



Summary of 2017 MISO State of the Market Report

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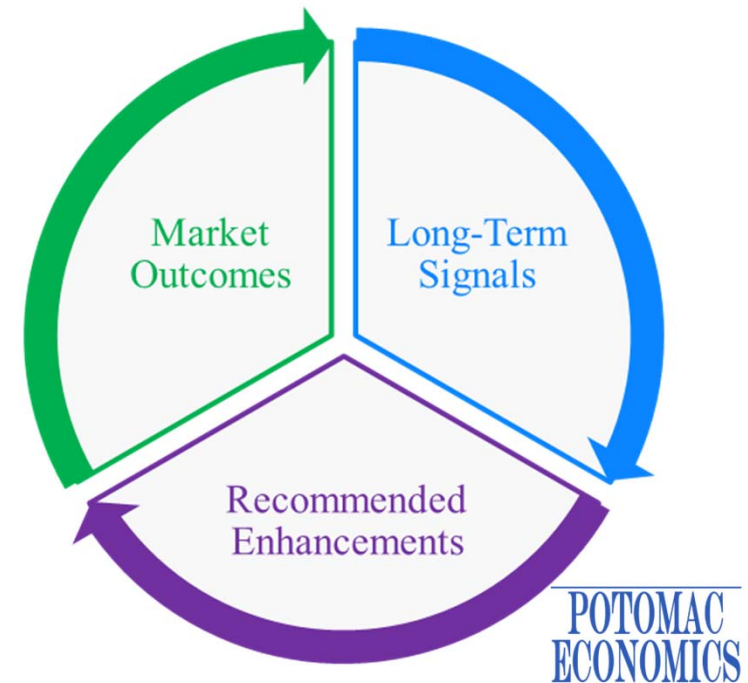
MISO Board Markets Committee

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Introduction

- As the Independent Market Monitor (IMM) for the Midcontinent ISO (MISO), we:
 - ✓ Evaluate the competitive performance and operation of the MISO markets; and
 - ✓ Identify and recommend changes to existing and proposed market rules and operating procedures.
- This presentation summarizes:
 - ✓ Market highlights from 2017;
 - ✓ The competitive performance and operational efficiency of the markets;
 - ✓ Long-term economic signals; and
 - ✓ Recommendations.





2017 Market Summary

- The MISO markets performed competitively.
 - ✓ The “price-cost mark-up” was close to zero – prices were highly competitive.
 - ✓ The “output gap” measure of potential economic withholding remained low at 0.11 percent of load, and market power mitigation was rare.
- Natural gas prices rose 17 percent in 2017 along with other fuel prices, leading to an 11 percent increase in energy prices throughout MISO.
 - ✓ Higher fuel prices also led to higher congestion, which rose 7 percent to \$1.5 billion in 2017.
 - ✓ Given that magnitude of the congestion costs, we are concerned about four key issues that are increasing the costs of managing congestion.
- Day-ahead and real-time markets operated efficiently.
- Design issues caused the capacity prices to remain inefficiently low.
 - ✓ Prices in the PRA remained close to zero market-wide in the 2017/2018 and 2018/2019 planning year.



Key Market Developments in 2017

- MISO implemented several market design changes that improved efficiency and competitiveness in 2017:
 - ✓ On May 1, MISO implemented ELMP Phase 2 that allows some additional online resources to be eligible to set real-time prices.
 - ✓ On June 1, MISO adopted PJM's 10-point "common" interface definition to calculate congestion settlements for imports and exports.
 - ✓ On July 1, MISO implemented emergency pricing construct changes that provide more accurate pricing during emergency events.
 - ✓ On October 3, MISO and PJM implemented Coordinated Transaction Scheduling (CTS) to allow market participants to schedule economic transactions based on the difference between forecast interface prices.
 - ✓ MISO filed for authority to define Dynamic Narrow Constrained Areas (DNCAs) consistent with our SOM Recommendation 2012-9. This was approved by FERC and became effective January 4, 2018.
- The three most significant changes – ELMP, interface pricing, and CTS – are not performing well. We discuss changes to address these performance issues.

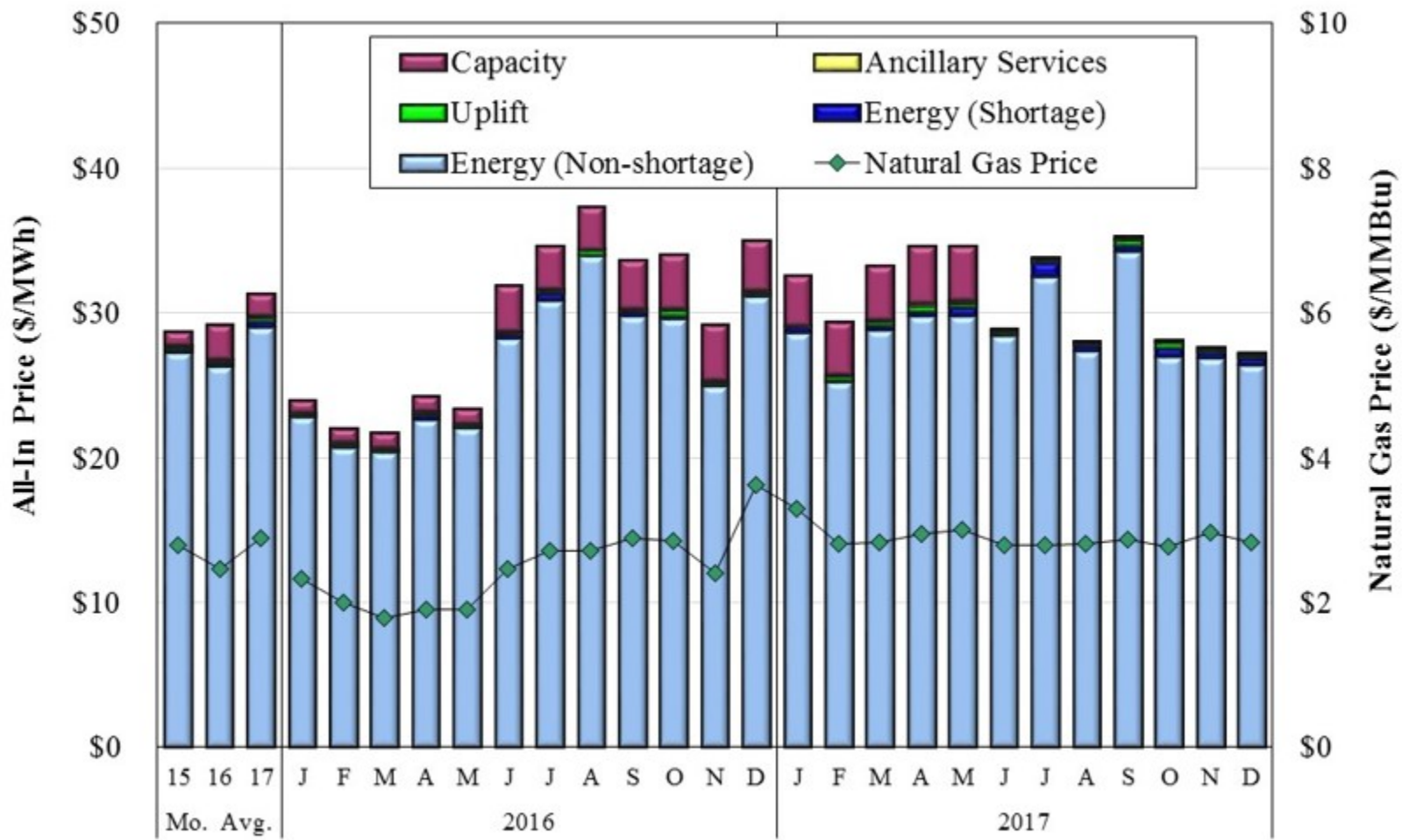


Market Highlights: Load and Prices

- The all-in price increased by 7 percent to average \$31.35 per MWh.
 - ✓ Higher energy prices, driven by increases in natural gas prices, were offset by low capacity-clearing prices in the 2017-2018 PRA.
- We exclude the effects of fuel price changes by calculating a fuel-adjusted system marginal price (SMP), which fell by one percent.
 - ✓ We expect the fuel-adjusted SMP to be relatively flat since most price changes in a competitive electricity market are driven by fuel changes.
- While winter and summer temperatures were milder than in 2016, average annual load fell only one percent because of higher load in spring and fall.
 - ✓ MISO's annual peak load of 120.6 GW was similar to last year, well below the forecasted peak of 125 GW.
- Higher fuel prices also led to higher real-time congestion and higher real-time RSG costs in 2017.
 - ✓ Fuel-price adjusted RSG costs were flat, although RSG incurred to manage subregional capacity needs (RDT-related) increased significantly.
 - ✓ This underscores the value of creating a subregional reserve product.

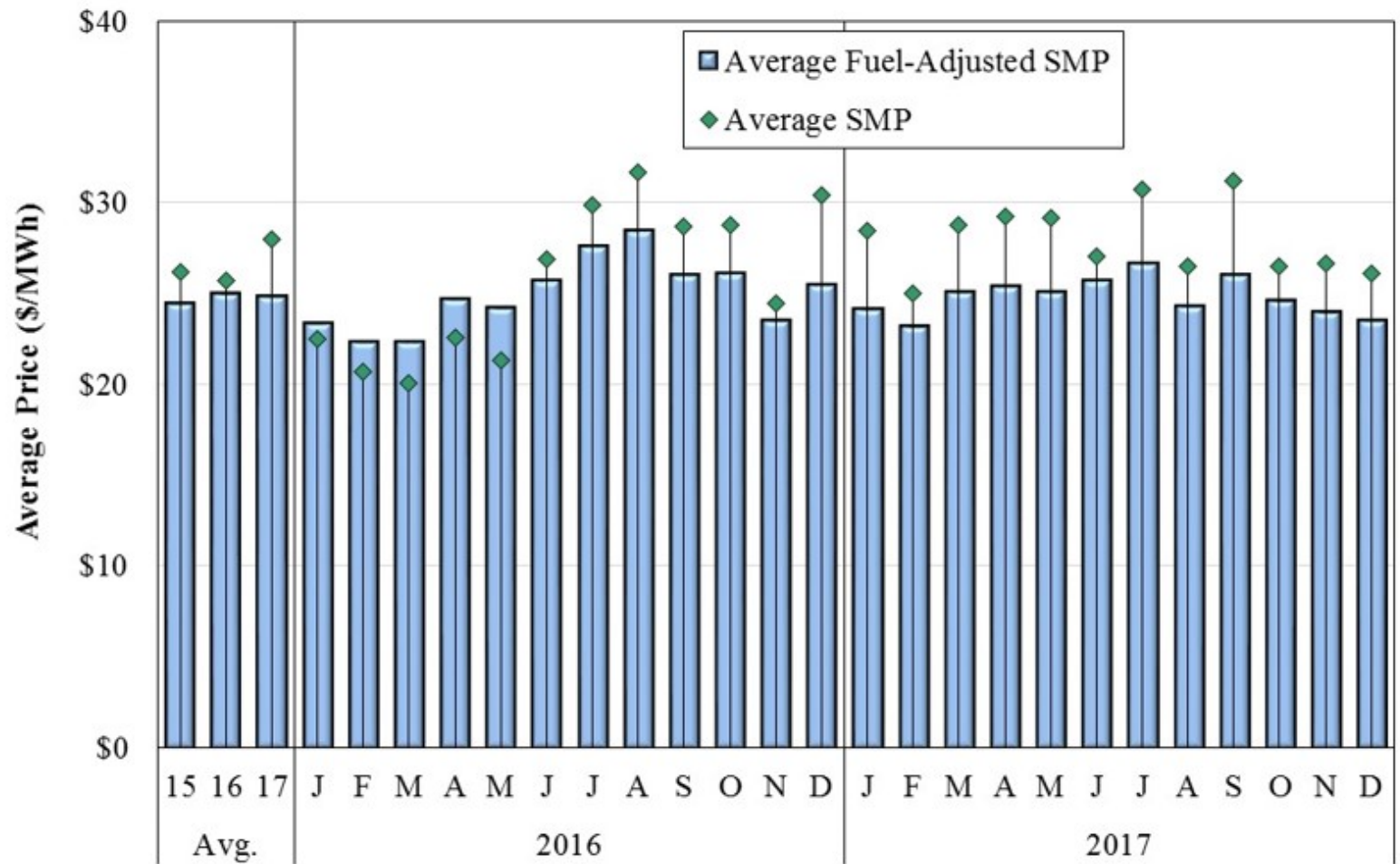


All-In Price



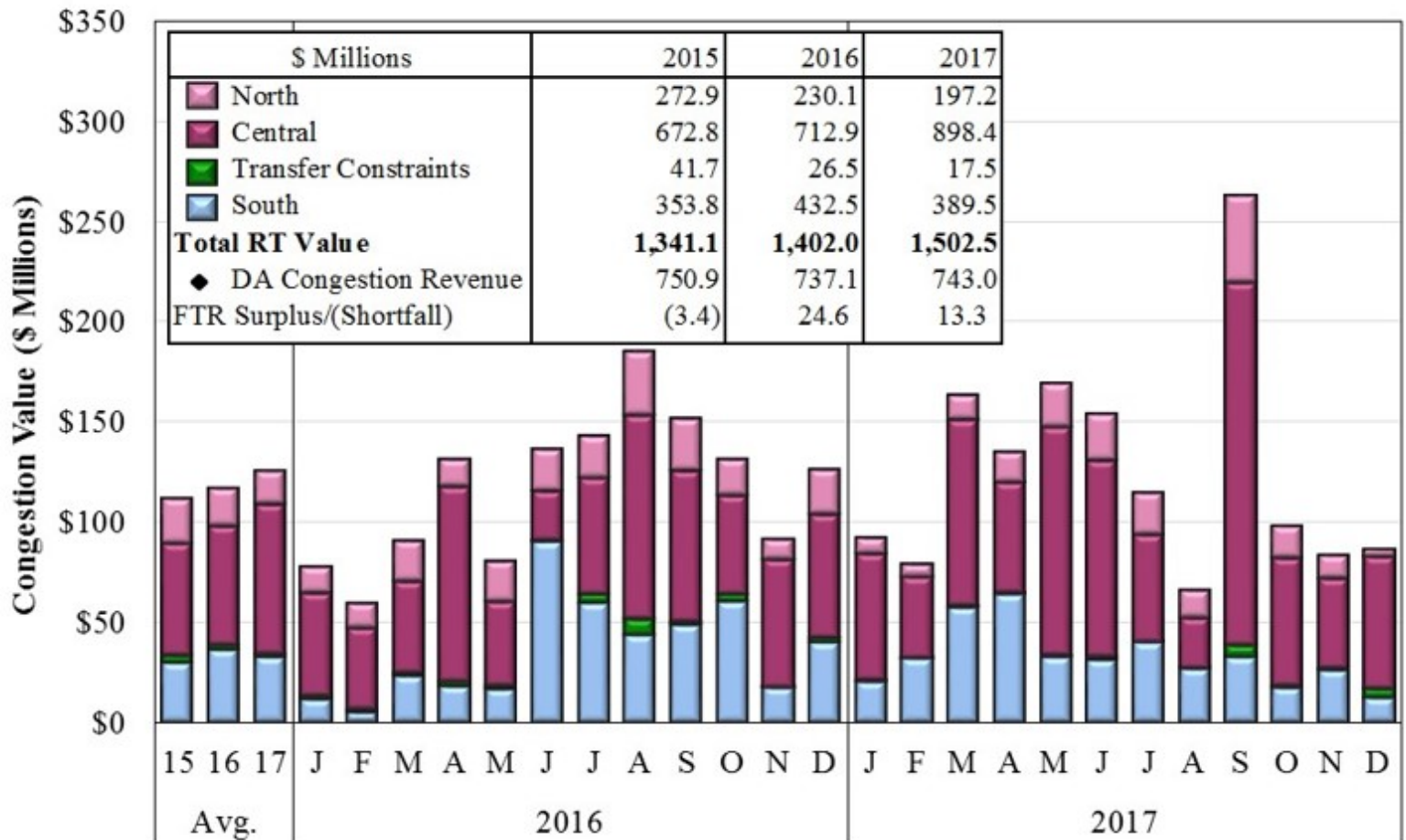


Fuel-Adjusted System Marginal Price



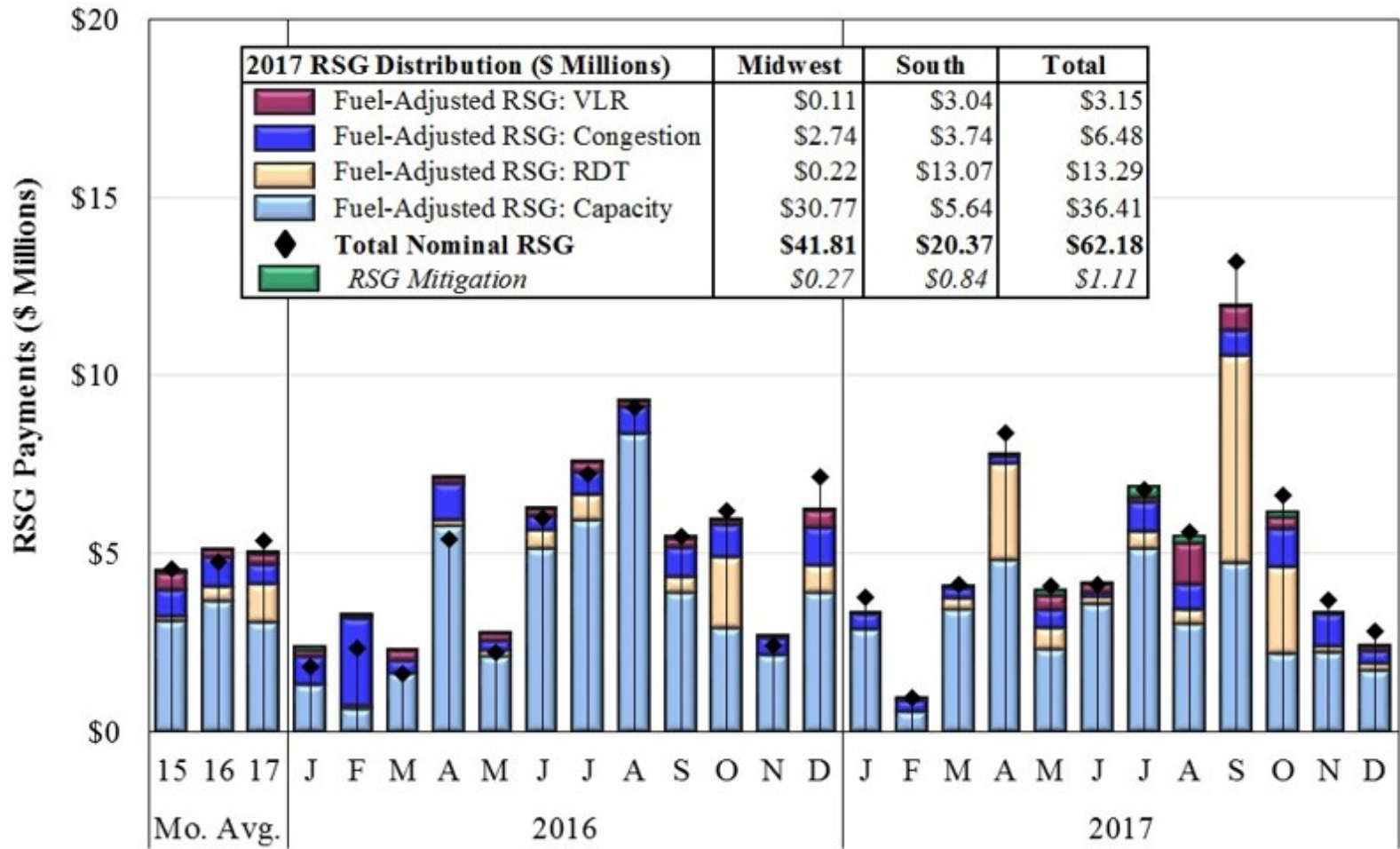


Real-Time Value of Congestion in MISO





Real-Time RSG Payments 2016-2017





Evaluation of Virtual Trading in MISO

- The day-ahead market performed well in 2017, in large part because of the liquidity provided by virtual trading. However, some have argued that virtual trading may generate costs that are greater than the benefits they provide.
- To evaluate this assertion, we have developed a multi-tiered set of screens to identify virtual trades that improve market efficiency and those that do not.
- A substantial majority of virtual trades improve efficiency (see table below).
 - ✓ Profits of efficiency-enhancing virtual trades exceeded losses by \$78 million, but the total benefits of virtual transactions are much larger.
 - ✓ Some virtual transactions profit that do not contribute to efficiency (profits on un-modeled constraints or loss factors). These rents totaled \$55 million.

	Total	Financial Participants	Physical Participants
Efficient Virtuals	56%	57%	51%
Not Efficient Virtuals	44%	43%	49%
Average MW per Hour	13,733	12,426	1,307

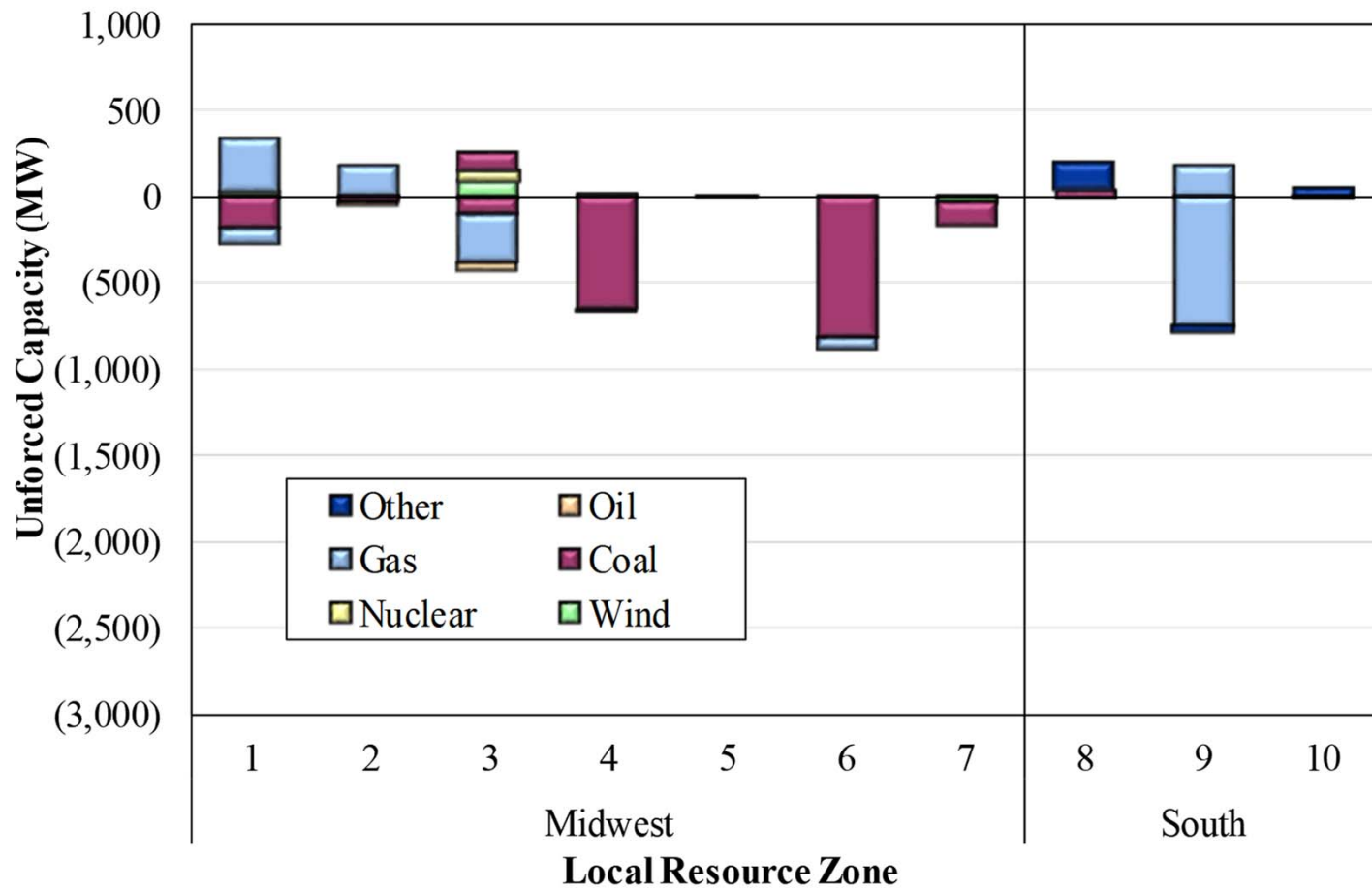


Capacity Margins and Long-Term Price Signals

- The 2018 summer capacity margin grew to 19.3 percent, signaling sufficient capacity exits to meet the 17.1 percent capacity margin requirement.
 - ✓ Including only accessible and reliable LMRs, MISO's margin falls to 13.7%.
 - ✓ Long notification times and summer-only obligations cause only a small fraction of MISO's LMRs to be available when needed during emergencies.
- MISO is lost 2.6 GW of capacity on net, largely attributable to:
 - ✓ Persistent low natural gas prices that result in lower energy prices.
 - ✓ Environmental regulations requiring costly retrofits for certain resources.
 - ✓ A poor capacity auction design that has generated inefficiently low prices.
- In MISO's two most recent Planning Resource Auctions, clearing prices were close to zero:
 - ✓ Capacity cleared at \$1.50 per MW-day in the 2017/2018 auction for the entire MISO footprint.
 - ✓ In the 2018/2019 auction, capacity cleared at \$10 per MW-day for all zones except zone 1 that was export-constrained and cleared at \$1 per MW-day.

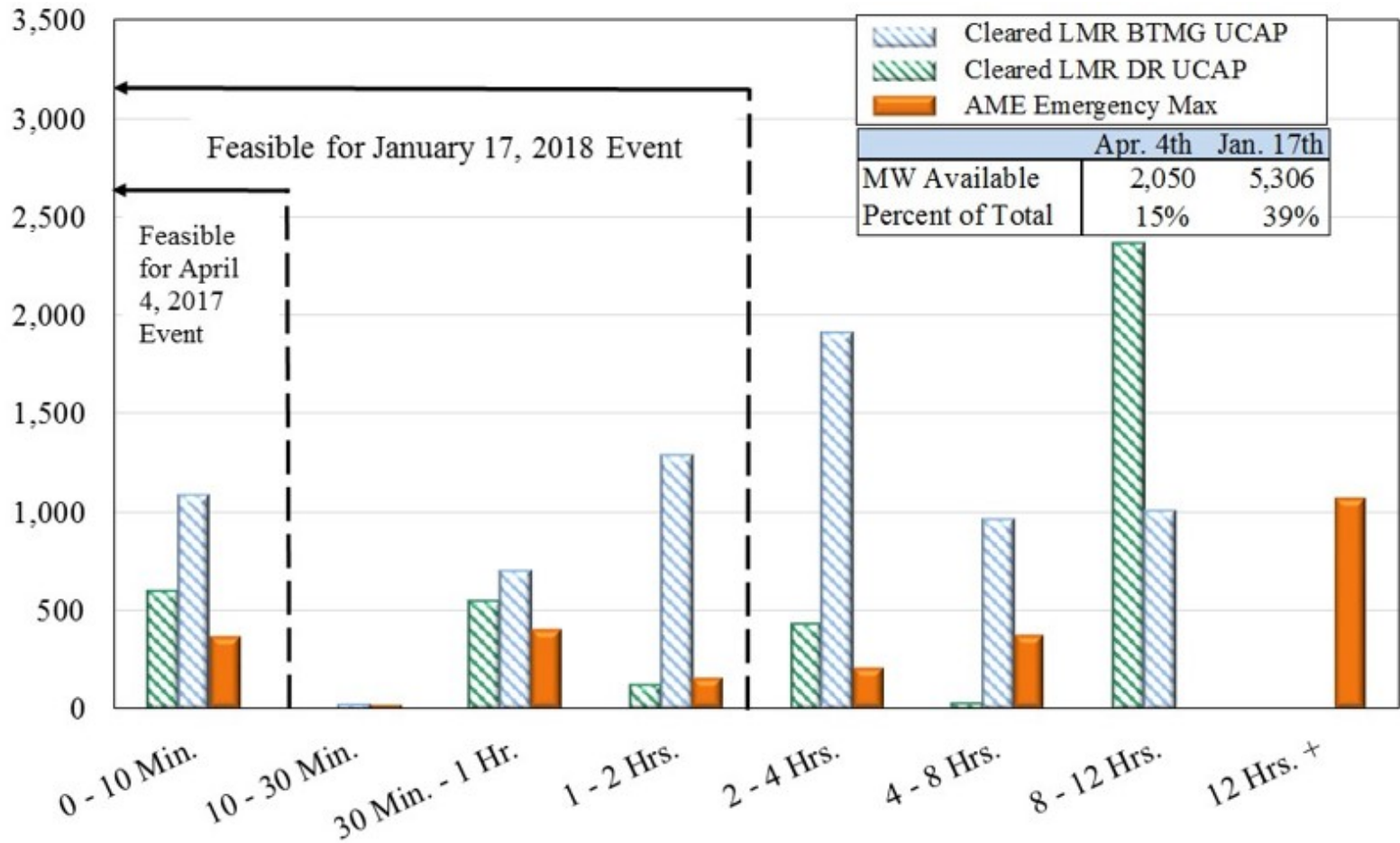


Capacity Additions and Retirements





Availability of Emergency Resources



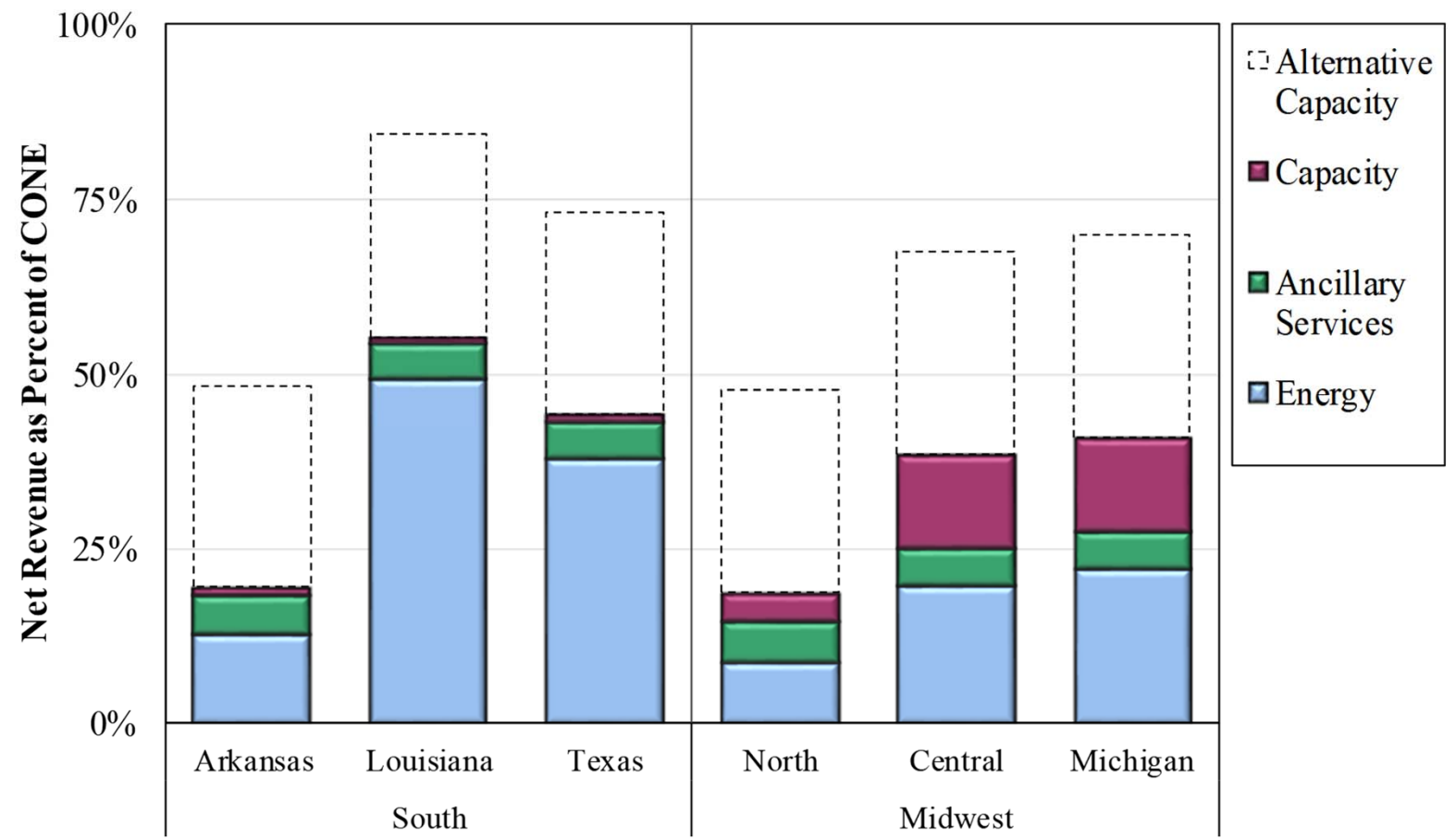


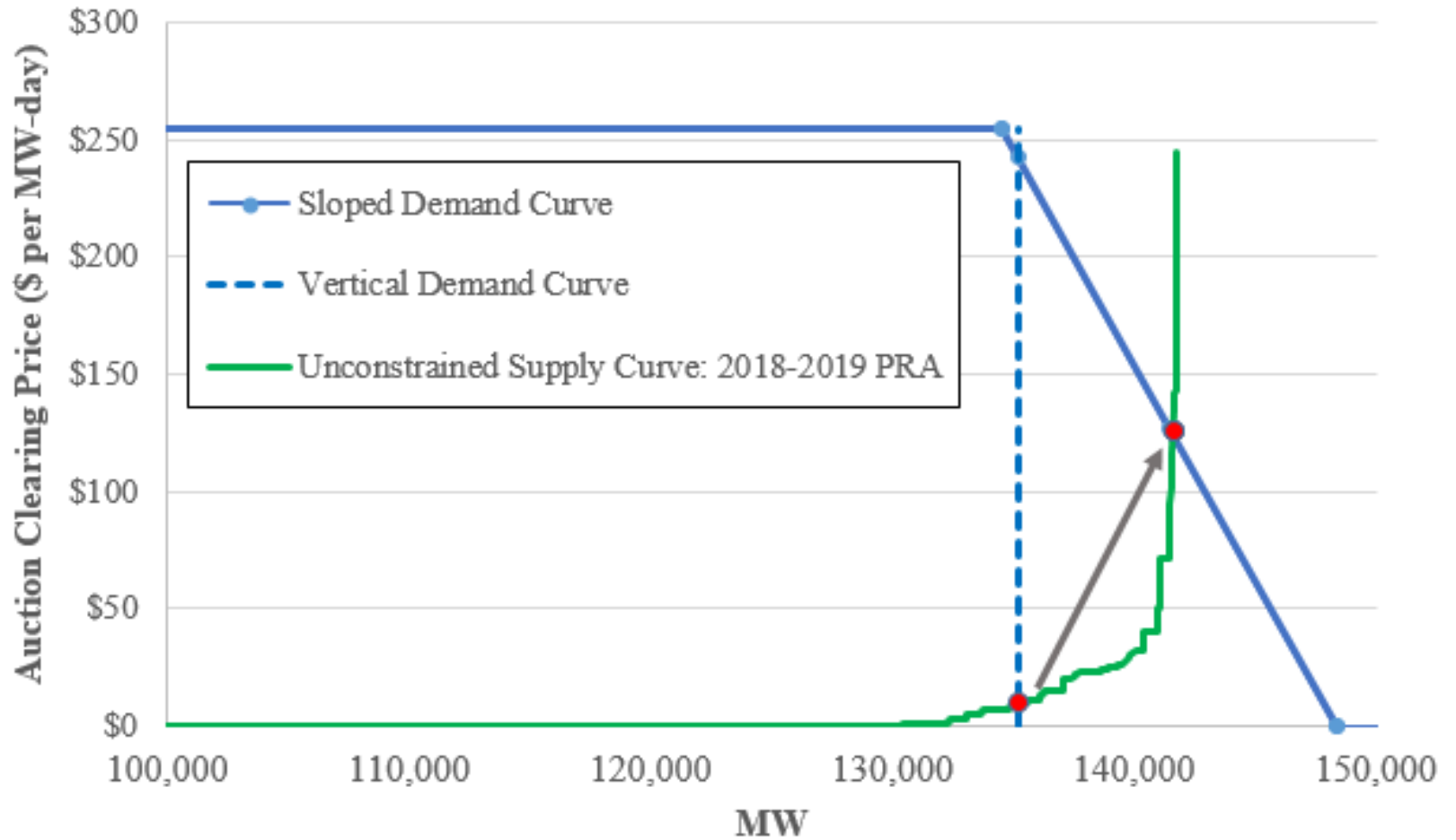
Long-Term Price Signals

- Well-designed markets produce sufficient net revenues to support efficient investment and retirement decisions.
 - ✓ Net revenue continues to be well below the cost of new entry (CONE).
 - ✓ Net revenues are insufficient to attract significant capacity additions or prevent needed resources from retiring.
- If MISO were to address the vertical demand curve flaw in its PRA, we estimate that this would have resulted in:
 - ✓ An auction clearing price of \$115.74 per MW-day in all zones in 2017/2018.
 - Net revenues would still be slightly less than CONE because of the capacity surplus that existed in 2017.
 - ✓ Clearing prices of \$111.06 per MW-day in all zones (except zone 8) in the 2018/2019 PRA.
- Improving the PRA design would deliver modest net benefits to the regulated utilities, but would substantially affect MISO's competitive participants.
 - ✓ Competitive suppliers' revenues and competitive loads' costs would both increase by more than \$400 million.



Long-Run Price Signals: Net Revenue and the Cost of New Entry





Type of MP	Net Revenue Increases	Net Revenue Decreases	Total
Vertically-Integrated LSEs	\$ 351	-\$ 320	\$ 32
Merchant Generators	\$ 413		\$ 413
Retail Choice Load		-\$ 445	-\$ 445



Transmission Congestion Issues

- We remain concerned about a number of issues that undermine the efficiency of MISO's management of transmission congestion:
 - ✓ *Market-to-Market Coordination.* We identified more than 160 constraints in 2017 that were not defined as M2M constraints, generally because MISO did not ask for testing – this congestion exceeded \$240 million.
 - ✓ *Outage Coordination.* Transmission and generation outages occurring simultaneously that affect the same constraint contributed to \$400 million – more than 30 percent of all of MISO's real-time congestion.
 - ✓ *Pseudo-Tied Resources.* PJM dispatching MISO resources has resulted in 95 new M2M constraints and led to \$155 million in congestion on these constraints -- 70 percent higher than before the pseudo-ties.
 - ✓ *Improved Transmission Ratings.* Most TOs do not adjust their facility ratings to reflect ambient temperatures and wind speeds – which could have saved MISO as much as \$127 million in production costs in 2017.



Congestion Management Concerns: M2M Coordination and Pseudo-Ties

Market-to-Market Coordination Issues

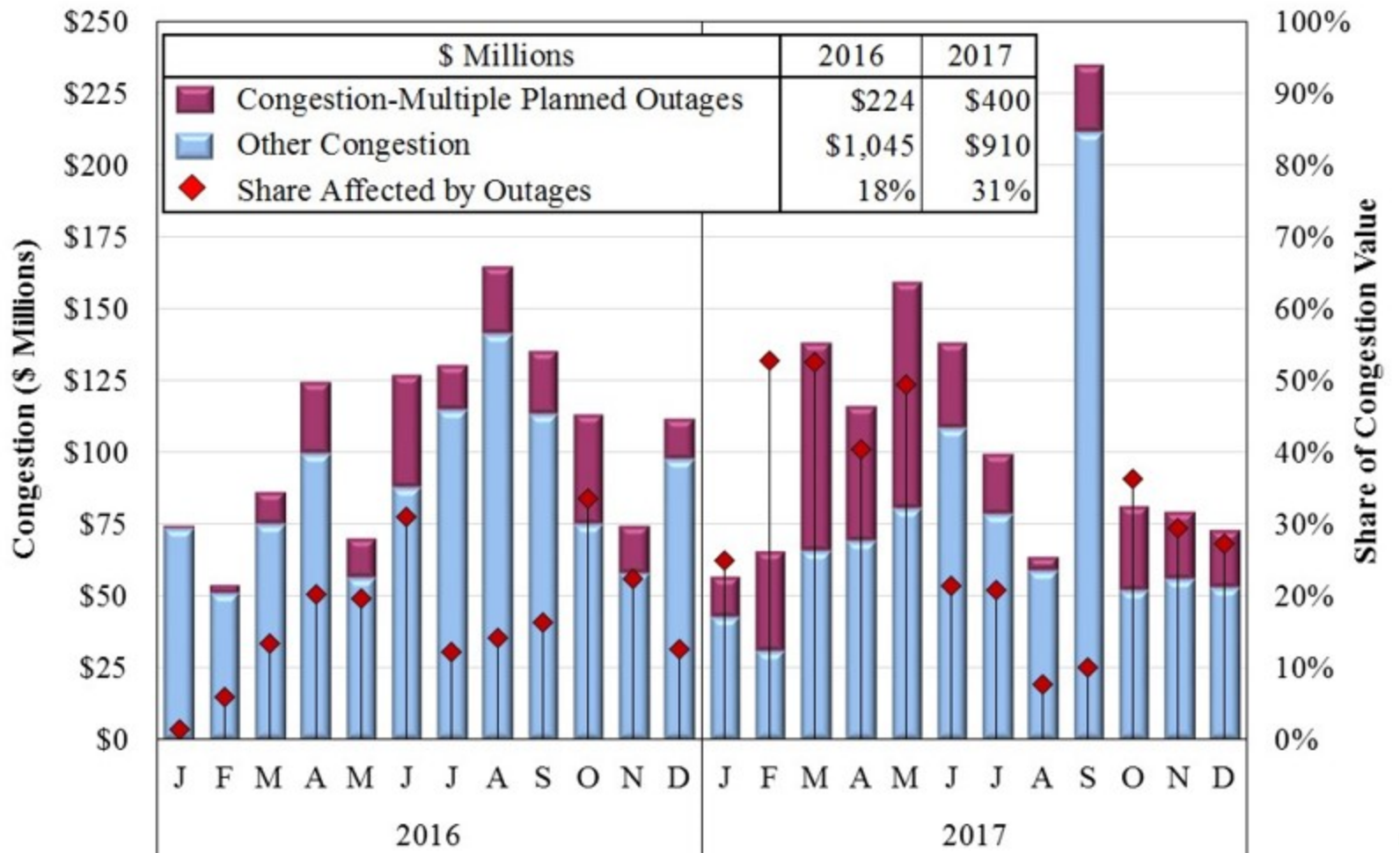
Item Description	PJM (\$ Millions)	SPP (\$ Millions)	Total (\$ Millions)
Never classified as M2M	\$84.6	\$109.2	\$193.9
M2M Testing Delay	\$19.3	\$11.5	\$30.8
M2M Activation Delay	\$6.3	\$12.1	\$18.5
Total	\$110.3	\$132.9	\$243.1

Pseudo-Tie Resource Issues

Year	M2M Constraints due to Pseudo-ties	RT Congestion on M2M Constraints (\$ Millions)
2016	66	\$70
2017	29	\$85
Total	95	\$155



Congestion Management Concerns: Outage-Related Congestion



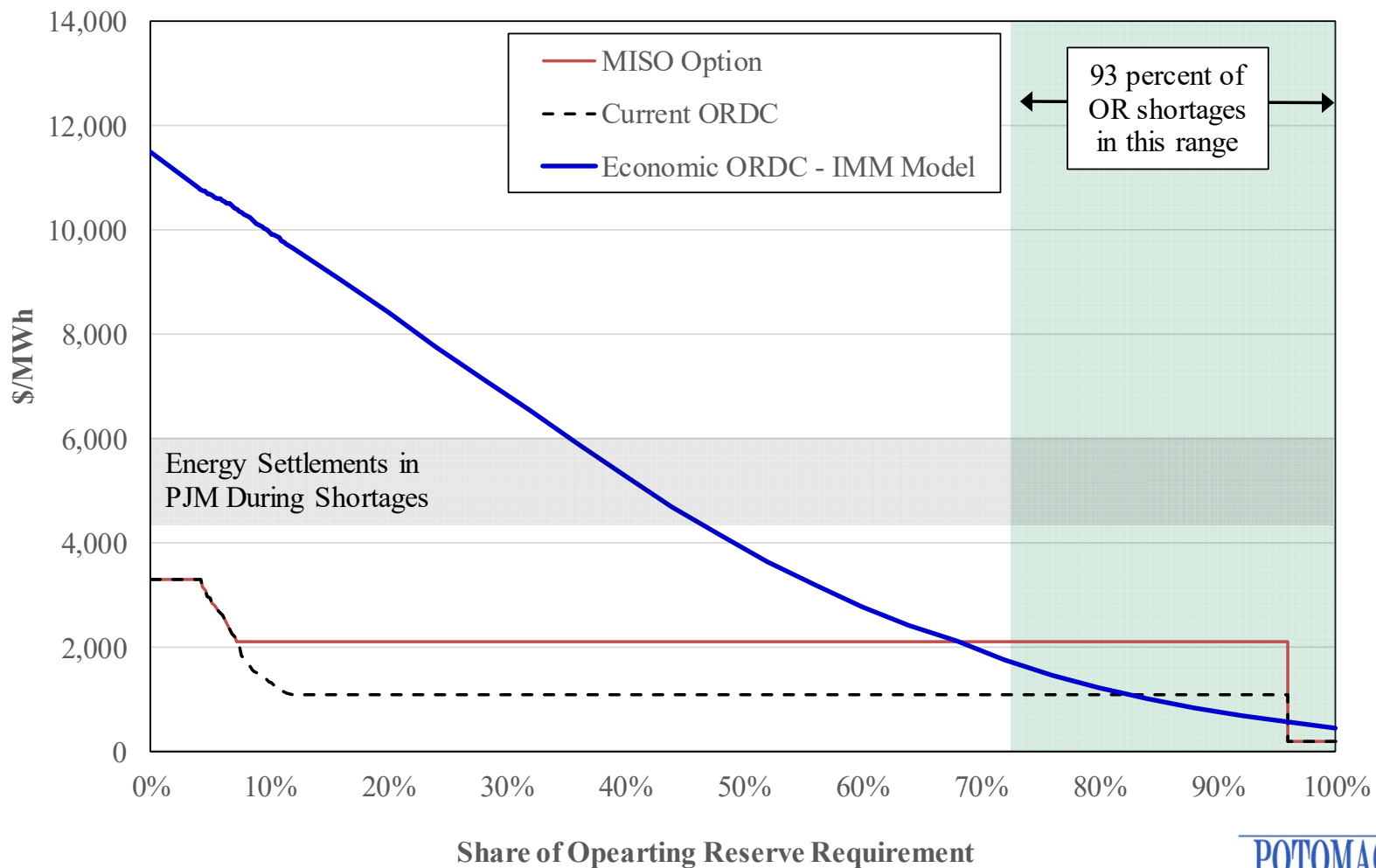


Improving Real-Time Price Formation in MISO: Shortage Pricing

- Shortage pricing provides critical economic signals to suppliers to be available and flexible, to perform well, and accommodate long-term changes:
 - ✓ Expansion of renewable resources,
 - ✓ Greater reliance on demand response, and
 - ✓ Lower capacity margins.
- Efficient shortage pricing is produced by Operating Reserve Demand Curves (ORDC) that are based on the value of electricity to customers: the expected value of lost load (VOLL).
 - ✓ ORDCs should set prices when MISO is short of reserves.
 - ✓ The current ORDC is not optimal, so we recommend that MISO develop RDCs based on the probability of losing load at different reserve levels.
 - ✓ We've also recommended that MISO disable offline pricing in ELMP that causes it not to price real shortages of reserves and transmission.

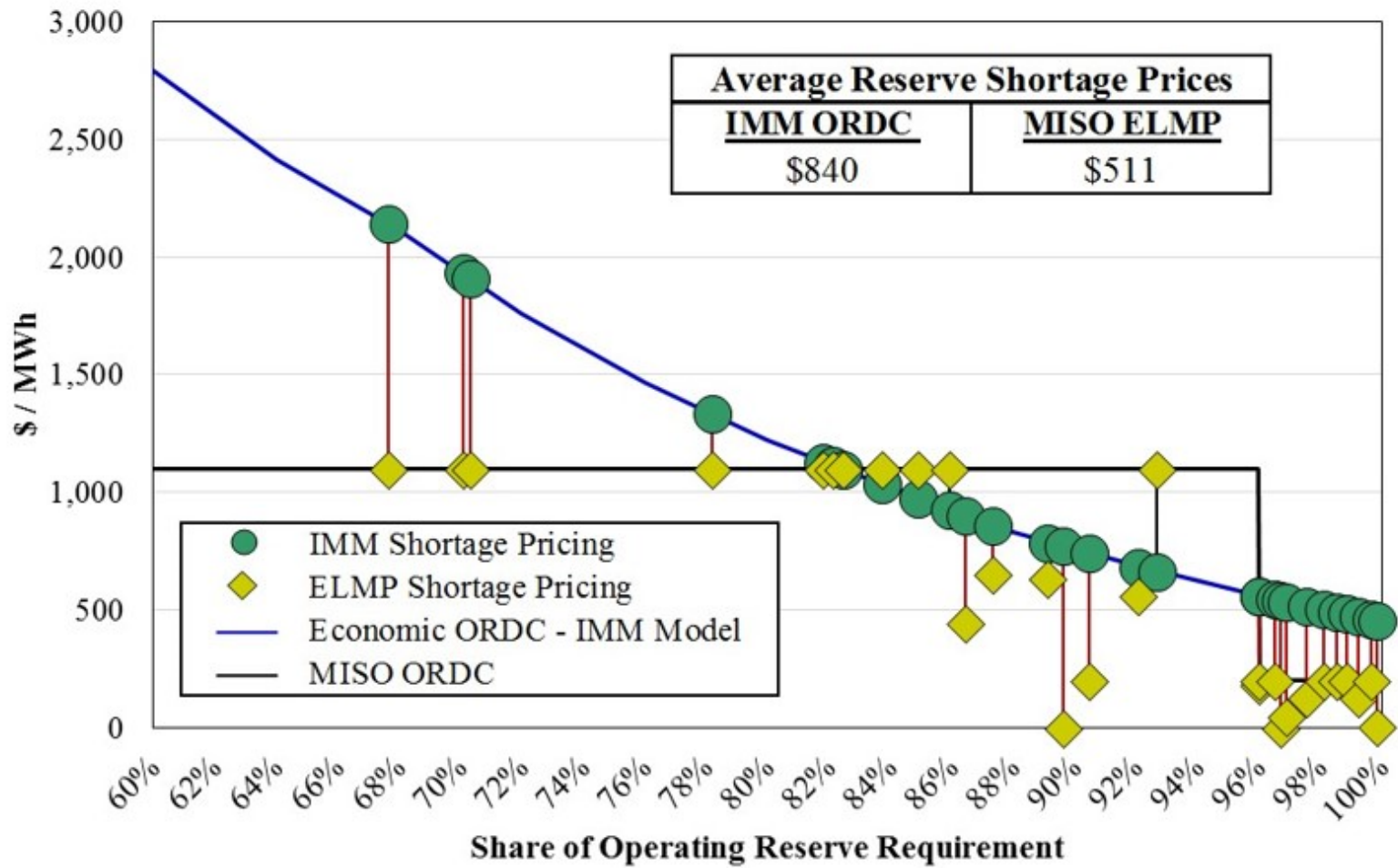


MISO's Operating Reserve Demand Curve





Shortage Pricing in 2017





Improving Real-Time Price Formation in MISO: ELMP

- Allowing fast-start peaking resources and emergency actions to set prices is essential for establishing efficient real-time prices, which:
 - ✓ Sends key price signals to schedule imports and exports, and to commit resources efficiently in the day-ahead market
- Based on our evaluation of the performance of the ELMP model in allowing online resources to set prices, we find:
 - ✓ The price effects are small and fail to capture the costs of peaking resources that should be setting prices.
 - ✓ Expanding the eligibility of resources and making one key change to the assumptions will increase its effectiveness by 300 to 400 percent.
- Our evaluation of offline pricing in ELMP continued to show that it is generally muting legitimate shortage pricing and should be disabled.
 - ✓ Shortages are often caused by uncertainty: contingencies, load uncertainty, changes in wind output, uncertain transmission flows, etc.
 - ✓ Offline units that can't start in time to respond should not set prices.

ELMP Evaluation

Evaluation of ELMP's Online Pricing

Alternative ELMP Methods	Avg. Price Increase (\$/MWh)	% of Fast-Start Peaker Eligible	% of Eligible MW Needed
Phase I*	\$0.09	5%	
Phase II*	\$0.41	26%	0.70%
<i>Plus Day-Ahead Units</i>	\$0.92	38%	1.70%
<i>No Ramp Limitation</i>	\$1.42	26%	2.00%
<i>Plus DA Units & No Ramp Limit</i>	\$1.81	38%	2.50%

* Phase I shows annual results from 2016. Phase II shows the last eight months in 2017.

Evaluation of ELMP's Offline Pricing

	Economic*	Started	Economic & Started
Operating Reserve Shortages	16%	11%	4%
Transmission Shortages	51%	12%	11%

*Does not include units that were never started, which would increase the values to: 20% for OR shortages and 61% for Tx shortages.

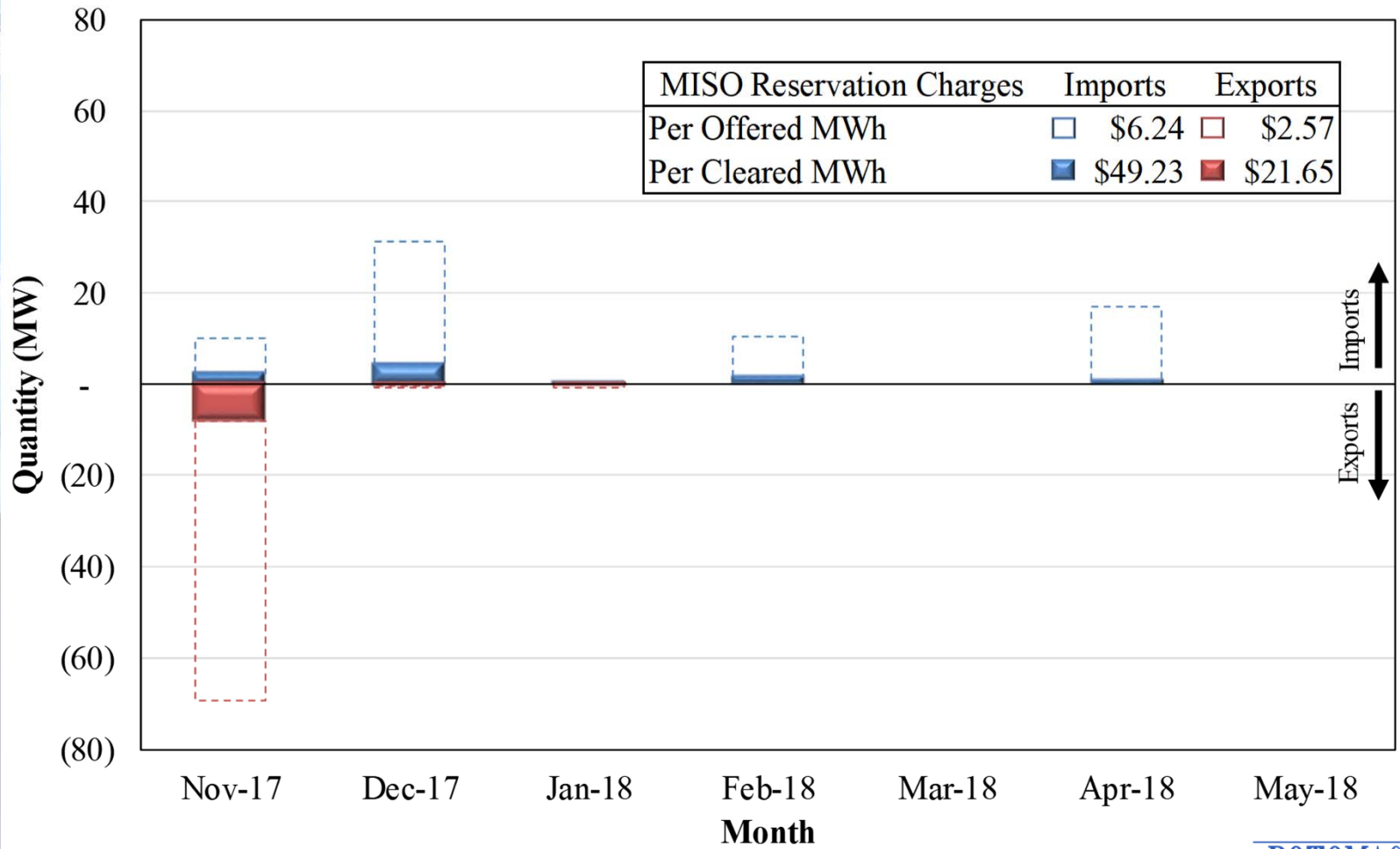


Coordinated Transaction Scheduling (CTS)

- On October 3, 2017, MISO implemented CTS with PJM.
 - ✓ Participants submit offers to schedule imports and exports that clear intra-hour 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.



Coordinated Transaction Scheduling (CTS)





List of Recommendations

SOM Number	Focus Area	Recommendations	High Benefit	Fast Track
Energy Pricing and Transmission Congestion				
2017-1	1,3	Improve the market power mitigation rules		✓
2017-2	4	Remove transmission charges from CTS transactions	✓	✓
2016-3	2,7	Enhance authority to coordinate transmission and generation planned outages		
2016-2	3,4	Improve procedures for identifying, testing, and transferring control of M2M flowgates		✓
2016-1	1,3,7	Improve shortage pricing by adopting an improved contingency reserve demand curve that reflects the expected value of lost load	✓	✓
2015-2	2,3	Expand utilization of temperature-adjusted and short-term emergency ratings for transmission facilities	✓	
2015-1	3	Expand eligibility for online resources to set prices in ELMP and suspend pricing by offline resources	✓	✓
2014-3	2	Improve external congestion related to TLRs by developing a JOA with TVA		



List of Recommendations

SOM Number	Focus Area	Recommendations	High Benefit	Fast Track
Energy Pricing and Transmission Congestion (cont.)				
2012-5	1,2	Introduce a virtual spread product		
2012-3	4	Remove external congestion from interface prices		
Operating Reserves and Guarantee Payments				
2017-3	3	Improve commitment classifications and implement a process to correct errors		
2016-5	1,5	Reform DAMAP and RTORSGP rules to improve performance incentives, and reduce gaming opportunities and unjustified costs	✓	✓
2016-4	1,3,7	Establish regional reserve requirements and cost allocation	✓	
2014-2	1,3,7	Introduce a 30-Minute reserve product to reflect VLR requirements and other local reliability needs	✓	
Dispatch Efficiency and Real-Time Market Operations				
2017-5	1.3	Assess the feasibility of implementing a 15-minute Day-Ahead Market under the Market System Enhancement	✓	



List of Recommendations

SOM Number	Focus Area	Recommendations	High Benefit	Fast Track
Dispatch Efficiency and Real-Time Market Operations (cont.)				
2017-4	1	Improve operator logging tools and processes related to operator decisions and actions		
2016-8	1,3	Validate wind resources' forecasts and use results to correct dispatch instructions		✓
2016-7	1,5	Improve forecasting incentives for wind resources by modifying deviation thresholds and settlement rules		
2016-6	1	Improve the accuracy of the LAC recommendations		✓
2012-16	1,3	Re-order MISO's emergency procedures to utilize demand response efficiently		✓
2012-12	1,5	Improve thresholds for uninstructed deviations	✓	✓
Resource Adequacy				
2017-7	7	Establish PRA capacity credits for emergency-only resources that better reflect their expected availability and deployment performance	✓	✓
2017-6	7	Require the ICAP of planning resources to be deliverable		✓



List of Recommendations

SOM Number	Focus Area	Recommendations	High Benefit	Fast Track
Resource Adequacy (cont.)				
2016-9	7	Improve the qualification of planning resources and treatment of unavailable resources		✓
2015-6	2,7	Improve the modeling of transmission constraints in the PRA		
2015-5	7	Implement firm capacity delivery procedures with PJM	✓ ✓	
2014-6	2,7	Define local resource zones based on transmission constraints and local reliability requirements		
2014-5	7	Transition to seasonal capacity market procurements		
2010-14	7	Improve the modeling of demand in the PRA	✓ ✓	