

IMM Quarterly Report: Spring 2020

MISO Independent Market Monitor

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Highlights and Findings: Spring 2020

- The MISO markets performed competitively this Spring, market power mitigation was infrequent, and conduct was highly competitive overall.
- Energy prices fell 30 percent compared to last spring, attributable to:
 - Low natural gas prices since MISO's inception under \$2 per MMBtu; and
 - ✓ Peak and average load were down 7 and 8 percent this quarter, respectively.
 - Weather was generally mild and COVID-19 measures were implemented by several member states.
 - MISO estimated the average impact of COVID on load was 8 percent.
- However, congestion increased for the quarter as May exhibited a significant increase in congestion in the Midwest and the South.
 - A high-voltage transmission outage caused by a storm contributed to \$13 million of congestion on one day in the South.
- MISO's improvements in its uninstructed deviation and make-whole payment rules continued to result in improved generator performance.
 - ✓ Generator deviations were down 14 percent overall from last spring and down as much as 27 percent during MISO morning ramp hours.

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Quarterly Summary

	Change ¹								Change ¹	
			-	Prior	Prior			-	Prior	Prior
-			Value	Qtr.	Year			Value	Qtr.	Year
	RT Energy Prices (\$/MWh)		\$18.42	-13%	-30%	FTR Funding (%)	0	99%	98%	99%
	Fuel Prices (\$/MMBtu)					Wind Output (MW/hr)	0	8,122	0%	13%
	Natural Gas - Chicago	9	\$1.64	-15%	-40%	Guarantee Payments (\$M) ⁴				
	Natural Gas - Henry Hub		\$1.71	-16%	-37%	Real-Time RSG	0	\$6.5	-11%	-54%
	Western Coal		\$0.69	0%	-2%	Day-Ahead RSG	٩	\$6.5	-3%	-33%
-	Eastern Coal		\$1.22	-8%	-28%	Day-Ahead Margin Assurance	0	\$5.6	35%	6%
	Load (GW) ²					Real-Time Offer Rev. Sufficiency	0	\$0.4	62%	-50%
	Average Load		64.9	-14%	-8%	Price Convergence⁵				
-	Peak Load		91.6	-4%	-7%	Market-wide DA Premium	0	2.6%	2.3%	3.7%
Ex.	% Scheduled DA (Peak Hour)		98.8%	98.8%	98.2%	Virtual Trading				
To	Transmission Congestion (\$M)					Cleared Quantity (MW/hr)	٩	18,177	18%	-3%
A	Real-Time Congestion Value		\$233.5	68%	24%	% Price Insensitive	٩	33%	30%	41%
	Day-Ahead Congestion Revenue		\$127.3	52%	6%	% Screened for Review	0	1%	0%	1%
	Balancing Congestion Revenue ³		-\$6.2	-\$2.4	-\$2.5	Profitability (\$/MW)	0	\$0.70	\$0.30	\$0.45
	Ancillary Service Prices (\$/MWh)					Dispatch of Peaking Units (MW/hr)	•	730	825	717
	Regulation		\$8.00	12%	-13%	Output Gap- Low Thresh. (MW/hr)	٩	55	27	103
	Spinning Reserves		\$2.13	25%	-14%	Other:				
_	Supplemental Reserves	9	\$0.16	-40%	-61%					
	Key: Expected		Notes:	1. Values	not in ita	lics are the values for the past period rather that	n the	e 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. -3-



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Impacts of Low Fuel Prices and COVID-19 (Slides 12-15, 30-31)

- Real-time prices fell 30 percent compared to last spring and were the lowest in MISO's history, averaging \$18 per MWh.
 - ✓ Gas prices were at historic lows throughout the quarter, falling as much as 15 percent over last quarter and 40 percent over last spring at Chicago Citygate.
 - Higher gas production in the winter quarter contributed to the lowest net withdrawals in four years, despite increased winter gas consumption.
 - ✓ Pandemic-related measures, including stay-at-home orders implemented by the majority of states, contributed to significant changes in load patterns.
 - While overall COVID 19-related impacts on load averaged 8 percent since March, the effects were as high as 10.6 percent in May.
 - Peak load fell by 7 percent over last Spring.
 - As states open back up, load has begun to increase.
- These factors also led to sizable reductions in:
 - ✓ Day-ahead and real-time RSG, down by 33 and 54 percent; and
 - \checkmark Regulation and reserve prices, down by 13 to 61 percent.



Displacement of Coal-Fired Resources (Slides 14, 16, 17, 25)

- Over half of coal resources in MISO rely on Powder River Basin coal, and PRB coal prices have remained relatively unchanged over the past few years.
 - Changes in natural gas prices significantly impacted MISO's dispatch as gasfired generation continues to displace coal-fired generation.
 - ✓ The energy share of output from coal-fired resources fell from 38 to 27 percent, while natural gas-fired resources increased from 30 to 37 percent.
 - ✓ Additionally, the share of output from wind grew from 11 to 15 percent.
- Historically, low energy prices continue to motivate coal resources to switch from "must run" to economic offers in MISO.
 - ✓ 98 percent of available offline coal units offered economically to MISO in the day-ahead market this spring, up from 89 percent last year.
 - Once coal units are running, owners often use the must-run designation to keep them from cycling.
 - ✓ Coal resources' net revenues fell substantially this spring and they were uneconomic this quarter in aggregate.
 - ✓ Some states are considering off-peak seasonal suspensions of coal resources.

<u>2020 – 2021 Planning Resource Auction Clearing (Slides 18, 19)</u>

- MISO's annual Planning Resource Auction was held in early April.
 - Michigan (Zone 7) cleared at CONE due to insufficient capacity resources offered within the zone to meet the Local Clearing Requirement.
 - MISO responded to our recommendation not to allow units expected to be on outage during the peak months to sell capacity.
 - This change reduced capacity offers in MI by 337 MW.
 - The rest of MISO cleared at \$5 to \$7 per MW-day, which is inefficiently low at less than 3 percent of the cost of building a new peaking resource.
- To estimate more efficient capacity prices, we conducted alternative capacity auction clearing scenarios:
 - Implementing our recommendations to address the qualification of capacity resources would raise prices in the South to \$27 and in the Midwest to \$108.
 - ✓ Improving the modeling of demand to be consistent with reliability would increase auction clearing prices to range from \$214 to \$234 per MW-day, which is roughly 80 percent of the cost of building a new resource.
 - ✓ As MISO's capacity margin continues fall and renewables enter, it will be increasingly important to send efficient long-term price signals.



Transmission Loading Relief called by IESO (Slide 21)

- IESO has continued to call frequent TLRs on the Ontario-MI Interface.
 - These TLRs have resulted in curtailments of transactions from PJM to MISO as high as 5 GW, resulting in price spikes in Michigan and MISO-wide.
- These TLRs raise potential concerns because:
 - Curtailing vast quantities of imports from PJM is a *very* inefficient means to lower flows over the Ontario interface and is costly to MISO's customers.
 - Transactions from IESO to MISO and to NYISO have a much larger impact, 5 to 20 times the impact as the curtailed PJM transactions. IESO's transactions are not being curtailed because they classify them as "firm".
 - ✓ TLRs are often called on the entire MISO IESO interface as a proxy for a specific facility on which MISO's impact is extremely small.
 - The criteria IESO is employing may lead to much more significant impacts in the future.
- We continuing to work with MISO and IESO to investigate these TLR actions and identify possible changes in IESO's procedures or alternatives to the TLRs that could be implemented through a Joint Operating Agreement.

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Wind Output and Forecasting (Slides 25-26)

- Wind capacity continues to increase by more than 3 GW from last Spring.
 - ✓ Output grew 13 percent from Spring 2019.
 - ✓ On April 9, MISO hit a new record peak of 18.1 GW.
 - ✓ Wind output changed as much as 4.4 GW in one hour this quarter.
 - As wind output grows these numbers are growing too, creating operational challenges that need to be managed.
- Although almost all wind resources switched to MISO's forecast after the May 2019 settlement changes, a few participants continued to rely on their own forecasts, and some participant forecasts had a persistent bias.
 - ✓ One resource was over-forecasting as high as 40 percent since January.
 - ✓ After consulting with the IMM it recently switched to MISO's forecast.
- MISO adopted our recommendation and eliminated the "higher-of" forecast logic in favor of exclusive use of the vendor forecast in February.
 - This eliminated the persistent over-forecast bias and reduced the absolute wind forecasting error, most significantly during the ramp-down periods

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Submittals to External Entities and Other Issues

- The IMM function has experienced no detrimental impacts from COVID-19.
- We responded to several FERC questions related to prior referrals and FERC investigations, and we continued to meet with FERC on a weekly basis.
- We provided comments on MISO's RAN initiatives related to LMR accreditation and LOLE modeling.
- We participated in RASC meetings to discuss ICAP deliverability issues.
 - ✓ We have been consulting with MISO and participants in the Resource Adequacy Subcommittee to address the issues in MISO's deliverability rules.
 - We prepared affidavits for each of MISO's recent filings to improve its deliverability rules.
- We discussed the proposed improvements to the market power mitigation measures in Module D of the Tariff to the MSC.
 - ✓ We will also be supporting MISO's re-filing of the physical withholding provision in Module D with an affidavit.





Submittals to External Entities and Other Issues

- We continued working with the SPP MMU and MISO on the Tier 1 items prioritized for study and have begun planning for Tier 2 items.
 - ✓ We completed the Tier 1 study of market-to-market coordination using all available data (the report was been delayed because of SPP data limitations).
 - ✓ We plan to publish the Tier 2 Interface Pricing study later this month this will be the last study under the initial seams study budget.
 - ✓ We also reviewed and collaborated on SPP's study of Coordinated Transaction Scheduling (CTS).
- We provided a discussion on Transmission Line Ratings to the OMS in May and we will be presenting to the MISO TOs at MISO Meetings in June.
- In May, we updated and made associated FERC filings related to Narrow Constrained Area Thresholds used in Market Power Mitigation.



Day-Ahead Average Monthly Hub Prices Spring 2018 – 2020



All-In Price 2018 – 2020



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Monthly Average Ancillary Service Prices Spring 2019 – 2020



MISO Fuel Prices 2018 – 2020



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Load and Weather Patterns Spring 2018 – 2020



<u>Notes</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.

* Effects estimated by MISO through back-casting using its load forecasting model.



Capacity, Energy and Price Setting Share Spring 2019 – 2020

	τ	U nforced C	apacity		Energy	Output	Price Setting					
Spring	Total ((MW)	Share	(%)	Share	e (%)	SMP	(%)	LMP (%)			
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020		
Nuclear	12,225	12,107	10%	9%	17%	18%	0%	0%	0%	0%		
Coal	48,775	46,864	38%	37%	38%	27%	41%	35%	84%	79%		
Natural Gas	55,240	56,673	43%	44%	30%	37%	56%	63%	96%	94%		
Oil	1,691	1,568	1%	1%	0%	0%	0%	0%	0%	0%		
Hydro	3,966	4,034	3%	3%	2%	2%	1%	1%	2%	2%		
Wind	3,005	3,660	2%	3%	11%	15%	1%	1%	48%	60%		
Other	2,678	2,703	2%	2%	2%	1%	0%	0%	2%	3%		
Total	127,580	127,608										



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Change in Coal Offer Patterns Spring 2019 – 2020



Planning Resource Auction 2020-2021







Alternative Capacity Auction Clearing 2020 – 2021 PRA

Alternative Canacity Auction	Affected	Vertical D	emand Cu	rve Prices*	Sloped Demand Curve Prices**			
Scenarios	UCAP	Unconstrained South	Zone 9 (LA, TX)	Unconstrained North	Unconstrained South	Zone 9 (LA, TX)	Unconstrained North	
Base Scenario (Actual Prices)		\$4.75	\$6.88	\$5.00	\$148.23	\$155.10	\$148.23	
- LMR > 6 hr Notification Time	1,226.6	\$12.12	\$12.12	\$12.12	\$168.51	\$168.51	\$168.51	
- Undeliverable ICAP	2,933.2	\$14.99	\$20.02	\$25.38	\$200.86	\$200.86	\$200.86	
+ Procurement for BTM Firm Load	270.2	\$4.75	\$23.64	\$5.00	\$152.89	\$171.94	\$152.89	
Combination of Alternative Scenarios	4,384.3	\$27.20	\$27.20	\$108.00	\$213.61	\$213.61	\$234.23	

* Zone 7 (MI) was short of its Local Clearing Requirement and cleared at CONE (\$257.73). This result is unchanged in all vertical demand scenarios.

** Zone 7 clears at \$270.41 (5% above CONE) in all sloped demand scenarios.

Generation Outage and Derate Rates Spring 2019 – 2020

/0%															
			Snr Monthly Avora				2	018		2019			2020		
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60%			🗾 Ford	ced: Lo	ng-Term	1	3.9%	3.8	3%	6.1%	3.5	5%	3.6%	1.89	%
			Forced: Short-Term			n	1.2%	0.9	9%	1.3%	0.6	5%	1.2%	1.29	%
50%			Unr	eported	ported in CROW		4.7% 9.8%		3%	4.4%	9.1	1%	5.1%	12.7	%
5070			Unplanned: Other				5.0% 3.1%		5.9% 2.1%		1%	3.1%	5.1%		
و			Planned: Extensions			is	1.4%	4.4	4%	2.0%	3.8	3%	2.1%	1.0	%
40%			Planned: Normal				13.9% 18.2%		2%	14.0%	19.6%	6%	12.0%	13.7	%
•			Tote	al			30.2%	40.	3%	33.7%	38.	7%	27.1%	35.5	%
30%															
20%															
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		2019		20	20		2019		2	2020		2019)	202	20
Total Outage								e		Derate					
														PO	TON

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IESO TLRs and Curtailments Spring 2020

Date TLR Hours		PJM Imports Curtailed (MW/hr)	Max Hourly Ex-Post SMP	Market Participant NSI Losses (\$)		
03/10/2020	6	1,198	\$62	\$	(53,564)	
04/03/2020	8	1,570	\$48	\$	(26,136)	
04/09/2020	14	2,428	\$84	\$	(141,401)	
04/10/2020	9	742	\$95	\$	(106,124)	
04/21/2020	15	1,936	\$106	\$	(417,978)	
04/25/2020	10	1,066	\$39	\$	(61,182)	
04/27/2020	6	573	\$62	\$	(51,994)	
05/09/2020	13	1,561	\$38	\$	(38,116)	
05/15/2020	3	441	\$104	\$	(14,543)	
Average/Tota	1	1,490	\$71	\$	(911,039)	

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Note: 7 TLR days are not shown due to low curtailments and impacts.



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Day-Ahead Congestion, Balancing Congestion and FTR Underfunding, 2019 – 2020



Value of Real-Time Congestion Spring 2019 – 2020



Real-Time Hourly Inter-Regional Flows Spring 2020



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Wind Output in Real-Time Daily Range and Average



Average Wind Forecasts by Source 2019 – 2020



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Day-Ahead and Real-Time Price Convergence Spring 2019 – 2020



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Day-Ahead Peak Hour Load Scheduling Spring 2019 – 2020



Peaking Resource Dispatch Spring 2019 – 2020



Day-Ahead RSG Payments Spring 2019 – 2020



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Real-Time RSG Payments Spring 2019 – 2020



Price Volatility Make Whole Payments Spring 2019 – 2020



Virtual Load and Supply Spring 2019 – 2020



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Virtual Load and Supply by Participant Type Spring 2019 – 2020



Virtual Profitability Spring 2019 – 2020



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Day-Ahead and Real-Time Ramp Up Price 2019 – 2020



Evaluation of ELMP Assumptions Spring 2020

\$1.00





Coordinated Transaction Scheduling (CTS) 2019 – 2020



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Average Resource Dragging by Hour



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Monthly Output Gap Spring 2019 – 2020



Day-Ahead And Real-Time Energy Mitigation 2019 – 2020



Day-Ahead and Real-Time RSG Mitigation Spring 2019 – 2020



List of Acronyms

- AAR Ambient-Adjusted Ratings
- 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
 - STE Short-Term Emergency
 - SMP System Marginal Price
 - SOM State of the Market
 - TLR Transmission Loading Relief
 - TCDC Transmission Constraint Demand Curve
 - VLR Voltage and Local Reliability
 - WUMS Wisconsin Upper Michigan System



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