

IMM Quarterly Report: Spring 2018

MISO Independent Market Monitor

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Highlights and Findings: Spring 2018

- The MISO markets performed competitively this spring.
 - Energy prices were unchanged from last year as natural gas prices fell 12 percent, which was offset by a 4 percent increase in load.
 - ✓ Market power mitigation was infrequent and offers were competitive overall.
- Temperatures departed significantly from historical averages:
 - Temperatures in March and April were well below average.
 - In April, a cold front in the Midwest put upward pressure on gas prices.
 - Gas prices at Chicago increased nearly 50% over 5 days in mid-April.
 - Record-high temperatures in May contributed to challenging operating conditions, Max Gen Alerts, high prices and congestion.
 - ✓ Peak load this Spring was 20 percent higher than last year at 111.9 GW.
- Day-ahead congestion fell by 17 percent over last year and real-time congestion fell by 7 percent largely because of lower gas prices.
- A new wind output record of 15.6 GW was set on March 31.
- In April, the 2018-2019 PRA again cleared at close to zero:
 - ✓ \$10 per MW-day except in Zone 1, which cleared at \$1 per MW-day.
- We evaluated the CTS and ELMP processes, which are not performing well.



Quarterly Summary

				Chan	ige ¹				Chan	ige ¹		
-				Prior	Prior			-	Prior	Prior		
			Value	Qtr.	Year			Value	Qtr.	Year		
	RT Energy Prices (\$/MWh)	9	\$29.84	-4%	0%	FTR Funding (%)	9	99%	101%	103%		
	Fuel Prices (\$/MMBtu)					Wind Output (MW/hr)	9	5,926	-18%	-9%		
	Natural Gas - Chicago		\$2.58	-16%	-12%	Guarantee Payments (\$M) ⁴						
	Natural Gas - Henry Hub		\$2.73	-11%	-10%	Real-Time RSG	0	\$13.5	-23%	-18%		
1	Western Coal		\$0.71	2%	8%	Day-Ahead RSG	9	\$8.6	-22%	-14%		
	Eastern Coal		\$1.47	-3%	1%	Day-Ahead Margin Assurance	9	\$10.4	-24%	-22%		
	Load (GW) ²					Real-Time Offer Rev. Sufficiency	9	\$1.2	19%	-26%		
-	Average Load		72.5	-9%	4%	Price Convergence ⁵						
A	Peak Load		111.9	5%	20%	Market-wide DA Premium	9	0.1%	2.4%	-2.2%		
	% Scheduled DA (Peak Hour)	9	99.1%	98.7%	98.5%	Virtual Trading						
A	Transmission Congestion (\$M)					Cleared Quantity (MW/hr)	3	15,536	0%	15%		
A	Real-Time Congestion ValueS4Day-Ahead Congestion RevenueS2Balancing Congestion Revenue3S2		\$434.5	13%	-7%	% Price Insensitive	9	32%	35%	27%		
			\$191.6	-17%	-17%	% Screened for Review	9	1%	1%	1%		
			\$9.6	\$0.7	\$16.3	Profitability (\$/MW)	9	\$0.86	\$1.32	\$1.06		
	Ancillary Service Prices (\$/MWh)					Dispatch of Peaking Units (MW/hr)	9	1,375	829	880		
	Regulation	9	\$10.48	5%	-3%	Output Gap- Low Thresh. (MW/hr)	3	84	82	105		
	Spinning Reserves		\$3.04	13%	-20%	Other:						
	Supplemental Reserves S0.8		\$0.89	-32%	-55%							
	Key: Expected Notes: 1. Values not in italics are the value for the past period rather than the change.											
	 Monitor/Discuss Comparisons adjusted for any change in membership. 											
	Concern 3. Net real-time congestion collection, unadjusted for M2M settlements.											
· · .	4. Includes effects of market power mitigation.											
-	5. Values include allocation of RSG.											



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Hot Weather in May, High Prices, and Congestion (Slides 12, 13, 16, 18)

- In late May, record-high temperatures, high load, and transmission outages contributed to high prices and congestion.
 - ✓ Nearly 10 percent of total quarterly congestion occurred on the last three days of May, and \$33 million of real-time congestion occurred on a single day.
- MISO declared Hot Weather Alerts for May 27 through May 29.
 - ✓ On May 28, Minneapolis hit a record 100 degrees.
 - ✓ High river temps caused deratings and one unit outage in the Central Region.
 - On May 29, challenging conditions led to several out of market actions:
 - MISO declared a Local Transmission Emergency in Michigan in order to commit AME resources and access generator emergency ranges.
 - ✓ 13 units were manually re-dispatched throughout the footprint.
 - ✓ Forced transmission outages led MISO to declare multiple TLRs.
 - ✓ Transmission ratings were lowered because of hot weather.
- Hot temperatures, and high forced outages, and high forecasted load led MISO to issue Max Gen Alerts for May 14-16 that were later canceled as conditions improved.

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Outages (Slides 36, 37)

- Outages were slightly lower this Spring than in 2016.
- During tight anticipated conditions in mid-May, several generators moved outages to increase available capacity and enabled MISO to cancel Maximum Generation Alerts it had declared.
- Overall, planned outages were slightly lower this Spring than in 2016, but:
 - ✓ Planned outages remained much higher in the South than in the North.
 - ✓ Short-notice planned outages have increased substantially (those that are planned less than 7 days prior to the start of the outage or extended).
 - They were especially high in May and contributed to the high prices.
 - A large share of these outages were extensions of planned outages.
 - This raises concerns because MISO has not planned for them.
 - ✓ We continue to recommend (SOM 2016-3) that pursue expanded authority to coordinate transmission and generation outages.







2018-2019 Planning Resource Auction (Slide 38)

- MISO's PRA cleared at \$10 per MW-day in all zones, except Zone 1 that was export-constrained and cleared at \$1 per MW-day.
 - ✓ This is a slight increase from the \$1.50 per MW price in the prior year, but remains close to zero. This is the direct result of a flaw in the design of the capacity market that undermine suppliers' long-term decisions.
- Cleared LMRs increased 17 percent over last year, driven by nearly 1 GW and 0.6 GW of additional cleared DR and BTMG, respectively.
 - ✓ We have concerns about the increasing amount of cleared LMRs because the majority of these resources are not available under critical conditions since:
 - MISO has to first declare an emergency before calling them; and
 - These resources have notification times of up to 12 hours.
 - ✓ Response during past emergencies have also been well below 100 percent.
- In March, MISO filed Tariff changes to create External Resource Zones.
 - \checkmark Provides better price signals for external capacity resources.
 - ✓ With limited exceptions, it prevents external capacity resources from offsetting Local Clearing Requirements.
 - \checkmark FERC has issued a deficiency letter to address outstanding questions.

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Coordinated Transaction Scheduling (Slide 30)

- On October 3, 2017, MISO implemented CTS with PJM.
 - Participants submit offers to schedule imports and exports that clear intrahour if forecasted price spreads between markets exceed offer prices.
 - ✓ The economic dispatch of external transactions through CTS can achieve sizable efficiency savings.
- Unfortunately, it was implemented in a manner that has removed the incentive for participants to submit transactions.
 - Participants pay transmission reservation fees to submit CTS offers, even if they do not clear.
 - ✓ These fees averaged \$49 and \$21 per cleared MWh of imports and exports, respectively. These fees explain the lack of participation shown in the figure.
- CTS continues to offer large potential benefits.
 - ✓ We recommend that MISO remove transmission reservation fees unilaterally and work with PJM to agree to eliminate their charges to CTS transactions.
 - This also underscores the importance of adhering to sound economic principles in developing new market products and rules because this outcome was predictable.

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Effectiveness of ELMP (Slide 22)

- The hot conditions in May led to an increased reliance on peaking resources, which are useful conditions under which to evaluate the effects of ELMP.
- ELMP reforms pricing by allowing peaking resources to set prices when they are:
 - ✓ Online and deemed economic and needed to satisfy the system's needs; or
 - ✓ Offline and deemed economic during transmission or energy shortage conditions.
- We have found the offline pricing under ELMP to be inefficient, muting legitimate shortage pricing signals, and we have recommended that it be disabled.
- The online pricing is critical because it:
 - ✓ Allows prices to fully reflect the costs of the resources needed by the system;
 - Improves the real-time price signals that govern day-ahead outcomes and decisions to import and export; and
 - ✓ Reduces reliance on RSG that compensates for understated real-time prices.
- ELMP's online pricing has had a small effect on MISO's prices since its inception.
 - ✓ Our prior evaluations concluded that the small effects were due to the limited eligibility of resources to set prices under ELMP.
 - ✓ This was expanded under "Phase 2" in May '17, but the effects are still small.



Effectiveness of ELMP's Online Pricing (Slide 22)

- We recommend further expansion to include day-ahead scheduled units.
 - ✓ This will substantially increase the eligibility of peaking units, particularly under high-load conditions, which lead to higher day-ahead scheduling of peaking units.

• We also evaluated a key assumption that determines when a unit will set price:

- ✓ Currently, units ramped down by ELMP at their max ramp rate will not set price.
- ✓ Both the ISO-NE and NYISO variants of ELMP more accurately test whether a unit is needed and should set price by testing whether it should ramp to zero.
- ✓ Our evaluation estimates the effects of modifying this assumption and allowing day-ahead scheduled peaking units to be eligible in the real-time market.
- The figure shows that:
 - Expanding eligibility would have increased the price effects by almost 300 percent, from \$0.58 per MWh to \$2.25 per MWh.
 - ✓ Relaxing the ramp rate assumption would raise the effectiveness further to \$4.19.
 - ✓ The effects are highest in the afternoon hours rising to more than \$12 per MWh on average in the 3 pm hour.
 - ✓ If reflected back into the day-ahead market, these prices would improve the generator commitments and lower the costs of meeting the system's demands.





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.
 - ✓ We responded to several data requests related to prior referrals.
 - ✓ We made several notifications of other potential Tariff violations.
 - ✓ We presented a review of monitoring screens and indices to FERC staff.
- We participated in the following FERC dockets.
 - ✓ We participated in stakeholder discussions and supported MISO's filing to authorize mitigation authority on the SRPBC in the N-S direction.
 - We will also be supporting MISO's response to FERC's deficiency letter seeking clarifications and supporting data.
 - ✓ We provided review and input for MISO's filing to improve PVMWP related to manually redispatched resources.
 - ✓ We filed comments in the Grid Resiliency docket, generally supporting MISO's resiliency conclusions and opposing PJM's pricing proposals.



Submittals to External Entities and Other Issues

- We sent MISO an additional memo recommending sanctions for resources for uneconomic production under Module D.
- We participated in a number of stakeholder discussions and working groups.
- We continued to work with MISO and stakeholders on proposed improvements to the Uninstructed Deviation Thresholds (SOM 2012-2) and improved incentives for PVWMP (SOM 2016-5).
 - MISO has worked with us and its stakeholders to develop a very good proposal and plans to file proposed tariff revisions in the 3rd Quarter.
 - ✓ We've also recommended that MISO address a gaming issue we have observed that leads to RTORSGP, which accounted for more than 40 percent of these payments in the Spring quarter.



Day-Ahead Average Monthly Hub Prices Spring 2016 – 2018





All-In Price Spring 2016 – 2018



Monthly Average Ancillary Service Prices Spring 2017 – 2018



MISO Fuel Prices 2016 – 2018



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Load and Weather Patterns Spring 2016 – 2018



Minneapolis. The South region includes Little Rock and New Orleans.

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Day-Ahead Congestion, Balancing Congestion and FTR Underfunding, 2016 – 2018



Value of Real-Time Congestion Spring 2017 – 2018



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







Real-Time Hourly Inter-Regional Flows 2017 - 2018



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



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Evaluation of ELMP Assumptions May 2018





Day-Ahead and Real-Time Price Convergence Spring 2017 – 2018





Indiana Hub	-2	-4	-4	0	-3	5	-3	1	-16	3	2	4	-6	-8	0	-4	-9
Michigan Hub	-3	-4	-6	-1	-1	0	-3	1	-11	-1	0	2	-2	1	-1	-2	-10
Minnesota Hub	-2	-1	-1	-5	1	5	-7	2	-7	-10	3	0	3	-6	1	0	-5
WUMS Area	2	-2	3	-1	3	3	-8	3	-11	0	0	2	2	-3	0	-6	-2
Arkansas Hub	-1	0	-3	0	2	5	-7	2	-2	5	-3	1	-7	-1	0	-4	3
Texas Hub	1	1	-2	3	4	-1	-1	3	1	8	-6	4	-5	-1	0	-5	7
Louisiana Hub	0	-9	2	-4	3	-1	-9	-6	-1	7	-5	5	3*	3	0	-3	10

* Excluding Jan. 17-18, 2018.



Day-Ahead Peak Hour Load Scheduling Spring 2017 – 2018



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Virtual Load and Supply by Participant Type Spring 2017 – 2018



Virtual Profitability Spring 2017 – 2018



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Day-Ahead and Real-Time Ramp Up Price 2016 – 2018



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Common Interface Pricing with PJM Spring 2018



Note: 76.8% within \$1.50 of ideal price.

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Coordinated Transaction Scheduling (CTS) Winter 2018





Peaking Resource Dispatch 2017 – 2018



Day-Ahead RSG Payments 2017 – 2018



Real-Time RSG Payments 2017 – 2018



RDT Commitment RSG Payments 2016 – 2018



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Price Volatility Make Whole Payments 2017 – 2018



Generation Outage Rates 2017–2018



Generation Outage Rates South: 2017–2018



Planning Resource Auction Results 2018 – 2019



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Monthly Output Gap 2017 – 2018







Day-Ahead And Real-Time Energy Mitigation 2017 - 2018



Day-Ahead and Real-Time RSG Mitigation 2017 – 2018







List of Acronyms

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- AMP Automated Mitigation Procedures
- BCA Broad Constrained Area
- CDD Cooling Degree Days
- CMC Constraint Management Charge
- CTS Coordinated Transaction Scheduling
- DAMAP Day-Ahead Margin Assurance
 Payment
- DDC Day-Ahead Deviation & Headroom Charge
- DIR Dispatchable Intermittent Resource
- HDD Heating Degree Days
- ELMP Extended Locational Marginal Price
- JCM Joint and Common Market Initiative
- JOA Joint Operating Agreement
- LAC Look-Ahead Commitment
- LSE Load-Serving Entities
- M2M Market-to-Market
- MSC MISO Market Subcommittee
- NCA Narrow Constrained Area

- ORDC Operating Reserve Demand Curve
- PITT Pseudo-Tie Issues Task Team
- 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
 - SMP System Marginal Price
- SOM State of the Market
- TLR Transmission Line Loading Relief
- TCDC Transmission Constraint Demand Curve
- VLR Voltage and Local Reliability
- WUMS Wisconsin Upper Michigan System



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