

IMM Quarterly Report: Winter 2017

MISO Independent Market Monitor

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March 21, 2017





Highlights and Findings: Winter 2017

- The MISO markets performed competitively and reliably this winter.
 - ✓ Market and weather conditions were mild during most of the quarter.
 - ✓ However, colder temperatures in December contributed to higher natural gas prices and loads, which led to higher energy prices early in the quarter.
 - ✓ Gas prices increased 55 percent and real-time energy prices increased 33 percent this winter compared to last year.
 - MISO experienced a number of days with severe storm conditions that caused outages and higher congestion.
 - ✓ Market power mitigation was infrequent and offer conduct was competitive.
- The value of real-time congestion increased by 48 percent from last year.
 - ✓ On February 7, tornadoes in MISO South led to transmission outages that lasted for several days, causing severe real-time congestion.
 - ✓ A single market-to-market constraint contributed 14 percent of all real-time congestion in the quarter, but MISO was able to significantly reduce congestion by transferring control of the constraint to PJM in early February.

Quarterly Summary

ACTA IN				Char	ige ¹				Chan	ige ¹	
-				Prior	Prior				Prior	Prior	
		Value	Qtr.	Year			Value	Qtr.	Year		
	Г Energy Prices (\$/MWh) 🛛 🔍 \$2		\$28.94	2%	33%	FTR Funding (%)	9	99%	100%	102%	
	Fuel Prices (\$/MMBtu)					Wind Output (MW/hr)		6,903	21%	20%	
	Natural Gas - Chicago		\$3.26	20%	55%	Guarantee Payments (\$M) ⁴					
	Natural Gas - Henry Hub		\$3.25	17%	59%	Real-Time RSG	9	\$11.8	-22%	82%	
1	Western Coal	Western Coal S0.6		3%	23%	Day-Ahead RSG	9	\$13.2	40%	32%	
	Eastern Coal	9	\$1.54	11%	13%	Day-Ahead Margin Assurance		\$10.7	2%	66%	
	Load (GW) ²					Real-Time Offer Rev. Sufficiency	9	\$1.3	-56%	-22%	
٨	Average Load	9	75.4	4%	0%	Price Convergence ⁵					
the	Peak Load % Scheduled DA (Peak Hour)		101.6	-12%	3%	Market-wide DA Premium		0.1%	0.4%	2.0%	
P			99.0%	98.1%	98.9%	Virtual Trading					
A	Transmission Congestion (\$M)					Cleared Quantity (MW/hr)	9	11,940	-7%	-1%	
	Real-Time Congestion Value		\$296.9	-21%	48%	% Price Insensitive		30%	26%	28%	
	Day-Ahead Congestion Revenue		\$148.5	-30%	7%	% Screened for Review	9	1%	1%	1%	
	Balancing Congestion Revenue ³		\$11.3	\$9.1	\$10.2	Profitability (\$/MW)		\$0.55	\$0.75	\$0.61	
	Ancillary Service Prices (\$/MWh)					Dispatch of Peaking Units (MW/hr)	9	755	881	535	
	Regulation		\$9.47	1%	72%	Output Gap- Low Thresh. (MW/hr)	9	92	101	42	
	Spinning Reserves		\$2.00	-17%	69%	Other:					
	Supplemental Reserves	9	\$0.74	-8%	57%						
****	Key: SExpected	change.									
	Monitor/Discuss										
	Concern 3. Net real-time congestion collection, unadjusted for M2M settlements.										
· · ·	4. Includes effects of market power mitigation.										
	5. Values include allocation of RSG.									OMAC	
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Highlights for Winter 2017

Weather Patterns, Fuel Prices, and Energy Prices (Slides 10, 12, 13)

- Gas prices rose sharply in December to nearly \$4 per MMBtu during periods of cold weather, but moderated over the remainder of the quarter.
 - ✓ There were record withdrawals of natural gas from storage and significant increases in natural gas prices in both the North and South in December when temperatures were colder than normal.
 - ✓ Changes in gas hub prices differences (as high as \$0.45/MMBtu) resulted in corresponding changes in the transfers between the North and South.
 - Energy prices were highest in December, averaging over \$30 per MWh, consistent with the changes in natural gas prices.
- Warmer than normal temperatures in January and February, and declining gas prices contributed to decreases in real-time energy prices.



Highlights from Winter 2017

Real-Time Congestion Increases (Slides 16, 17)

- Real-time congestion increased 48 percent over last year, although it fell 21 percent from the prior quarter.
 - ✓ Much of the increase in real-time congestion occurred along the MISO PJM seam and was caused by transmission outages and high wind output.
 - One market-to-market constraint alone accounted for congestion of \$40 million and was difficult to manage because it is dominated by PJM.
 - On February 7, MISO transferred control of this constraint to PJM, reducing congestion on the constraint and improving the dispatch.
 - ✓ We would like MISO, PJM, and SPP to become more active at transferring such constraints, but it requires agreement and improved processes.
- The growth in wind production also contributed to higher congestion.
 - ✓ Wind output rose 21 percent from the fall and 20 percent over last winter, and MISO set new wind output records in December.
 - ✓ Wind output contributed to \$47 million of real-time congestion costs.
- Severe storms on February 7 led to \$19 million of real-time congestion that we discuss below.



Highlights for Winter 2017

February 7: Severe Storms in MISO South (Slide 15)

- On February 7, tornadoes in MISO South led to multiple transmission outages.
 - MISO declared a Severe Weather Alert for several MISO South areas, and the tornadoes led to multiple transmission outages.
 - ✓ Although generators responded to high prices and some turned on during the event, congestion was very high for several late afternoon and evening hours.
 - ✓ Prices at the Louisiana Hub exceeded \$1,000 for three hours.
- Day-ahead prices were significantly lower than real-time prices, as participants could not have foreseen the events.
- Much of the volatility in the South in February can be attributed to the outages that occurred after the tornadoes on February 7.
- Because the outages resulted in significantly lower real-time limits on a number of constraints, MISO incurred \$11 million in balancing congestion (negative ECF) that is generally collected through uplift charges to load.



Submittals to External Entities and Other Issues

- We responded to FERC questions related to prior referrals and continued to meet with FERC on a weekly basis to discuss market outcomes.
 - ✓ We also made two new referrals of wind suppliers associated with inaccurate forecasts and a partial pseudo-tied resource for failing to provide accurate offers.
 - ✓ MISO implemented our recommendation to remove the eligibility for price volatility make-whole payments from a resource we determined to be earning unjustified payments and we referred the resource to FERC for inaccurate offers.
- We have been discussing two tariff flaws related to MISO's DAMAP payments, one where the tariff doesn't match MISO's current practice and one that is allowing payments to wind resources in periods when they should not be eligible.
 - ✓ We understand that MISO is preparing to make a filing to resolve the first issue and is considering options for addressing the second issue.
- We filed comments on FERC's rulemaking on fast-start resource pricing.
 - ✓ We expressed strong support for on-line pricing, proposing that FERC expand the set of eligible on-line units;
 - ✓ We expressed concerns regarding allowing offline fast-start units to set prices based on our evaluation of MISO's results. We encouraged FERC to allow only offline units that are being started by an RTO to set prices.



Submittals to External Entities and Other Issues

- MISO made a compliance filing in the complaint docket related to last year's Planning Resource Auction, which required tariff filings related to reference levels and the calculation of the transfer limit used in the PRA.
 - We supported MISO's filing on Technology-Specific Avoidable Costs (used to develop reference levels for the Planning Resource Auction);
 - ✓ We did not support MISO's method for calculating the transfer limit in the PRA, which has resulted in an understated limit and led to inflated prices in MISO North and understated prices in MISO South.
- We are preparing for the upcoming PRA by calculating Facility Specific Reference Levels and processing exclusion requests.
- We supported MISO's filing of changes to Module D that is responsive to our PRA recommendations to: a) apply physical withholding tests to affiliates jointly, and b) exclude of demand response resources from mitigation.
- We filed a Protest on MISO's Competitive Retail Solution and an Answer to MISO's Answer to our protest.
 - ✓ FERC's Order cited the same fundamental concerns that we raised in our protest.
 - ✓ We hope to work together with MISO to develop an economically sound capacity market proposal that will address competitive load and supply issues.



Submittals to External Entities and Other Issues

- Congestion on constraints impacted by neighbors continues to be an issue.
 - MISO M2M constraints where PJM has most of the effective relief generated substantial real-time congestion.
 - ✓ Similar issues have arisen with SPP and the most effective resolution is to transfer control of the constraint to the RTO with the most relief.
- On March 9, PJM made a 205 filing to add criteria for accepting pseudo-ties.
 - ✓ PJM says new criteria are needed to address unintended negative impacts on PJM.
 - ✓ The impacts are consistent with the problems forecasted in our 2015 SOM report:
 - A dramatic increase in M2M constraints, less efficient congestion management, higher congestion costs, and higher costs for PJM customers (they also raise costs for MISO customers but this is not addressed by PJM).
 - MISO also made a filing to address some of the pseudo-tie reliability requirements.
 - ✓ These filings do not solve the problems caused by pseudo-tied resources, they mainly erect barriers to pseudo-tying and, therefore, to capacity transactions.
 - ✓ We will be filing comments on these filings, but also recommending that FERC order PJM to solve the underlying problem by: *eliminating the PJM requirement that capacity importers pseudo-tie their resources to PJM*.
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Day-Ahead Average Monthly Hub Prices Winter 2015–2017



All-In Price Winter 2015 –2017



Monthly Average Ancillary Service Prices Winter 2016 – 2017



MISO Fuel Prices 2015–2017



Load and Weather Patterns Winter 2015–2017



<u>Note</u>: Midwest degree day calculations include four representative cities in the Midwest: Indianapolis, Detroit, Milwaukee and Minneapolis. The South region includes Little Rock and New Orleans.



Louisiana Hub LMP and ECF Feb. 7, 2017



Day-Ahead Congestion, Balancing Congestion and FTR Underfunding, 2016–2017



Value of Real-Time Congestion Winter 2016–2017



Real-Time Hourly Inter-Regional Flows 2016 - 2017





MISO Congestion Value and JOA Settlement Constraints Impacted by Pseudo-Ties



Wind Output in Real-Time and Day-Ahead Markets Monthly and Daily Average



Day-Ahead and Real-Time Price Convergence Fall 2015–2016





Indiana Hub	1	1	-2	2	1	-1	-7	-1	1	3	-2	0	-2	-5	1	0	1
Michigan Hub	2	1	0	4	3	-1	-6	4	0	5	-9	-2	4	-1	2	1	1
Minnesota Hub	4	0	3	4	5	-3	2	6	-5	0	-6	-2	-2	2	-6	3	4
WUMS Area	2	-3	0	4	3	0	0	1	-3	-5	-7	1	4	1	-6	-1	-2
Arkansas Hub	3	1	4	2	2	-3	-3	7	4	-1	0	-3	-2	-6	0	1	3
Texas Hub	3	1	3	1	6	3	-18	13	2	-3	1	2	3	-1	2	-2	3
Louisiana Hub	3	-9	4	2	3	-2	2	1	-14	-1	-4	-3	1	0	1	1	-30*

* Excluding Feb. 7 2017, the price differential was -2 percent.



Day-Ahead Peak Hour Load Scheduling Winter 2016–2017





Virtual Load and Supply Winter 2016–2017



Virtual Load and Supply by Participant Type Winter 2016–2017



Virtual Profitability Winter 2016–2017



Ramp Up Price November 2016 – February 2017





Peaking Resource Dispatch 2016–2017



Day-Ahead RSG Payments 2016–2017



Real-Time RSG Payments 2016–2017



Price Volatility Make Whole Payments 2016–2017



Generation Outage Rates 2016–2017



Generation Outage Rates South, 2016–2017



Monthly Output Gap 2016–2017



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ECONOMICS

Day-Ahead And Real-Time Energy Mitigation 2016–2017



Day-Ahead and Real-Time RSG Mitigation 2016–2017





List of Acronyms

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- AMP **Automated Mitigation Procedures**
- BCA Broad Constrained Area
- CDD **Cooling Degree Days**
- CMC **Constraint Management Charge**
- Day-Ahead Margin Assurance DAMAP Payment
- DDC Day-Ahead Deviation & Headroom • Charge
- Dispatchable Intermittent Resource DIR •
- HDD Heating Degree Days
- JCM Joint and Common Market Initiative
- JOA Joint Operating Agreement
- Look-Ahead Commitment LAC
- LSE Load-Serving Entities
- M2M Market-to-Market
- MSC **MISO** Market Subcommittee
- NCA Narrow Constrained Area
- ORCA **Operations Reliability Coordination** Agreement
- ORDC **Operating Reserve Demand Curve**
 - Pseudo-Tie Issues Task Team PITT

- PRA **Planning Resource Auction**
- **PVMWP** Price Volatility Make Whole Payment
 - RAC **Resource Adequacy Construct**
- RDT **Regional Directional Transfer**
- RSG **Revenue Sufficiency Guarantee**
- RTORSGP Real-Time Offer Revenue Sufficiency Guarantee Payment
 - System Marginal Price SMP
 - SOM State of the Market
 - **SRPBC** Sub-Regional Power Balance Constraint
 - TLR Transmission Line Loading Relief
 - **Transmission Constraint** TCDC Demand Curve
 - VCA Voluntary Capacity Auction
 - VLR Voltage and Local Reliability
 - WPP Weekly Procurement Process
 - WUMS Wisconsin Upper Michigan System

