

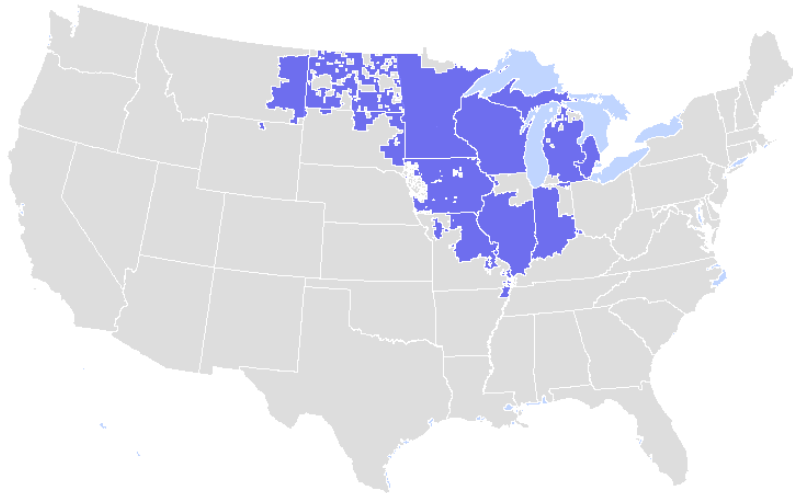


MISO Regional Transmission Operator

History and Geography of MISO

The Midwest Independent System Operator (MISO) is a Regional Transmission Operator (RTO).¹ Established in 1998, MISO was one of the first organizations to be recognized by the Federal Energy Regulatory Commission (FERC) as an RTO (in 2001). MISO is responsible for managing the energy and operating reserves markets for 11 U.S. states in the upper Midwest (Exhibit 1).² MISO is established as a non-profit corporation, and has over 130 members including 35 owners of transmission line assets, with over \$18.1 billion in transmission assets under MISO's functional control. As of November 2012, MISO provided dispatch signals and reliability services to 144,599 MW of capacity over 49,670 miles of transmission lines providing electric service to 38.9 million people.³ An all-time peak demand of 98,576 MW was set on July 23, 2012.³ In December 2013 the utility Entergy is expected to join MISO, which will add over 15,000 miles of transmission lines and 30,000 MW of generation capacity and 35,000 MW of load to MISO's footprint. This will expand the RTO's geographic scope through parts of Louisiana, Arkansas, Mississippi, and Texas.⁴

Exhibit 1 MISO market area



Map developed by NETL. Source: ABB Velocity Suite²

Similar to other RTOs and ISOs, a primary function of MISO is to facilitate the energy markets in its service area and maintain reliable electricity service in a cost-effective manner. MISO operates the energy markets to serve load and meet reserve obligations with the lowest-cost resources possible, and has designed a locational market structure to ensure that transmission capability is used efficiently and that energy prices reflect the marginal cost of providing the service at each location. While the wholesale cost of electricity includes services to ensure reliable supply of power, as seen in Exhibit 2, the majority of the electricity price in MISO is dominated by energy services (i.e., the cost of generating power, which includes fuel costs, operation and maintenance for generators, and reimbursement for the capital cost of generators).

¹ Many of the technical terms used in this primer are defined in a companion *Glossary for Power Market Primers*.

² ABB Velocity Suite. (2013). *Intelligent Map*. Retrieved on January 16, 2013, from

<https://velocitysuite.globalenergy.com/Citrix/MetaFrame/auth/login.aspx>

³ MISO. (2012). *MISO Corporate Information (November 2012)*. Retrieved on December 3, 2012, from:

<https://www.misoenergy.org/Library/Repository/Communication%20Material/Corporate/Corporate%20Fact%20Sheet.pdf>

⁴ MISO. (2011). *Entergy Initiative*. Retrieved on October 20, 2011, from

<https://www.misoenergy.org/WhatWeDo/StrategicInitiatives/Pages/EntergyInitiative.aspx>

Exhibit 2 MISO average wholesale electricity price 2009, 2010, and 2011 (\$/MWh)⁵

Price	2009	2010	2011
Energy	\$ 28.99	\$ 34.21	\$ 33.61
Ancillary Services	\$ 0.15	\$ 0.15	\$ 0.15
Uplift	\$ 0.29	\$ 0.39	\$ 0.31
Capacity	\$ 1.85 ⁶	\$ 0.01	\$ 0.01
Total	\$ 31.28	\$ 34.76	\$ 34.11

MISO Products and Services

MISO manages competitive markets that provide energy services and reliability services through a day-ahead market, real-time market, financial transmission rights (FTR) market, and, as of January 2009, an ancillary services market (ASM). In 2011 these markets aggregated billings of over \$23.6 billion across MISO's 356 market participants.³

Energy Market

MISO's main role as an RTO is to coordinate an energy market throughout the service area, which consists of facilitating the continuous buying, selling, and delivery of wholesale electricity, providing dispatch requests to generators, and acting as a data clearinghouse. In addition to acting as a clearinghouse for bilateral power contracts, MISO manages a day-ahead market and a real-time market for power delivery. In each market MISO "clears the market," i.e., coordinates which generators will operate, at what time, and at what price, at over 1,900 pricing nodes, or local areas. At each node the price of electricity is based on the cost of bringing the next marginal unit of electricity on line. This method of calculating electricity price is called locational marginal pricing (LMP).

The day-ahead market clears both energy and operating reserves for each hour of the next operating day by matching energy demand bids at each LMP node and operating reserve requirements throughout the system with the generators' ability to provide power. Thus, MISO ensures scheduling adequate resources to meet the next day's expected demand, taking into account physical limiting factors such as transmission capacity and generators' scheduled maintenance. Generators participate in the real-time market by submitting bids to provide electricity at a certain price at least 30 minutes prior to the identified hour of operation (i.e., the hour in which the generator proposes operating and providing the electricity). MISO then sends the generators dispatch signals every five minutes based on the current demand and the generator's bid price—with the lowest-cost resources dispatched first.⁵

Capacity Market

To ensure that generators have sufficient incentive to develop and make available sufficient generation resources to meet expected demand plus a reserve margin, load-serving entities (LSE) are responsible for contracting for capacity services above and beyond the anticipated demand in their service area. Thus, LSEs calculate an expected peak demand and then must contract for "Planning Resources"—which can be either generation or load response programs—to account for events such as unplanned outages, weather disruptions, or an unexpected surge in demand. LSEs can meet their requirement for planning resources through their own generation assets, bilateral contracts with other generators, or participation in

⁵ Potomac Economics. (2012). *2011 State of the Market Report for MISO Electricity Markets*. Retrieved on December 3, 2012, from http://www.potomaceconomics.com/uploads/midwest_reports/2011_SOM_Report.pdf

⁶ Capacity market began in June 2009; in the first month of operation of the market, a number of capacity bids were entered at non-competitive rates and did not clear. However, since average prices are calculated at spot prices, this capacity price is included in the average cost for the year. Capacity prices going forward are expected to be more in line with 2010 cost, because the region currently has more than sufficient generation resources.

MISO's monthly Voluntary Capacity Auction. Statistical back testing is performed on a monthly basis to determine if LSEs provided for sufficient planning resources to meet reserve margin requirements. If the requirements were not met, LSEs are subject to a deficiency charge.

Ancillary Services Market

MISO facilitates an ancillary services market in a similar manner to the real-time market, with generators providing bids for 15-minute increments. MISO then matches this availability with minute-by-minute grid demand in order to ensure adequate supply of electricity within a variety of technical reliability parameters (e.g., voltage, physical power flows, etc.)

Financial Transmission Rights

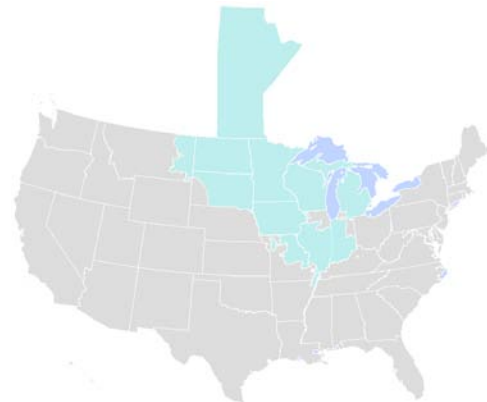
The FTR market provides a financial instrument for market participants to hedge against congestion costs in the system. In the absence of any transmission constraints, all LMP nodes would price at the lowest-priced generation resource. However, there is not enough physical transmission to deliver electricity from low-cost resources to the place demanding the electricity at all times. Thus, some nodes will, by necessity, use power from higher cost resources and therefore the LMP at that node will be higher. The difference in LMPs between two nodes that is attributable to the transmission constraints is called "congestion cost" or "the cost of congestion" because, but for the lack of transmission capacity, a lower-cost resource would be used to meet demand. An FTR can be thought of as a "reservation" for access to a specific transmission path (e.g., between LMP nodes) for a specific timeframe, but does not actually correspond with a physical right to deliver energy. Rather, an FTR will create a revenue stream (or charges) based on the difference between two LMP prices at specific times.

Reliability Assurance

MISO manages the reliability of the power grid per North American Electric Reliability Corporation (NERC) standards in a geographic region slightly larger than its market area (Exhibit 3), with the greatest differences being the inclusion of the remainder of North and South Dakota, and the Canadian Province of Manitoba.⁷ Although MISO does not provide energy market services to these additional areas, it is responsible for modeling expected electricity demand and providing dispatch signals to generators to match supply and demand.

MISO employs a variety of system monitors and modeling tools to compare actual and predicted electricity flows against individual lines' voltage limits or other constraints. These data points and the results from modeling calculations are presented to grid operators, on a real-time display, to help visualize the status of the grid and to inform any needed corrective actions.

Exhibit 3 MISO reliability coordination area



Map developed by NETL. Source: ABB Velocity Suite²

Transmission and Resource Planning

MISO is responsible for maintaining the operations and reliability of the grid in its service area and, as such, conducts periodic reviews of grid adequacy. Transmission expansion is assessed on an annual basis, in conjunction with members' annual planning cycles, to understand the projects being studied or currently underway, as well as to suggest future projects needed to ease congestion or other grid issues. Similarly, MISO undertakes a resource adequacy study on an annual basis, modeling expected supply and demand to determine available reserve margins and plan for the integration of additional generation or transmission, in order to maintain reliable service. Seasonal assessment reviews are also completed prior

⁷ MISO. (2013). *Corporate Information*. Retrieved on January 16, 2013, from <https://www.midwestiso.org/Library/Repository/Communication%20Material/Corporate/Corporate%20Fact%20Sheet.pdf>

to each summer and winter, to review predicted demand and resources for the MISO reliability area and to assess potential risks.

In addition to assessing the need for new transmission or generation resources, MISO also performs generator interconnection studies to understand the impact of connecting new generation resources to the grid.

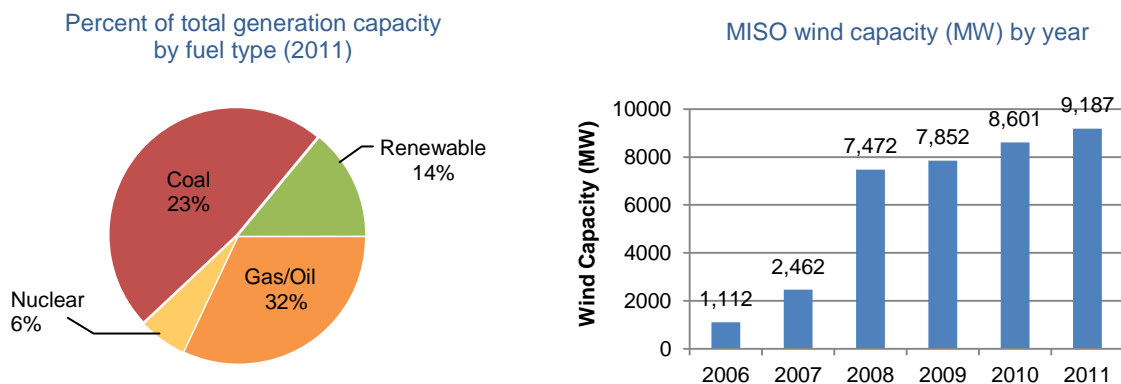
Tariff Administration

As an RTO, MISO is responsible for administering its “Open Access Transmission, Energy and Operating Reserve Markets Tariff.” This tariff is filed with FERC, and outlines how MISO will determine rates for transmission service, evaluate and approve requests for transmission service, perform transmission impact studies, and coordinate use and administration with other transmission providers in the region, among other activities. With FERC’s approval of the tariff, MISO is the sole decision-making authority on the provision of transmission service in accordance with the tariff. However, MISO has established an Alternate Dispute Resolution (ADR) Committee⁸, a six-member, board-appointed, closed committee to adjudicate disputes between parties who may have different interpretations of the tariff.

MISO Generation Profile

While MISO does not own or directly operate power generation facilities, it is responsible for managing scheduled outages for maintenance and maintaining reliable electricity service at the lowest cost possible, as provided by the different generators on the system. Thus, to maintain reliability, MISO continually evaluates the fuel mix of generation assets in the region. As seen in Exhibit 4, the majority of the region’s power comes from coal-fired generation facilities. However, wind capacity has grown over eight fold in the past five years alone. Since wind is an intermittent resource, this creates additional complexity for MISO as a grid operator to ensure that sufficient generation resources are available to provide more or less power should the strength of the wind significantly change hour-by-hour (or even minute-by-minute).

Exhibit 4 MISO Fuel Mix and Wind Capacity Additions⁹



In June 2011, MISO introduced a new resource designation: Dispatchable Intermittent Resource (DIR). Previously, wind resources were “price takers,” meaning they were paid for the prevailing energy cost at the time they were in operation, without any supply bids into markets. The DIR designation allows wind resources to fully participate in the real time market and be automatically dispatched (up to a forecasted limit based on an offer price and system conditions).

⁸ MISO. (2013). *Alternative Dispute Resolution*. Retrieved on January 17, 2013, from <https://www.midwestiso.org/Library/Tariff/Pages/AlternativeDisputeResolution.aspx>

⁹ MISO. (2011). *2010 Annual Report*, p. 12. Retrieved on October 11, 2011, from <https://www.midwestiso.org/Library/Repository/Communication%20Material/Financial%20Information/2010%20Annual%20Report.pdf>