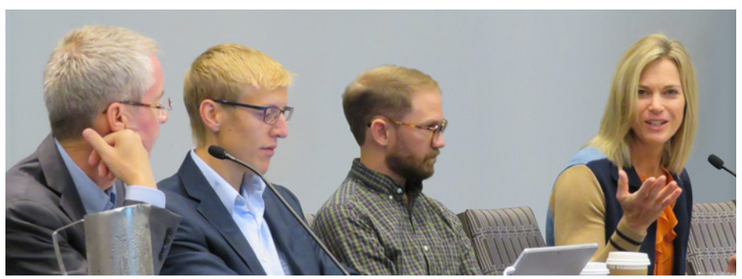
ORGANIZATION OF MISO STATES (OMS)

OMS is a Regional State Committee (RSC) of retail utility regulators, formed in 2003 to centralize the work of following complex transmission policy and increasing the influence of state regulators. With the distribution system under the jurisdiction of state regulators, the evolution of DER and its impact on the transmission system requires close collaboration between MISO and OMS. Collaboratively, MISO and OMS have established joint priorities, initially in 2018 and then updated in 2020, to identify and work on common questions. These joint priorities led to workshops with stakeholders throughout 2018, 2019 and 2020 with future plans to work through DER issues.

OMS also created an annual survey of MISO-region utilities, beginning in 2018, on the topic of DER. This survey is valuable to MISO as an indicator of non-market-participating DER installed in the MISO footprint.

The current OMS/MISO joint priorities are to:

- Collaborate through stakeholder processes to develop DER-related policies, market rules and planning processes through continuation of DER-stakeholder workshops in 2020-2021
- Coordinate across the transmission and distribution system interface to ensure efficient and reliable participation of DERs in wholesale and retail markets. Proactively evaluate the interface of DERs in planning, modeling, markets and operations. States will continue to share how state policies are shaping DER deployment and distribution system evolution within the region. MISO will continue to share a regional view on how the BES and wholesale markets are supportive of those choices, and potentially impacted by them.
- Work together and with stakeholders on any market design improvements proposed via the stakeholder process or initiated by FERC. Monitor the integrity of wholesale markets as they integrate evolving technologies, through Market System Enhancement planning. Encourage exchange across relevant MISO stakeholder entities to ensure cohesion.
- Continue to improve the OMS DER Survey for 2021.



MISO and OMS collaborating on visibility needs

FERC and NERC Advance DER Visibility Issues at the National Level

FEDERAL ENERGY REGULATORY COMMISSION (FERC)

FERC is an independent agency that regulates the interstate transmission of electricity, natural gas and oil. It first raised the topic of addressing wholesale market access for both aggregated DER and Electric Storage Resources in its November 2016 Notice of Proposed Rulemaking. FERC issued Order 841 in February 2018 on the topic of Electric Storage Resources. In April 2018 FERC held a technical conference on the topic of aggregated DER. In September 2020, FERC issued Order 2222, requiring RTOs to modify their respective tariffs to facilitate the participation of DER aggregations. Compliance filing are due in mid-2021.

While the FERC Order 2222 will enable greater wholesale market participation of DER, the topic of visibility-that is, MISO's ability to understand how DER affects the BES – extends beyond market-participating DER.

NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC)

As the distribution system becomes more dynamic, the electric system, as a whole, needs to modify and update its processes to ensure reliability. NERC's mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid. NERC has established the SPIDER Working Group (System Planning Impacts from Distributed Energy Resources) to address key points of interest related to system planning modeling and reliability impacts.

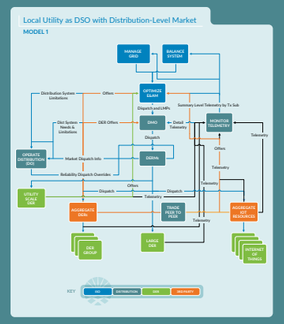
Integration Models Show Relationships with DER, Utilities and ISOs

Several models for integrating DERs with bulk system grid operations and markets are developing across the industry. Furthermore, these integration models could continue to change over the next decade as the technologies and techniques for managing DERs evolve. The different approaches, in turn, affect what information is available from whom and create different engagement models for MISO. In order to prepare for a diversity of evolving approaches across 15 states and the province of Manitoba, MISO explored a variety of integration models with consultation from Black & Veatch. MISO utilizes models such as those framed by its consultants as research tools to investigate and think through possible future scenarios. These models do not represent MISO's preference but rather reflect scenarios of possibility.

In the following pages, MISO shares four different integration models that were reviewed. Two models — *Extension of Today's Roles and Responsibilities* and *Local Utility as Distribution Systems Operator (DSO) with Distribution-Level Market* — emerged as most likely to provide the best insight into impacts because of their ease of acceptance and their commonality of impacts with other models. *Extension of Today's Roles and Responsibilities* will capture slowly evolving distribution business models and transition states for others, while *Local Utility as DSO with Distribution-Level Market* will capture most of the nuances of alternative models that have distribution markets.

Of the other two models, *Local Utility with Independent Entity Administering Distribution-Level Market* was identified as a possible integration model for adoption inside of MISO; this model shared many common impacts with the *Local Utility as DSO with Distribution-Level Market*. The *Local Utility Facilitates Peer-to-Peer Market* model was identified as least likely to be adopted.

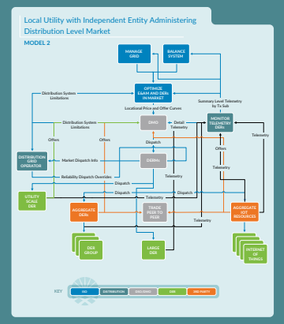
Multiple Potential Pathways to Enhance Visibility Across the Transmission and Distribution Interface



MODEL 1

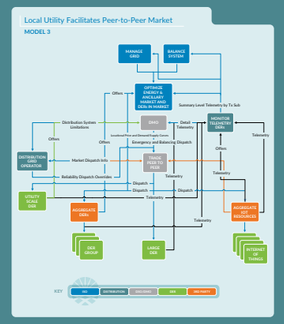
Local Utility as DSO with Distribution-Level Market

SEE FOLLOWING DEEP DIVE



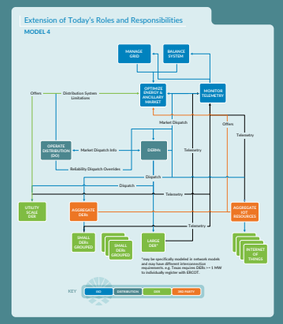
MODEL 2

Local Utility with Independent Entity Administering Distribution-Level Market



MODEL 3

Local Utility Facilitates Peer-to-Peer Market



MODEL 4

Extension of Today's Roles and Responsibilities

SEE FOLLOWING DEEP DIVE

Extension of Today's Roles and Responsibilities

DESCRIPTION

In this model, the RTO is responsible for the reliable operation of the BES and for balancing energy on a real-time basis. The RTO utilizes a range of markets to achieve reliability objectives. The RTO interfaces with the Transmission Owner for coordination of transmission maintenance, transmission capabilities, reliability studies, transmission planning and interconnection. The ISO also works with the LBA for metering and forecasting of load within the LBA and for real-time balancing operations.

In this future there is some increased interface (when compared to today) with distribution operators to exchange information about DER location; availability and participation in MISO markets; and reliability activities. The distribution utility has developed a Distributed Energy Resource Manager (DERM) role to control DERs as necessary for reliability. This model assumes no centralized distribution market.

CHALLENGES

Challenges relative to other models include linkage between BES needs and markets to distribution system needs and abilities. Also, wholesale market participation rules designed for large, central station resources may not align with the capabilities or meet the needs of small resources or aggregations of small resources. Expanded data interactions may challenge the processes and systems designed for a limited number of BES assets. Increased volumes of DERs will impact energy flows and impacts to the BES.

DER intermittency and uncertainty will impact load forecasting, reliability coordination, ramping needs and quantity of ancillary services. Long-range planning must account for this level of uncertainty.

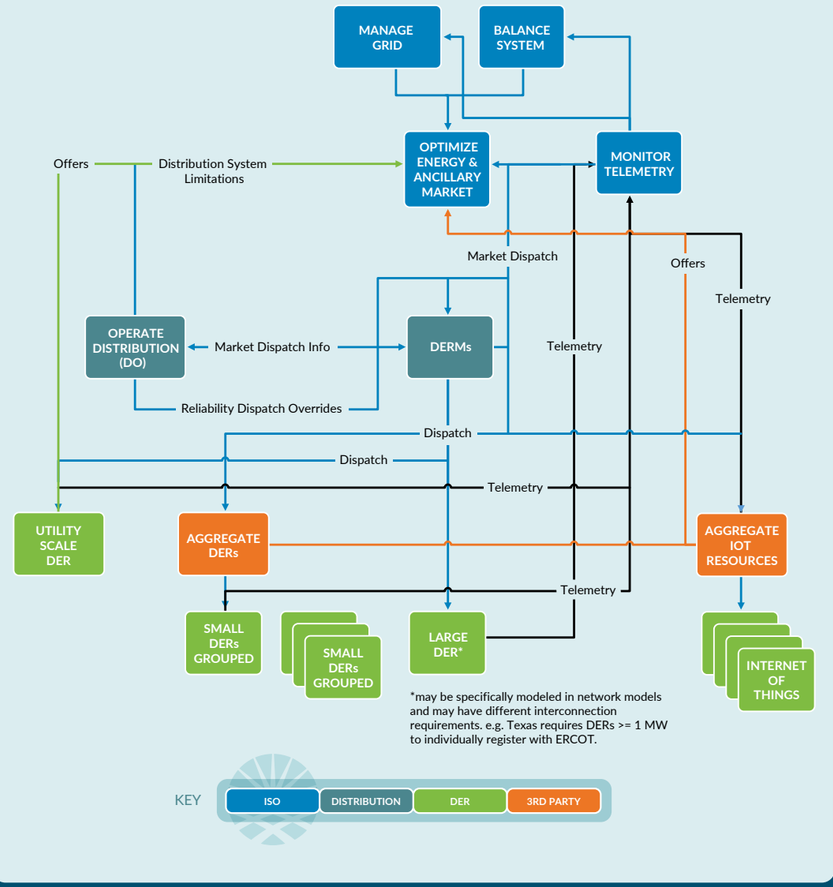
OPPORTUNITIES

This model represents incremental advancement on today's roles and responsibilities. Changes to utility and cooperative business models and regulatory oversight evolve with a greater adoption of DER. Many lines of processes and coordination are in place and well understood. MISO is focused on the coordination efforts required by this structure. With hundreds of local utilities in the MISO region, communicating effectively with a panoply of resources raises questions about scale, security, latency and aggregation of data.

In Order 2222, FERC requires the ISO to expand its participation model to allow greater access for DERs and DER aggregations to the wholesale market. It also requires the ISO to establish coordination with local utilities and retail regulators on wholesale market participation and reliability impacts.

Extension of Today's Roles and Responsibilities

MODEL 4



> Some of Entergy's utilities have received multiple interconnection requests for larger-scale solar PV systems that will potentially backfeed into the substation, requiring transfer trip and other protection efforts to maintain reliability and address islanding. These larger-scale PV systems may also have a future impact on how load shed plans are developed and implemented.

Jason Otwell
Manager, Distribution Planning
Entergy

Local Utility as DSO with Distribution-Level Market

DESCRIPTION

Under the *Local Utility as DSO with Distribution Level Market* model, the local utility assumes the role of the Distribution Market Operator (DMO) and the DERM, in addition to its responsibility as Distribution Grid Operator (DGO). The distribution market and wholesale markets coordinate with each other but are separate. The degree of integration between wholesale and retail markets will depend on the DMO and the distribution market design. Distribution markets may range from complex real-time locational energy markets, to more simple targeted markets for services such as voltage support or congestion relief. Distribution limitations, needs and opportunities are reflected in the distribution market and appear as bids and offers into the wholesale market. The DMO may optimize distribution needs with input from wholesale market prices and capabilities. The DMO market may be a subset of the local utilities' service area and may employ nodal pricing. The DMO may aggregate resources from the distribution market to offer into the wholesale market. Individual DERs and aggregators may independently offer into the wholesale market and will be required under all models under FERC Order 2222. There may be a need for coordination between the DMO, DGO and RTO on dispatch of DERs to ensure reliable distribution operations.

CHALLENGES

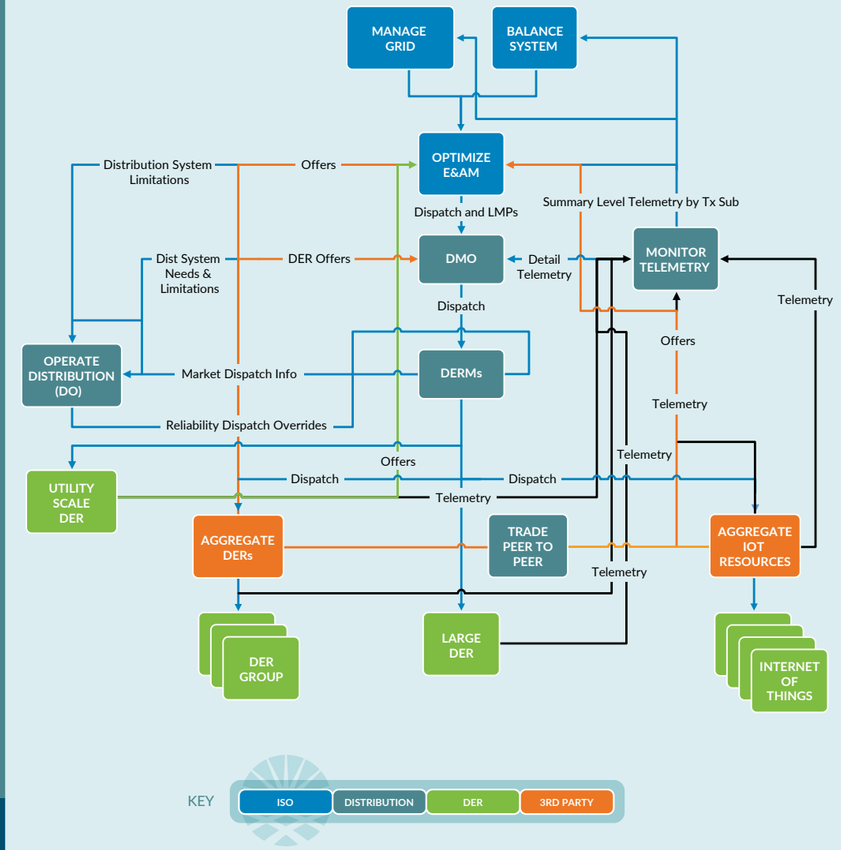
This model offers more autonomy and flexibility for utilities, but requires reporting to MISO for DER limitations and wholesale market opportunities. This model requires a code of conduct separation between distribution operations and the DMO to ensure unbiased access of non-utility owned resources to the distribution market, similar to FERC 889 for open transmission access. This model may result in many seams between MISO and new distribution markets; each seam may be unique in market rules and timing.

OPPORTUNITIES

This model would allow flexibility and autonomy in each utility's distribution market designs, thus meeting individual state and local needs and regulations. This model will also give rate-based resources (such as non-transmission alternatives) the ability to participate in markets. Local utility understanding of its system can be leveraged in market design and administration.

Local Utility as DSO with Distribution-Level Market

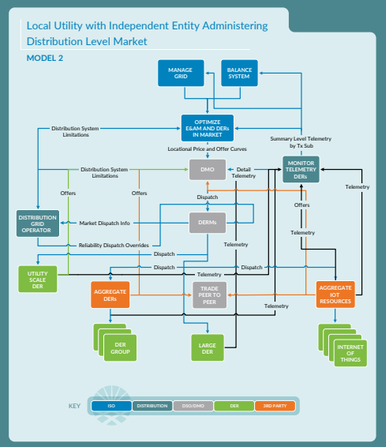
MODEL 1



> We're similar to other utilities where the distribution system over the last hundred years was really built for radial distribution of energy in one direction. Now we're going to have that occurring in both directions. Upgrading the infrastructure that's quite old to new infrastructure, and at the same time, doing it so that we can accommodate having all of these new distributed resources connected, is a big challenge for us. We need to comply with new standards, and use new communication and control technologies, so that adding distributed resources on the distribution system doesn't disrupt traditional utility reliability.

Tim Sparks
VP of Electric Grid Integration
CMS Energy

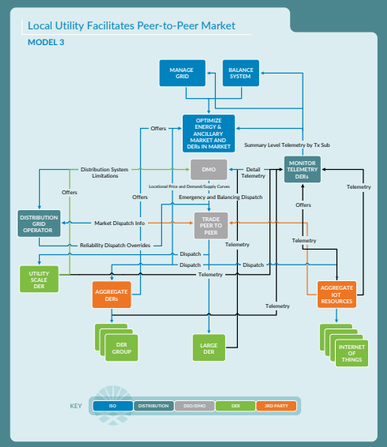
OTHER INTEGRATION MODELS



MODEL 2

Local Utility with Independent Entity Administering Distribution-Level Market

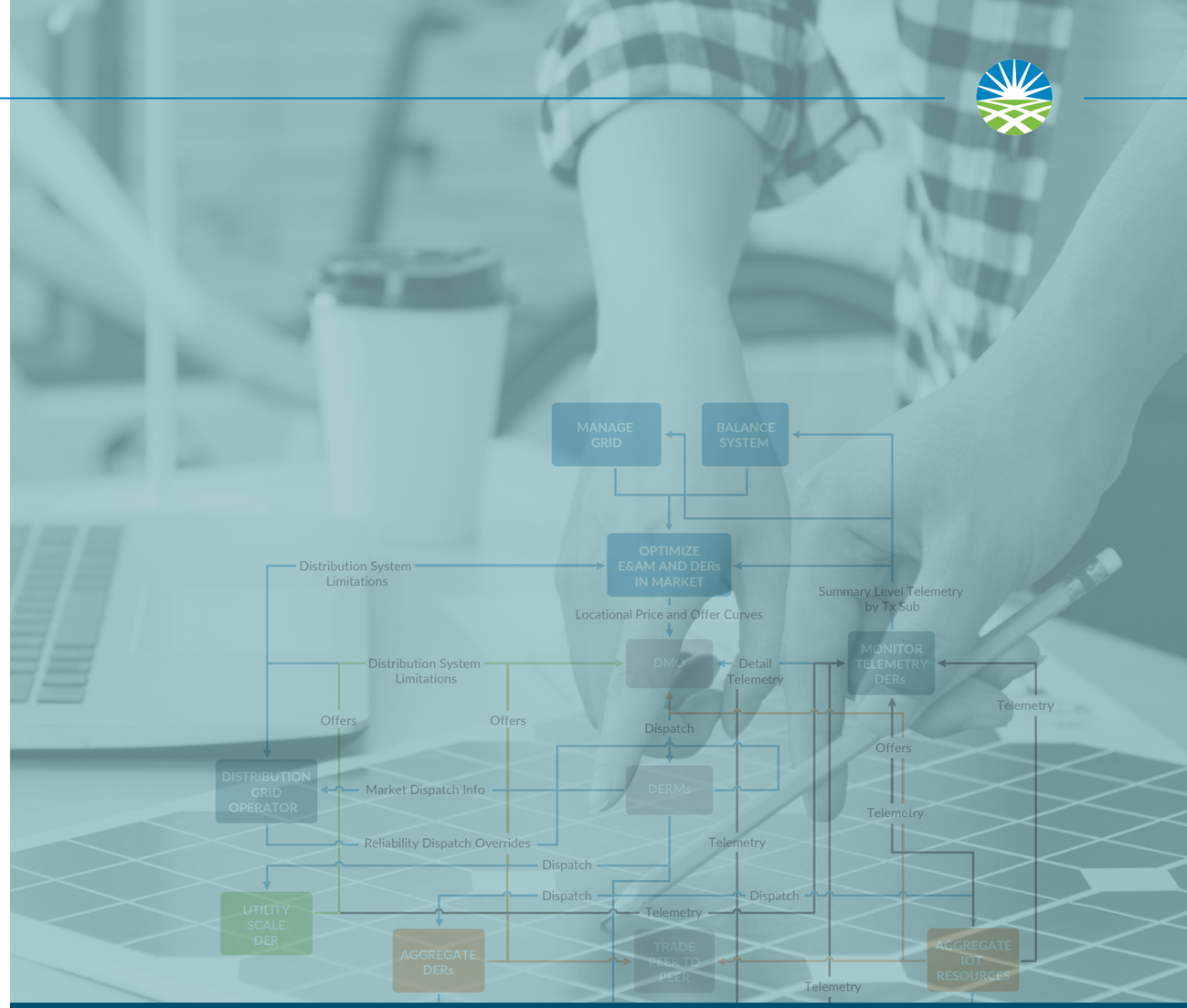
This model shows an entity other than the Local Distribution Utility operating as the DMO and DERM. The scope and functioning of the distribution market is similar to that of the Utility as DMO model. However, an independent entity (that is neither within the Local Distribution Utility nor within the ISO) serves as the market operator. Because an independent entity operates the distribution market, there is less concern about conflicts of interest for distribution-based resources participating in the distribution market. Close coordination between the DMO, DERM and Local Distribution Utility will be needed in areas such as distribution limitations and needs, metering and billing.



MODEL 3

Local Utility Facilitates Peer-to-Peer Market

There is no centralized distribution market in this model; resources and loads perform bilateral trades. The DMO may provide a match-up and clearing, tracking and billing function for the trades. The market may support a large range of granularity. In a pure peer-to-peer model, DERs are self-dispatched to fulfill contracts but have no guarantee of sufficiency to meet system needs. A provider of last resort would assure balance and meet voltage and power quality needs. The local utility as provider of last resort would need some cost-recovery mechanism. Interactions with wholesale market would be at the discretion of the peer traders or DER aggregators.



> We've reached a point where utility customers are investigating and increasingly investing in Distributed Energy Resources (DER). This move is driven by energy price increases, sustainability objectives, increased desire for control, DER price decreases and state and federal regulations. This market environment requires utilities to rethink their business models and distribution grid operating requirements and ISOs to evolve to model more dynamic, flexible participating DER resources.

Heather Donaldson
Managing Director, Management Consulting, Electric Industry Transformation Strategy & Planning
Black & Veatch Management Consulting

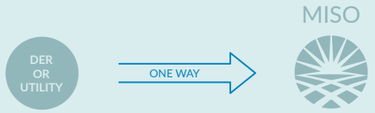
DER Data Exchange: Communication Vision

MISO, utilities, cooperatives, transmission owners and operators, distribution owners and operators, and DER owners may all need to regularly exchange information to ensure reliable service, efficient market operations and conduct adequate planning.

MISO has started mapping, at a high level, some of the data streams it will need to investigate with these stakeholders as DER grows in the MISO footprint. These communication pathways will evolve as the influence of DER grows.

DER Siting and Forecasts

Receive information about DER additions and projections, whether market-participating or not



DER Modeling in Planning

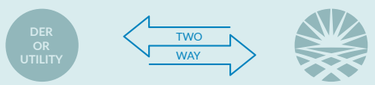
Receive modeling data for DER at the transmission/distribution boundary, including transient characteristics and aggregation details

DER Non-Market Participant Telemetry

Telemetry from individual large DER with material impact on the transmission system

Interconnection Queue Requests

Periodic updates on distribution queue information and data returning to utilities on affected system studies



Emergency Event Coordination

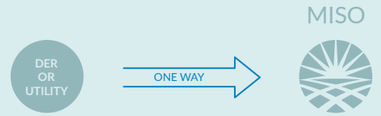
Emergency on the distribution or transmission system will require communication to avoid unintended loss of generation or islanding, and ensure worker safety

System Restoration

Communication to restore power safely, and ability of DER to enable black start in localized systems

Distribution System Status

System status messages when market-participating DER could be affected; ensures dispatch signals aren't counter to local system requirements



DER Market Participation and Control

Ability of DER to receive market dispatch signals, indicate status and response

Settlement, Measurement and Verification Coordination

Meter data necessary for wholesale market settlement and to distinguish between retail and wholesale activity

> "Traditionally, field communication costs has been the long tent pole, but those costs are rapidly approaching zero. The challenges going forward are more administrative and security related – the steps to set up and manage robust communications between stakeholders to coordinate their use of DER."

Travis Rouillard
Chief Technology Officer
Gridbright

Brainstorming: The Art of the Possible

Current solutions can enhance different aspects of interoperability, but no comprehensive option exists

Given the numerous integration models, what are MISO's options for making any of them a reality? Visibility solutions are rapidly evolving. What is possible in terms of data monitoring, metering, communication, quality, latency, security, etc. is more advanced than it was even five years ago. While a single solution for a multi-state RTO does not currently meet all visibility needs, partial options exist to improve situational awareness. In the spring of 2020, MISO held brainstorming workshops with 10 different potential technology partners and vendors to envision potential solutions.

Key questions were discussed with each company and bounded by two constraints: (1) MISO does not own or control any assets on the distribution system; and (2) there are hundreds of distribution utilities in the MISO footprint, not all of which are registered members, with a wide array of communication technologies and architectures.

How can MISO:

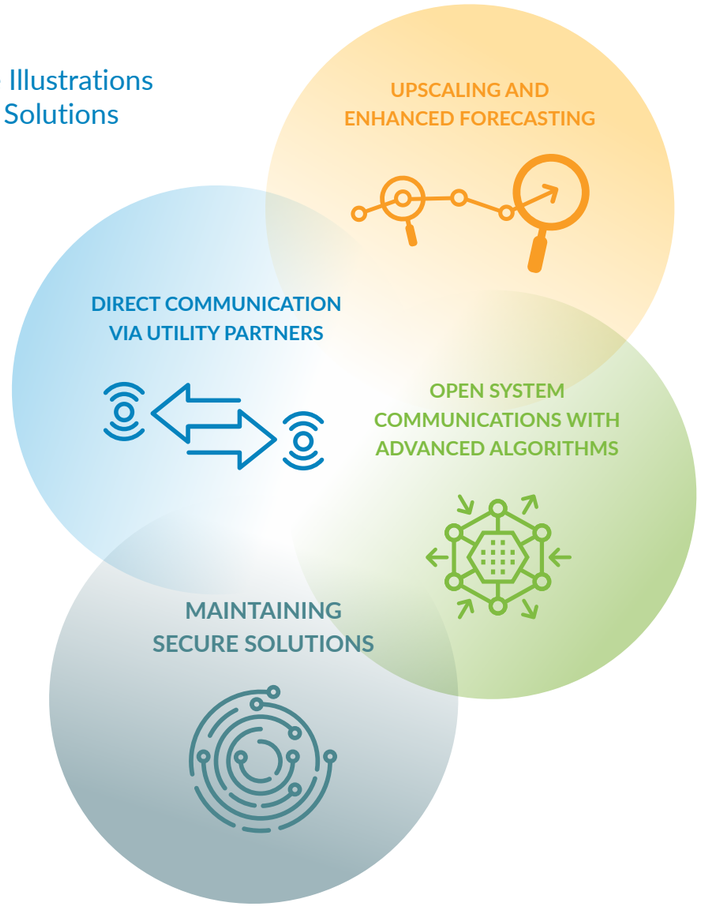
- Receive data in different ways from different utilities and/or DER owners/aggregators?
- Synthesize that data into a common format?
- Draw actionable insights from that data for control room operators?
- Provide control room operators with visuals that give them actionable insight?
- Allow control room operators to see a big picture or drill down to areas where there may be higher risk at a given time period?
- Identify extremely cost-effective metering and communication options?
- Understand key considerations for triangulating data based on sampling in a given geographic area (e.g., ZIP code or load zone)?
- Ensure the privacy of individual DER owners while communicating necessary information to balancing operators?

The solution options can be organized into three main categories of features, which will be discussed in greater detail in the following section:

1. Improved forecasting by upscaling data sampling from a subset of total DERs in an area.
2. Direct communication from a broad array of DERs – likely through utility partners – to MISO.
3. A more futuristic option that combines more direct communication with advanced algorithms to improve real-time situational awareness.

In September 2020, MISO released an InnoCentive crowdsourcing challenge around situational awareness and visualization to foster idealization from outside of its industry. MISO received 100 active solvers and 16 solutions submitted responses from this challenge and will begin to analyze the submissions.

Key Feature Illustrations of Potential Solutions



Solution Brainstorming Partners

GRIDBRIGHT
OSI
HITACHI Inspire the Next
OATI
BLACK & VEATCH
CAMUS Zero Carbon Grid Orchestration
enbala YOUR GRID. IN BALANCE.
westMONROE
energy & meteo systems
solaredge

UPSCALING AND ENHANCED FORECASTING

Upscaling data from a subset of DER with close to real-time communication is one solution option to improve visibility. One benefit of improved forecasting will be better situational awareness in MISO operations. Developing solutions that allow operators to quickly understand the status of the grid is critical; time spent interpreting data equals risk in a 24-7-365 critical operations setting. Upscaling data works by using production data, typically on a five-minute basis, from inverter companies via a cloud-based monitoring platform. That data is projected to a broader set of known DERs that don't provide production data. Together, they produce a complete picture for a given geographic area on a near real-time basis and improve forecasting.

A key enabler for this approach is a dataset of the various types and general location of other DERs. While this is not currently available in all areas, some states are beginning to require this information and have established public databases. Privacy is a priority and can be managed by using appropriately sanitized data sets from data providers.

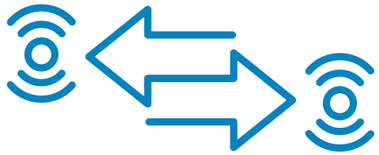
DER awareness in the MISO footprint and forecasted behavior of those resources becomes more important with increased penetration. Operators will need to have easy access to the location of DERs and awareness of when they have excess capacity. Some vendors have developed generation-specific visibility tools, and operators would ultimately benefit from a resource one-stop-shop.

DIRECT COMMUNICATIONS VIA UTILITY PARTNERS

Several vendors offer solutions aimed at managing data from multiple communication systems and integrating a diverse array of communication protocols. Traditional energy industry stand-alone communication systems, such as supervisory control and data acquisition (SCADA) and Energy Management System (EMS), have required costly metering hardware in order to participate. However, DER management systems can bring in data from more diverse and affordable metering and monitoring options while also supporting SCADA systems.

Vendors are in the process of addressing the challenge of numerous gateway inverters that were developed under a variety of custom protocols. Developers have created communication platforms with their own products, but communicating with other gateways is still under exploration. MISO will need to interact with multiple protocols across its footprint.

There is an additional opportunity to explore the most cost-effective way to bridge the siloed communication across the energy ecosystem



to enable real-time visibility and two-way communication. To build on the benefits utilities create by investing in these systems, it will be important for MISO to partner with utilities to deliver fully integrated solutions.

Utilities have spent decades investing in communication infrastructure, and any solution will need to leverage that while also developing new options.

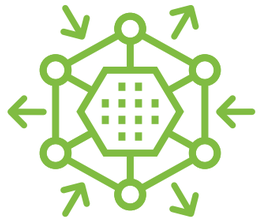
> Security is of paramount concern to all involved, adding complexity to any proposed solution.

OPEN-SYSTEM COMMUNICATIONS WITH ADVANCED ALGORITHMS

Taking an open-system approach to developing software solutions is another option. This architecture structure can fuse together operations data from multiple sources balanced with enhanced technology and reduces data discrepancies with transparency.

Providing an optimization and control technology that can integrate multiple assets is the key focus of some vendors. Leveraging existing internet infrastructure minimizes costs.

Other areas to explore include: leveraging insights from existing data sources and having the ability to fuse them with customer systems; as well as local generation models and third-party telemetry to build a complete picture of current and near-future grid connections near-future grid connections.



MAINTAINING SECURE SOLUTIONS

Maintaining secure and reliable solutions is a top priority for both MISO and solution vendors. Balancing the need to share data appropriately while not compromising the security is foremost as MISO frames and evaluates future solutions.

Bringing it Together with Collaboration Across Sectors

Collaboration with its utility member customers, research partners and vendors has helped MISO better understand the priorities, possibilities and processes. It also helps MISO consider some key questions, such as: How can MISO advance from current tools, how can understanding the range of options and possibilities inform a plan for moving forward?

A common theme in many of the solution brainstorming workshops was that the answers could be provided as a service rather than the need for onsite infrastructure. Approaching next steps with this mindset enhances MISO's adaptability as the challenges and opportunities of the industry continue to evolve and the reliability risks shift.

Pursuing these options increases the impact of MISO's reliability imperative as DER penetration continues to grow. MISO members are investing in advanced communication and technology platforms while metering costs continue to decline. All of MISO's proactive outreach, training and education and industry collaboration have fostered our readiness to respond to FERC's Order 2222.

Next Steps Focus on FERC 2222 Compliance and Visibility Pilots

Maintaining reliability in a more distributed future will require MISO to change the way visibility is considered. Traditionally, it was possible to rely on historical data to plan for the future. Emerging technology may allow MISO to utilize more predictive data to plan in the long-term, day-ahead and real-time operations horizons. MISO is also exploring ways to maximize the potential value of existing DER, such as LMR for operations, whether by modifying its internal procedures or enhancing its tools to increase visibility.

Learning from others, such as the recent challenges in the California ISO, will help MISO as it continues to prepare for more DER penetration. MISO will also look outside of the industry to gain insights from others who have faced disruptive technology as MISO thinks about the future.

MISO will continue to collaborate with stakeholders to ensure continued transparency on the opportunities and challenges with DERs and to better understand changes needed to policies, market rules and planning processes.

> DER located on the distribution system or behind customer meters include everything from rooftop solar panels and storage resources to demand response and energy efficiency resources, such as grid-enabled water heaters and even electric vehicles and their supply equipment…DER can hide in plain sight in our homes, businesses, and communities across the nation – but their power is mighty. How much so? Well, some studies have projected that the United States will see 65 GW of DER capacity come online over the next four years, while others have even projected upwards of 380 GW by 2025.
>
> Neil Chatterjee
> FERC Chairman

Explore

- Investigate forecasting methods for load served by generation on the distribution system
- Identify areas where MISO-participating demand response such as LMRs could be enhanced
- Evaluate situational awareness and data visualization in a DER InnoCentive challenge
- Identify options for communicating with DER Management Systems (DERMS)
- Continue to assess various integration models and pros/cons with stakeholders.
- Continue to advance the understanding of communication options and possibilities, including state and member views on viability

Decide

- Determine the viability of pilots to further explore communication options with utilities, distribution operators, aggregators and DERs
- Work with distribution utilities and aggregators on cyber security requirements

Do

- Coordinate with distribution companies on operational questions surrounding dispatch, signaling and coordination for distribution-located, wholesale-market-participating DERs, such as energy storage resources
- With OMS, repeat DER Foundations stakeholder workshops to enable further conversation on DER topics
- Develop a coordination framework in compliance with FERC Order 2222, enabling participation of DER Aggregations in RTO/ISO markets

Done

- 2018-2019: OMS and MISO jointly presented stakeholder introductory workshops on the topic of DER
- MISO drafted guidance for states incorporating IEEE-1547 2018 into their interconnection processes
- DER Framing whitepaper

Visit MISO'S STAKEHOLDER CALENDAR for future workshops

Glossary of Terms

Bulk Electric System (BES) – The electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment. Generally operated at voltages of 100 kV or higher.

Communication – There will be DER, usually in aggregate, which will participate in the wholesale market. MISO will need to envision future telemetry it receives from these assets, as well as price signals it may send for price-responsive demand.

Customer – Purchases energy services to serve grid-connected equipment and appliances (load).

DER asset owner – Individuals, aggregated groups, or companies that own or have been proxied ownership control of DER assets.

Distributed Energy Resource (DER): FERC Order No. 2222 defines DERs that may participate in a wholesale market, in the form of DER aggregation, to include any resource located on the distribution system or behind a customer meter. This includes battery energy storage, renewable energy, distributed generation, demand response, energy efficiency, thermal storage, and electric vehicles and their supply equipment.

Distributed Energy Resource Management System (DERMS) – Allows utilities to manage distribution grids with a variety of interconnected DER assets, including behind-the-meter and larger utility-grade resources, while capitalizing on the benefits from the distributed resources.

Distributed Energy Resource Manager (DERM) – Responsible for the monitoring, management, coordination, and optimization of numerous DERs owned and operated by the utility, independent producers or third-party aggregators.

Distribution Grid Operator (DGO) – Responsible for the real-time operations of the electric distribution system within its jurisdiction.

Distribution Market Operator (DMO) – Responsible for managing a platform for utility and third-party bids, offers, and bilateral transactions for distribution services, as well as transaction clearing and settlement.

Distribution market participant – Individuals, aggregated groups or companies that buy or sell services to the distribution market.

Distribution utility – Any electric cooperative, private corporation, government-owned utility or existing local government unit that has an exclusive franchise area to operate a distribution system. Responsible for the ownership, field operations and electric distribution system within its jurisdiction.

Energy Management System (EMS) – A system of computer-aided tools used by operators of electric utility grids to monitor, control and optimize the performance of the generation or transmission system.

Gateway inverter – A device for converting frequency and simultaneously communicating with the with grid by providing monitoring and analytical information. It also has the ability to run diagnostics to find and correct faulty behavior.

Grid Edge - Technologies working near or at the end of electrical grids. New processes and business models surfacing from grid end solutions are part of the definition, as well.

Independent entity – An organization that does not currently exist that would be established to perform DMO and/or DERM and possibly even DGO roles. This entity could manifest itself as a for-profit company, government or pseudo-government agency, or a not-for-profit organization.

Independent System Operator (ISO) – Responsible for real-time operations of the bulk transmission system and operation of a competitive wholesale power market within its jurisdiction. Also responsible for long-term transmission planning maintenance of the infrastructure and equipment of the Electric Distribution System.

Producer – Provides energy services from connected distributed energy resources and related equipment.

Prosumer – An individual or business who purchases and installs electricity-generating equipment that will produce some amount of kWh to offset their electric usage.

Ride-through – A generating facility that connects to and synchronizes with the transmission system during system disturbances within a range of over- and under-frequency conditions, in accordance with good utility practice.

Supervisory Control and Data Acquisition (SCADA) – A computer system for gathering and analyzing real-time data. SCADA systems are used to monitor and control a plant or equipment.

Third-party aggregator – Transacts with multiple consumers and/or producers to aggregate and transact bundled energy services for delivery to the DSO, utility, or RTO.

Utility – Responsible for the ownership, field operation and maintenance of the infrastructure and equipment of the Electric Distribution System.

Visibility – The ability to retain situational awareness of all flows that can affect the BES. This includes having the ability to estimate distribution-located resources that are not participating in the wholesale market. MISO must plan for gross load and significant amounts of DER, which offset local load will affect MISO's load forecasting.

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