



Summary of 2016 MISO State of the Market Report

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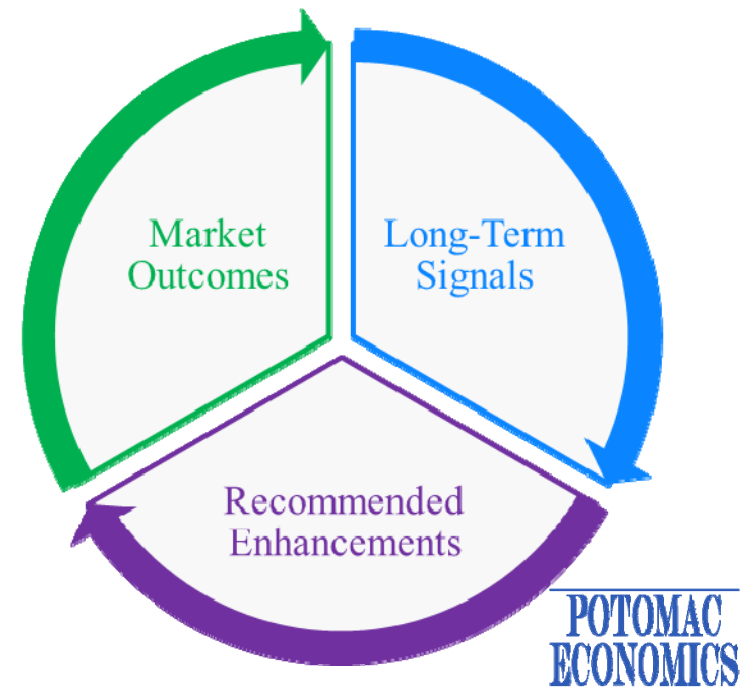
Federal Energy Regulatory Commission

David B. Patton, Ph.D.
MISO Independent Market Monitor

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Introduction

- As the Independent Market Monitor (IMM) for the Midcontinent ISO (MISO). In this role, 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 2016;
 - ✓ The competitive performance and operational efficiency of the markets;
 - ✓ Long-term economic signals; and
 - ✓ Recommendations





2016 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 infrequently applied.
- Fuel prices fell sharply in 2015 and modestly declined in 2016, which contributed to slightly lower energy prices (3 percent), congestion costs (2 percent) and real-time make-whole payments (1.6 percent).
- Day-ahead and real-time markets operated efficiently, with the exception of network congestion issues attributable to:
 - ✓ Pseudo-tying MISO generation to PJM;
 - ✓ Market-to-market coordination issues; and
 - ✓ Lack of coordination of generation and transmission outages.
- Capacity prices were volatile and did not produce efficient long-term signals.
 - ✓ Prices rose significantly in the North for the 2016/2017 planning year, but fell to close to zero market-wide in the 2017/2018 planning year.
 - ✓ Market design problems continues to be a significant concern.



Key Market Developments in 2016

- MISO implemented several market design changes that improved efficiency and competitiveness in 2016:
 - ✓ February 1: The Regional Dispatch Transfer (RDT) constraint replaced the 1000 MW Subregional Power Balance Constraint, allowing 3,000 MW of flows North-to-South and 2,500 MW of flows South-to-North.
 - ✓ May 1: Ramp product implemented, contributing to low price volatility.
 - ✓ July 1: Emergency Pricing was implemented to prevent prices from being understated during emergency events.
 - ✓ September 1: The Real-Time Offer Enhancement (RTOE) was implemented to allow resources to update real-time offers intra-hour.
 - ✓ November 5: The day-ahead market moved ahead one half hour to more closely align with the gas market.
- In May 2017, MISO implemented ELMP Phase 2 that allows an expanded set of fast-starting peaking resources to set energy prices.



Market Highlights: Load and Price Trends

MISO Prices and Load in 2016 (Slides 8, 9)

- Energy prices and day-ahead congestion fell slightly (2 to 3 percent) in 2016, largely because fuel prices fell slightly in 2016.
 - ✓ Average natural gas price fell 10 percent in 2016 reaching historic lows in the first half of the year.
 - ✓ Powder river basin coal prices were virtual unchanged from 2015 to 2016.
- Weather was relatively mild and load was modest in most of 2016, weather was more severe and load was higher in the summer months.
 - ✓ MISO's annual peak load of 121 GW was slightly higher than last year, but well below the forecasted peak of 125.9 GW.
- Although the energy markets generally set efficient prices in 2016, we recommend improvements to MISO's price formation through improved shortage pricing and price-setting by peaking resources.



Market Highlights: Load and Price Trends

Transmission Congestion and Regional Transfers (Slide 10)

- While day-ahead congestion fell slightly, the value of real-time congestion rose 4.3 percent to total roughly \$1.4 billion, amongst the highest in the U.S.
- This small increase was comprised of:
 - ✓ No change in congestion throughout the North;
 - ✓ 37 percent *reduction* in congestion on transfers between the North and South subregions; and
 - ✓ 22 percent *increase* in congestion in MISO South, partly due to high and uncoordinated transmission and generation outages.
- Although total congestion was unchanged outside the South region, we are concerned that some of the congestion was not efficiently managed related to:
 - ✓ PJM taking dispatch control of MISO resources (affecting \$82 million).
 - ✓ Congestion affected by multiple simultaneous outages (\$224 million).
 - ✓ Potentially conservative transmission ratings (\$155 million).
 - ✓ Market-to-market coordination issues with PJM and SPP (\$238 million).



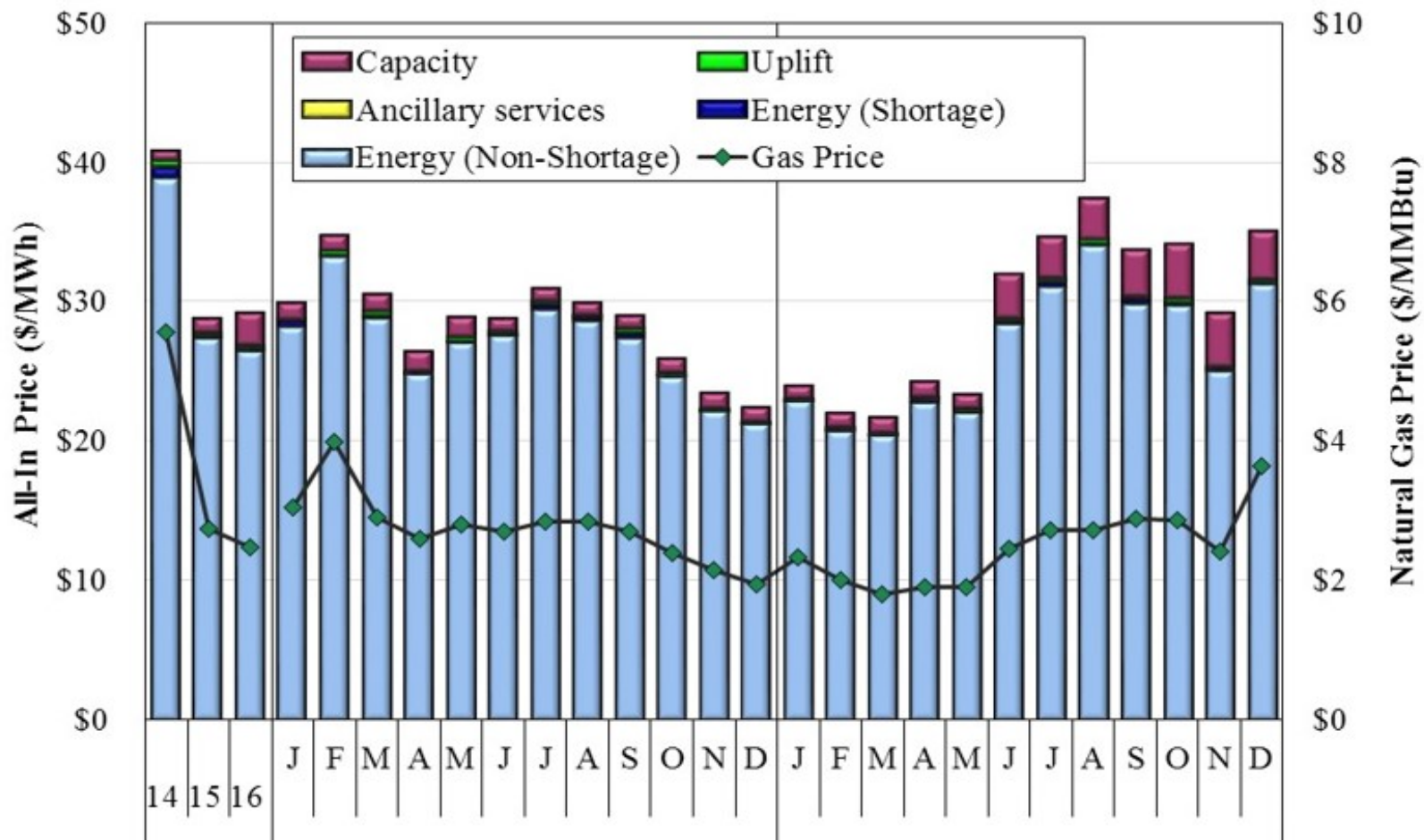
Market Highlights: Long-Term Price Signals

Capacity Margins and Long-Term Economic Signals (Slides 11, 12, 13)

- While the 2017 summer capacity margin fell to 18.9 percent, sufficient capacity exists to meet the 15.8 percent capacity margin requirement.
- Well-designed markets produce sufficient net revenues to support investment when existing resources are not sufficient to meet the system's needs.
- Net revenues for new resources rose in most areas, long-term price signals remained well below those needed to incent investment.
 - ✓ This result is partly due to the prevailing capacity surplus in MISO.
 - ✓ But capacity market design continues to undermine long-term signals and will likely cause them remain insufficient when the surplus dissipates.
- Capacity cleared at \$1.50 per MW-day in the 2017/2018 auction for the entire MISO footprint – this is essentially zero.
 - ✓ This is not an efficient price under current capacity levels and will motivate poor retirement and export decisions by MISO's competitive suppliers.
 - ✓ MISO attempted to address this in 2016 with an unsound proposal that was not accepted by FERC, by we encourage MISO to pursue efficient alternatives.

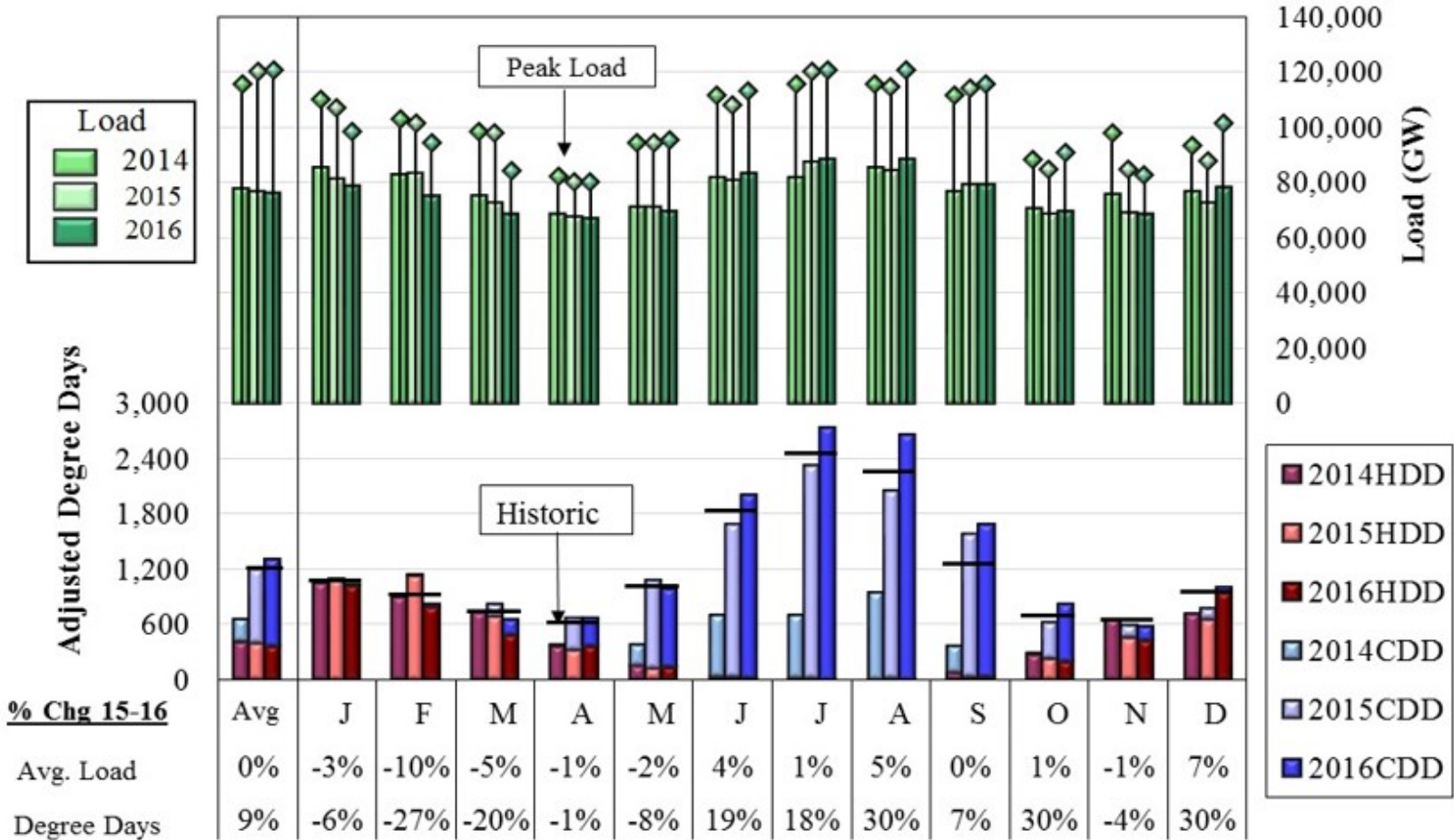


All-In Price



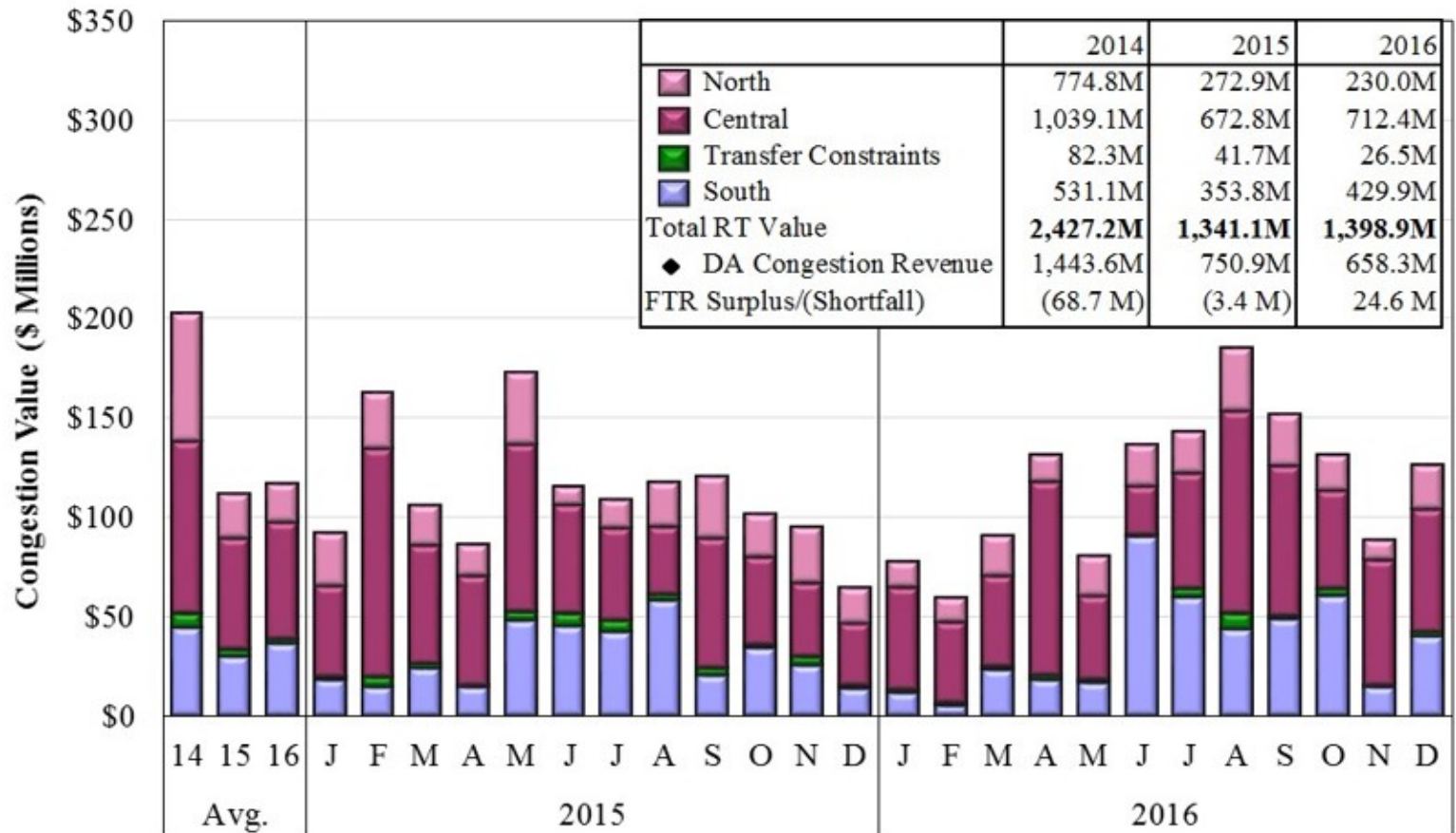


Weather and Load in 2015





Real-Time Value of Congestion in MISO





Capacity Margins in Summer 2017

	Alternative IMM Scenarios			
	Base Case	Realistic DR	High Temperature Cases	
			Full DR	Realistic DR
Load				
Base Case	125,020	125,020	125,020	125,020
High Load Increase	-	-	7,211	7,211
Total Load (MW)	125,020	125,020	132,231	132,231
Generation				
Internal Generation	140,850	140,850	140,850	140,850
BTM Generation	4,009	4,009	4,009	4,009
Hi Temp Derates*	-	-	(4,900)	(4,900)
Adjustment due to Transfer Limit**	(2,157)	(2,157)	-	-
Total Generation (MW)	142,701	142,701	139,958	139,958
Imports and Demand Response				
Demand Response***	6,112	4,890	6,112	4,890
Capacity Imports****	3,483	3,483	3,483	3,483
Capacity Exports	(3,636)	(3,636)	(3,636)	(3,636)
Margin (MW)	23,640	22,417	13,686	12,464
Margin (%)	18.9%	17.9%	10.9%	10.0%

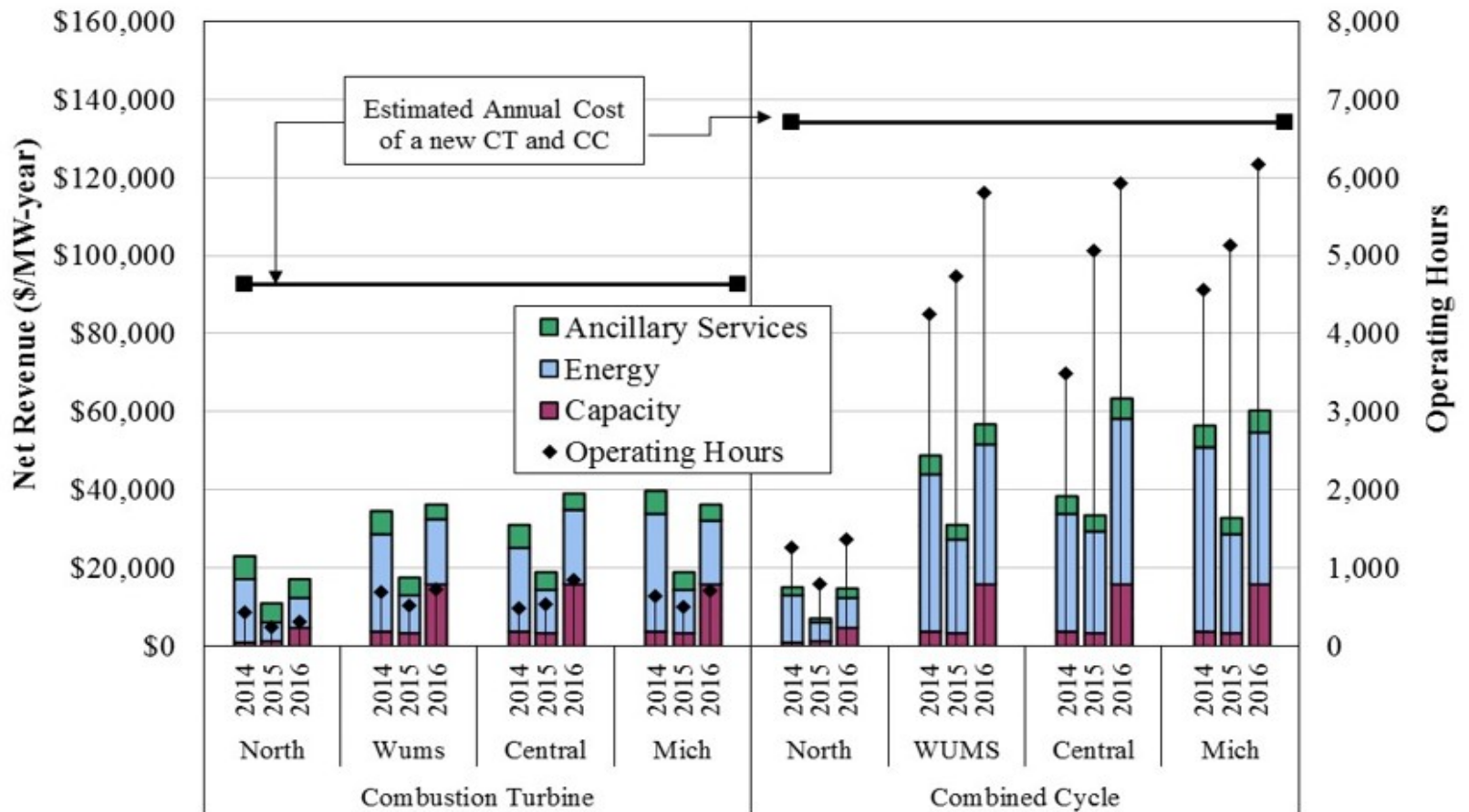
Notes:

* Based on an analysis of quantities offered into the day-ahead market on the three hottest days of 2012 and on August 1, 2006. Quantities can vary substantially based on ambient water temperatures, drought conditions, and other factors.

**The MISO Base Case Reserve Margin assumes that 2,157 MW (50/50 scenario) of capacity in MISO South cannot be accessed due to the 2,000 MW Transfer Limit (applying probabilistic derates on the 2,500 MW Transfer Limit) so this reduces the overall MISO Capacity Margin.

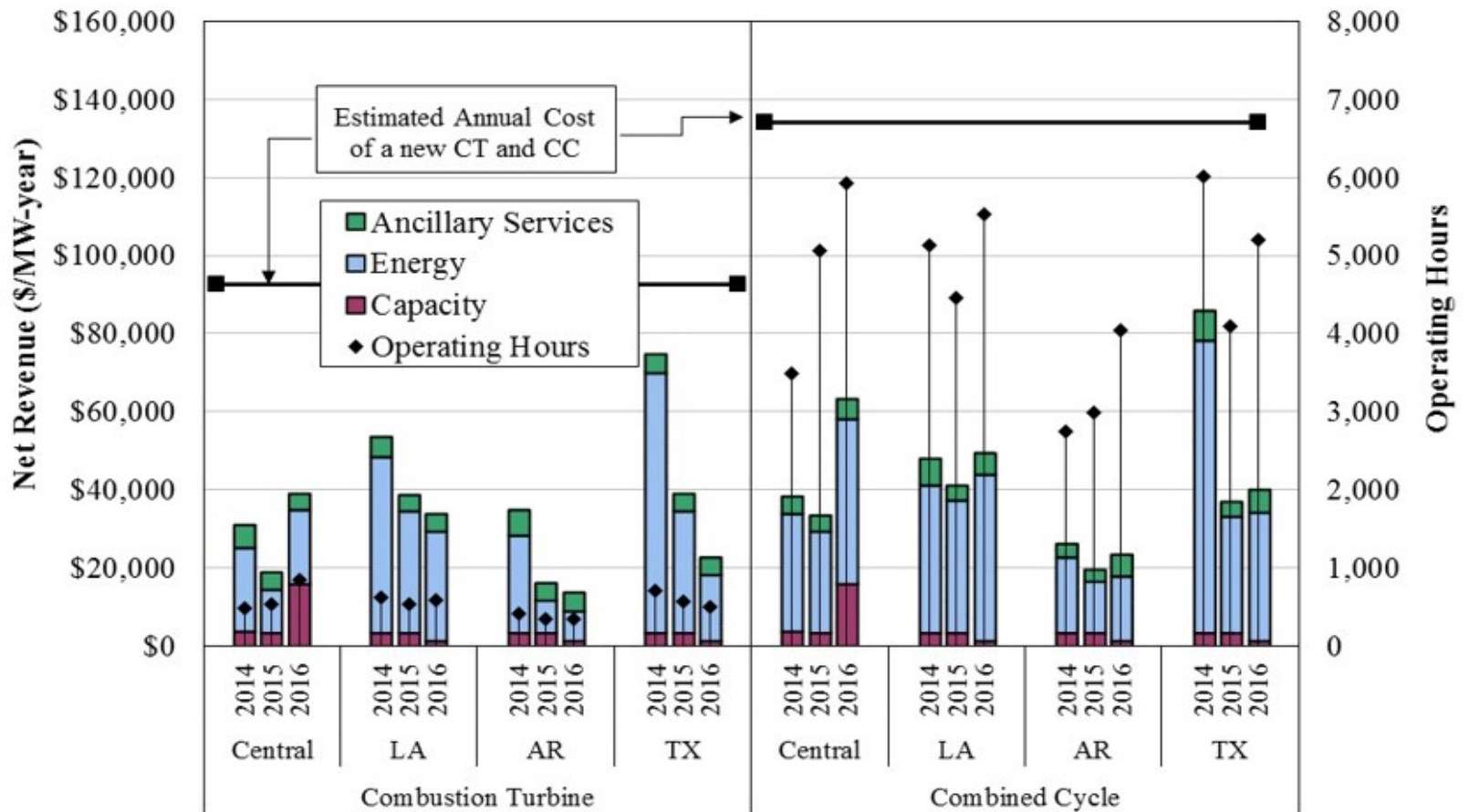


Long-Run Price Signals: Net Revenue Midwest Region





Long-Run Price Signals: Net Revenue South Region





Evaluation of Virtual Trading in MISO

- Some have argued recently 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 \$65 million, a 15 percent increase over 2015, 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 \$35 million.

	Financial Participants		Physical Participants		Total	
	Average Hourly MWh	Share of Class	Average Hourly MWh	Share of Class	Average Hourly MWh	Share of Total
Efficiency - Enhancing Virtuals	6,790	58%	400	47%	7,190	57%
Non - Efficiency - Enhancing Virtuals	4,956	42%	456	53%	5,412	43%

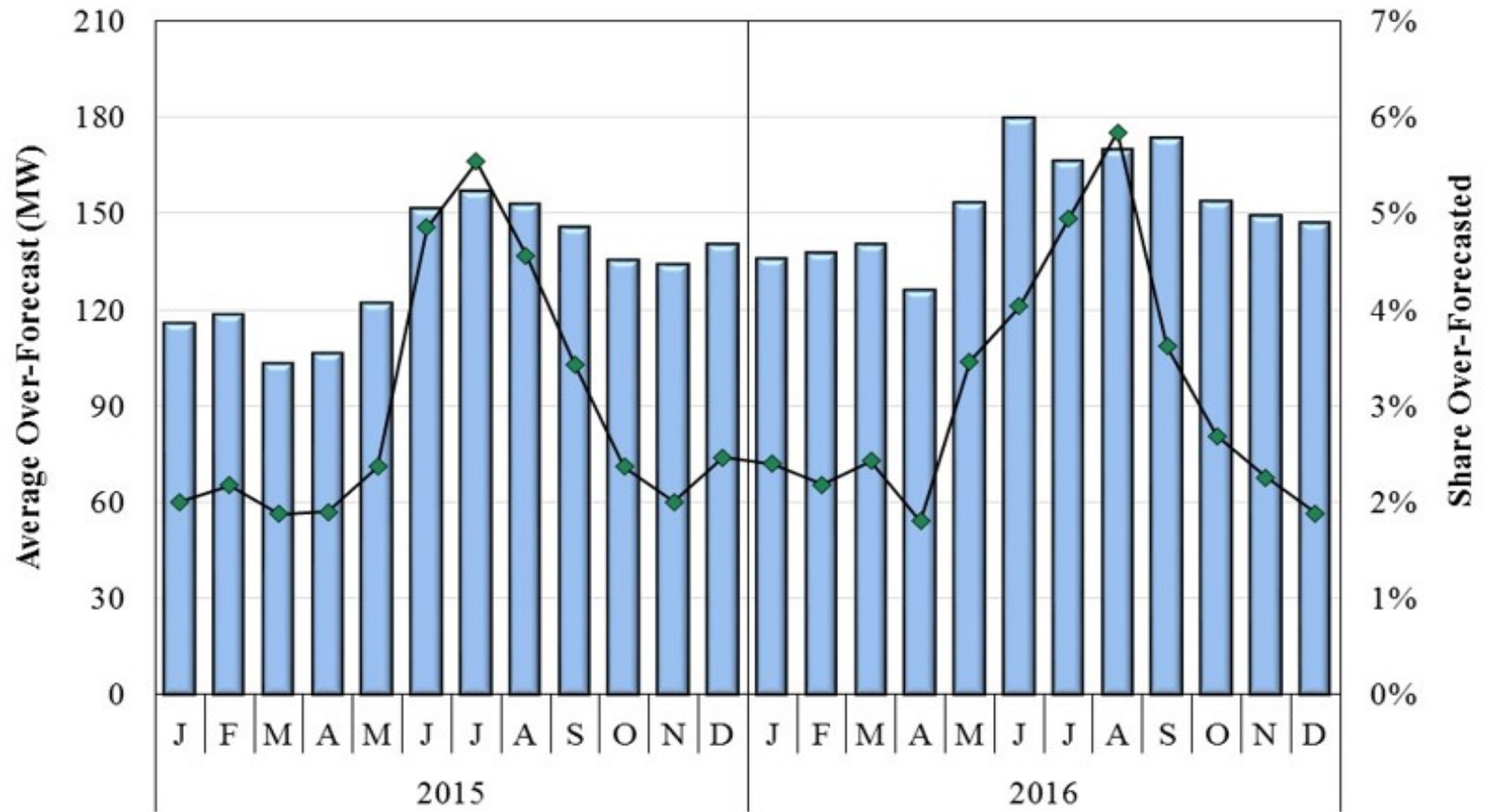


IMM Recommendation 2016-6 and 2016-7: *Improve Deviation Thresholds and Settlement Rules for Wind to Improve Forecasting Incentives and Validate Wind Forecasts*

- MISO has one of the best wind dispatch capabilities through its DIR process, but it is highly dependent on accurate wind forecasts.
 - ✓ MISO dispatch uses wind forecasts as the dispatch maximum for wind units, which generally results in dispatch instructions equal to the wind forecast.
 - ✓ We have identified chronic over-forecasting by certain wind suppliers.
 - ✓ Settlement rules create a strong incentive for DIR wind resources in MISO to over-forecast their output in real-time, due to current market settlement rules.
- Principle/Approach:
 - ✓ Principle: Provide incentives for suppliers to submit accurate forecasts and procedures to address persistent forecasts errors.
 - ✓ Approach: Consider a modified excess energy threshold for wind to allow resources more latitude to exceed their dispatch when no congestion exists and other changes to balance the EXE/DFE settlements that wind units face.
 - ✓ Approach: Develop procedures to validate market participant forecasts and utilize alternative forecasts when participants' forecasts are inaccurate.
- Benefits: Better utilization of transmission and lower production costs.

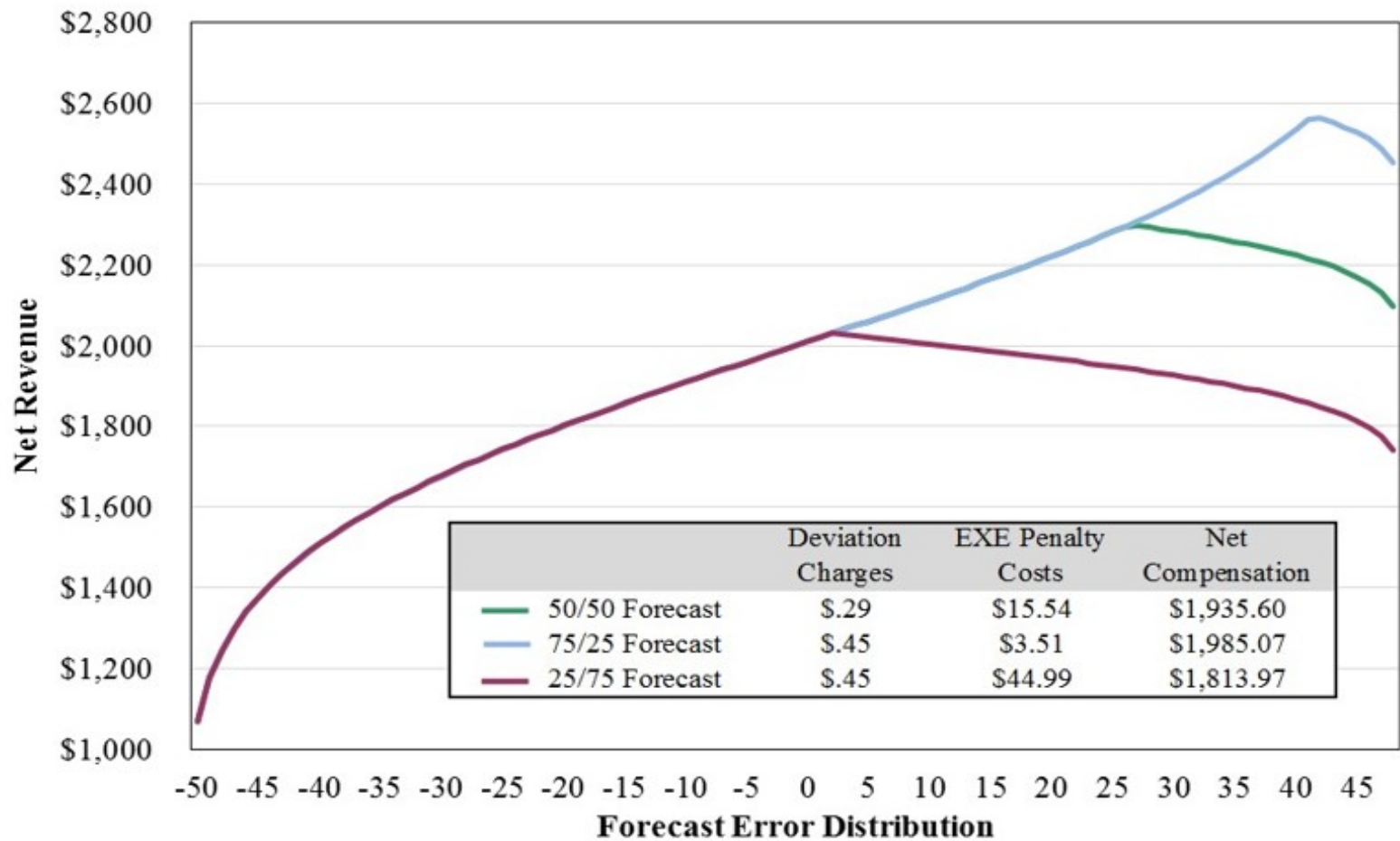


Wind Over-Forecasting in 2016



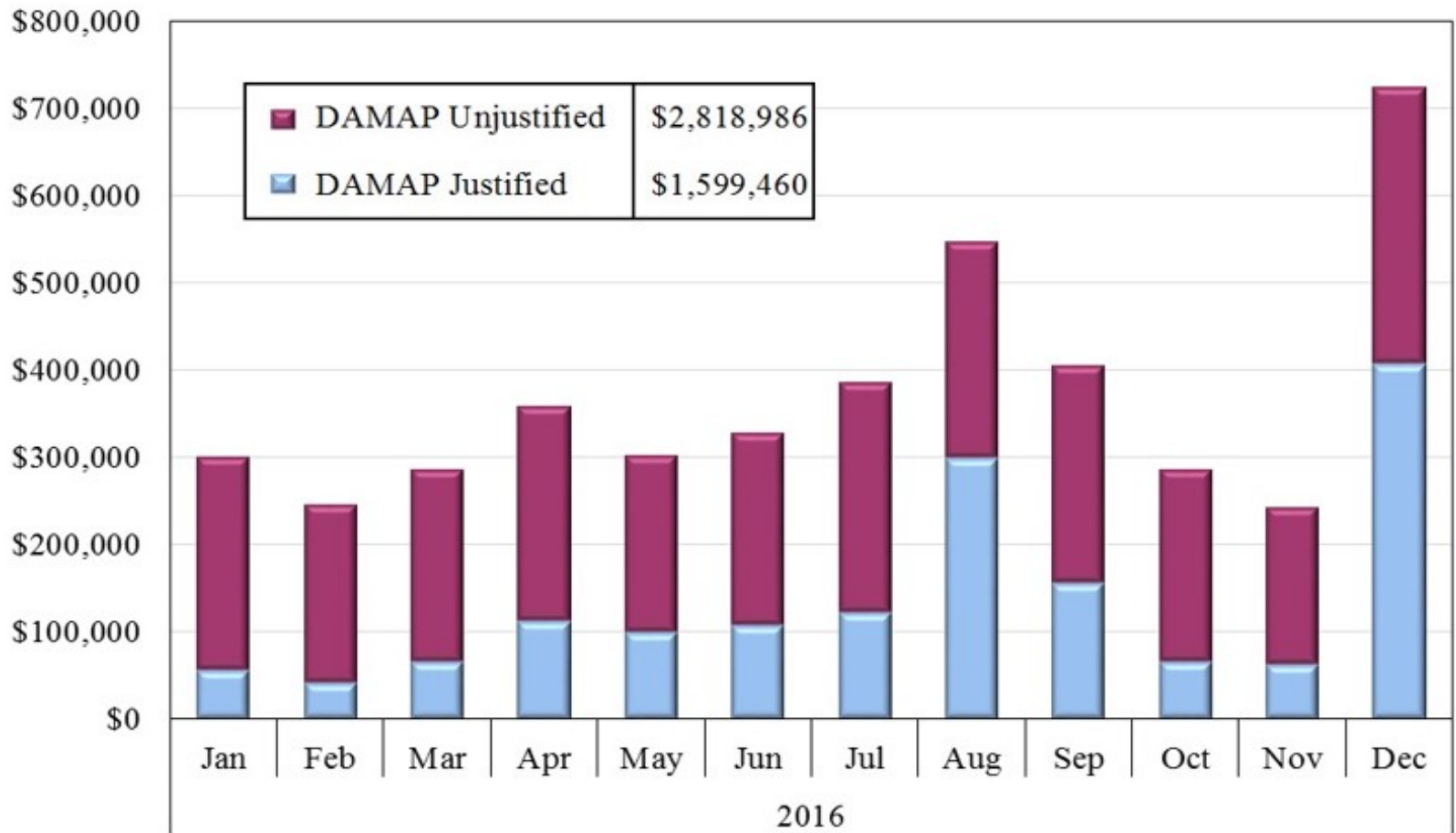


Expected Settlement Value of Forecast Alternatives for Wind





Unjustified DAMAP to Wind Resources

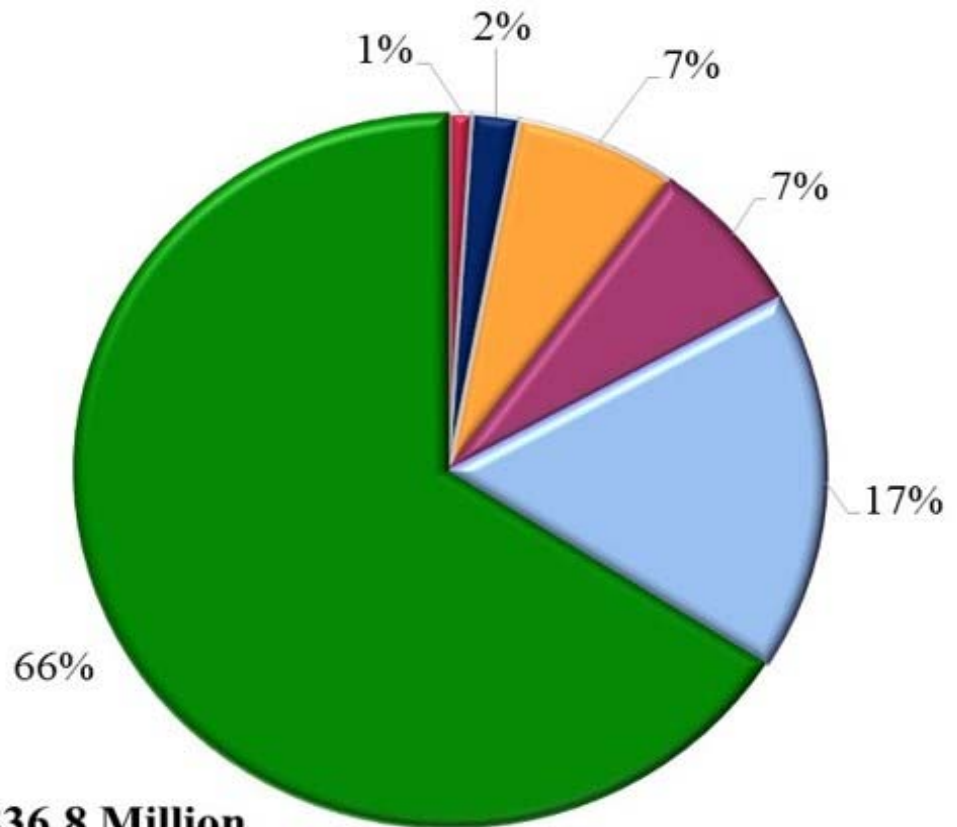




IMM Recommendation 2016-5: *Reform DAMAP and RTORSGP Rules to Improve Performance Incentives and Reduce Gaming Opportunities*

- Our evaluation of DAMAP and RTORSGP reveals that significant amounts were paid to resources not performing well:
 - ✓ Of nearly \$37 million paid to generating resources in 2016, only two-thirds of the payments were paid to units following MISO's dispatch instructions.
 - ✓ The remaining third reduces the costs to generators of performing poorly.
 - ✓ Almost \$3 million was paid to wind resources for forecast errors because of a flaw in MISO's tariff that should be corrected as soon as practicable.
- Principle/Approach:
 - ✓ Principle: Reward good performers and penalize poor performers.
 - ✓ Approach: Incorporate a performance metric in the calculation of make-whole payments that would reduce the payment by the amount that corresponds to resources' dispatch deviations.
- Benefits:
 - ✓ Align incentives with good resource performance, and improving reliability.
 - ✓ Lower unjustified make-whole payment costs.

DAMAP Payments



Total DAMAP in 2016 = \$36.8 Million

* Excluded Hour 0 in the analysis

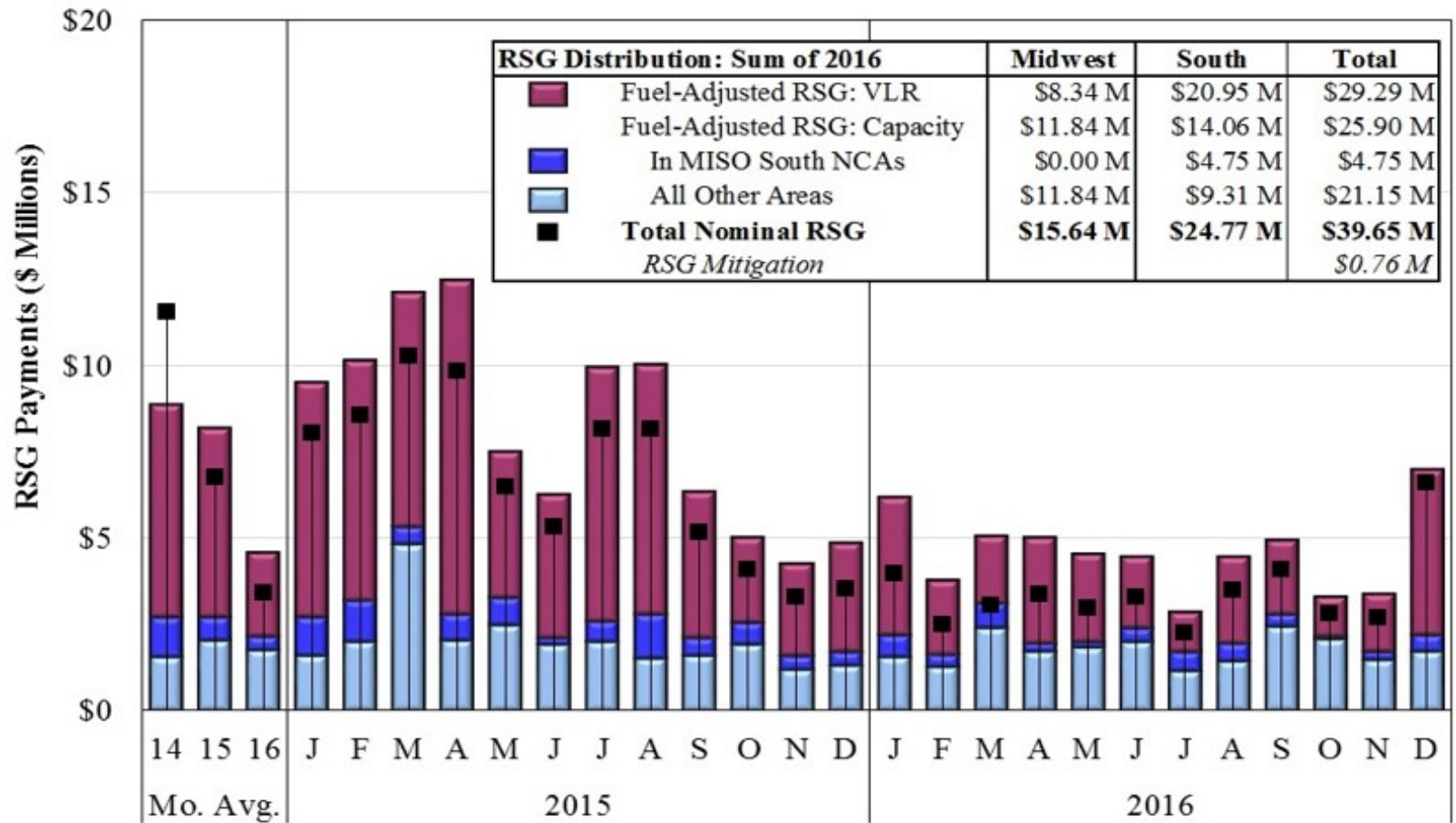


IMM Recommendation 2016-4 and 2014-2: *Establish Regional Reserve Requirements and a 30-Minute Local Reserve Product to Reflect the VLR and Subregional Capacity Needs*

- MISO incurs high RSG costs in some areas to satisfy subregional capacity or VLR needs beyond first contingencies – which are operating reserve needs..
 - ✓ The VLR needs exist because some areas do not have resources that can start within 30 minutes to restore the lost supply after a contingency.
 - ✓ MISO makes a substantial number of resource commitments and often incurs RSG to satisfy subregional capacity needs when the RDT may bind.
- Principle/Approach:
 - ✓ Principle: Align market products with reliability needs.
 - ✓ Approach: Create a local 30-minute reserve product and establish procurement requirements for the VLR areas and the subregions.
- Benefits:
 - ✓ Lower costs by allowing the markets to satisfy MISO’s reliability needs and reducing out-of-market actions by MISO operators.
 - ✓ Expand the supply available to meet the VLR requirements.
 - ✓ Provide market signals to build fast-starting units that can satisfy the VLR needs at a much lower cost (they can satisfy the requirements while offline).
 - ✓ Allow MISO to accurately price subregional shortages (N and S).

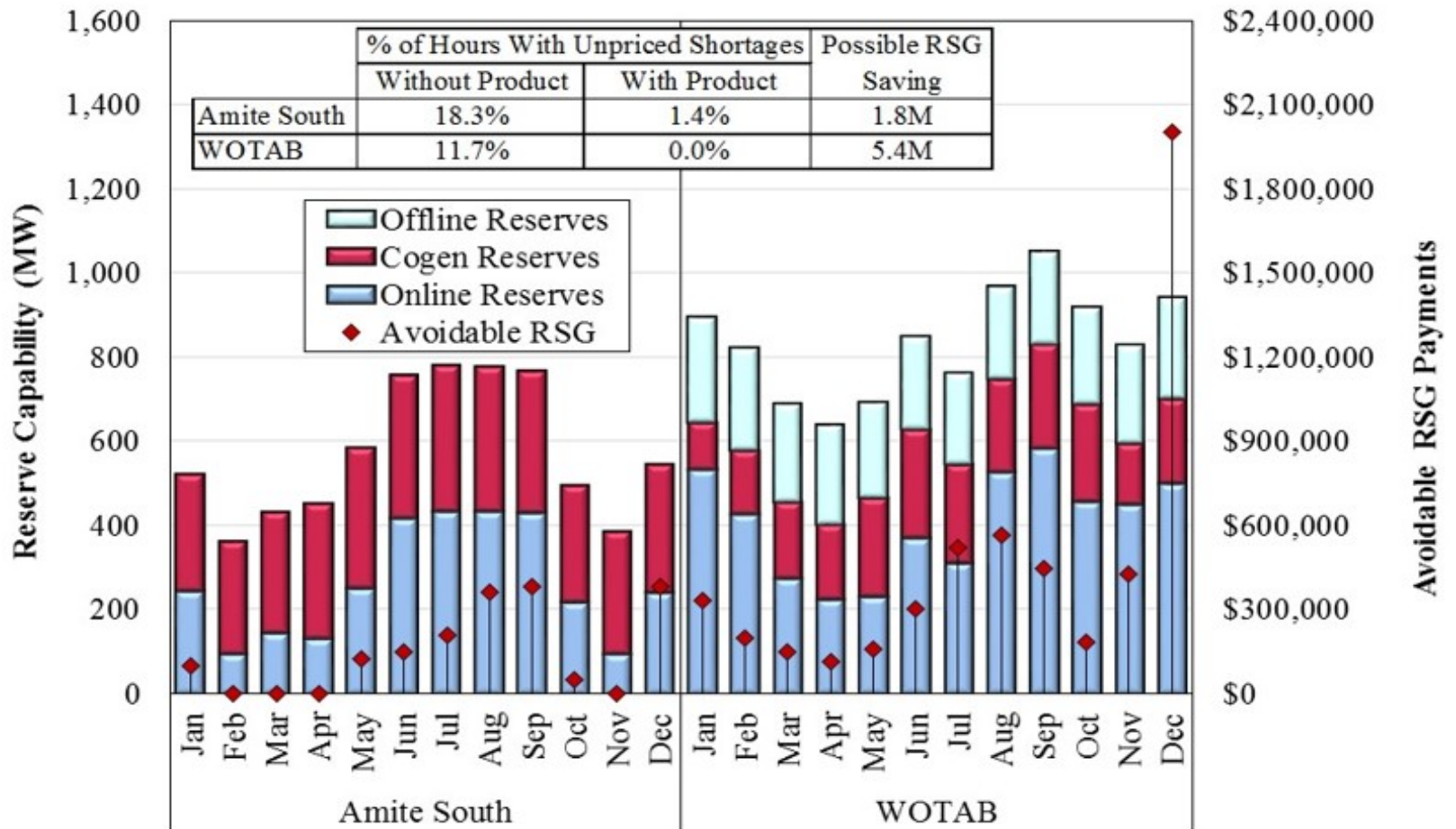


Day-Ahead RSG Payments 2015-2016



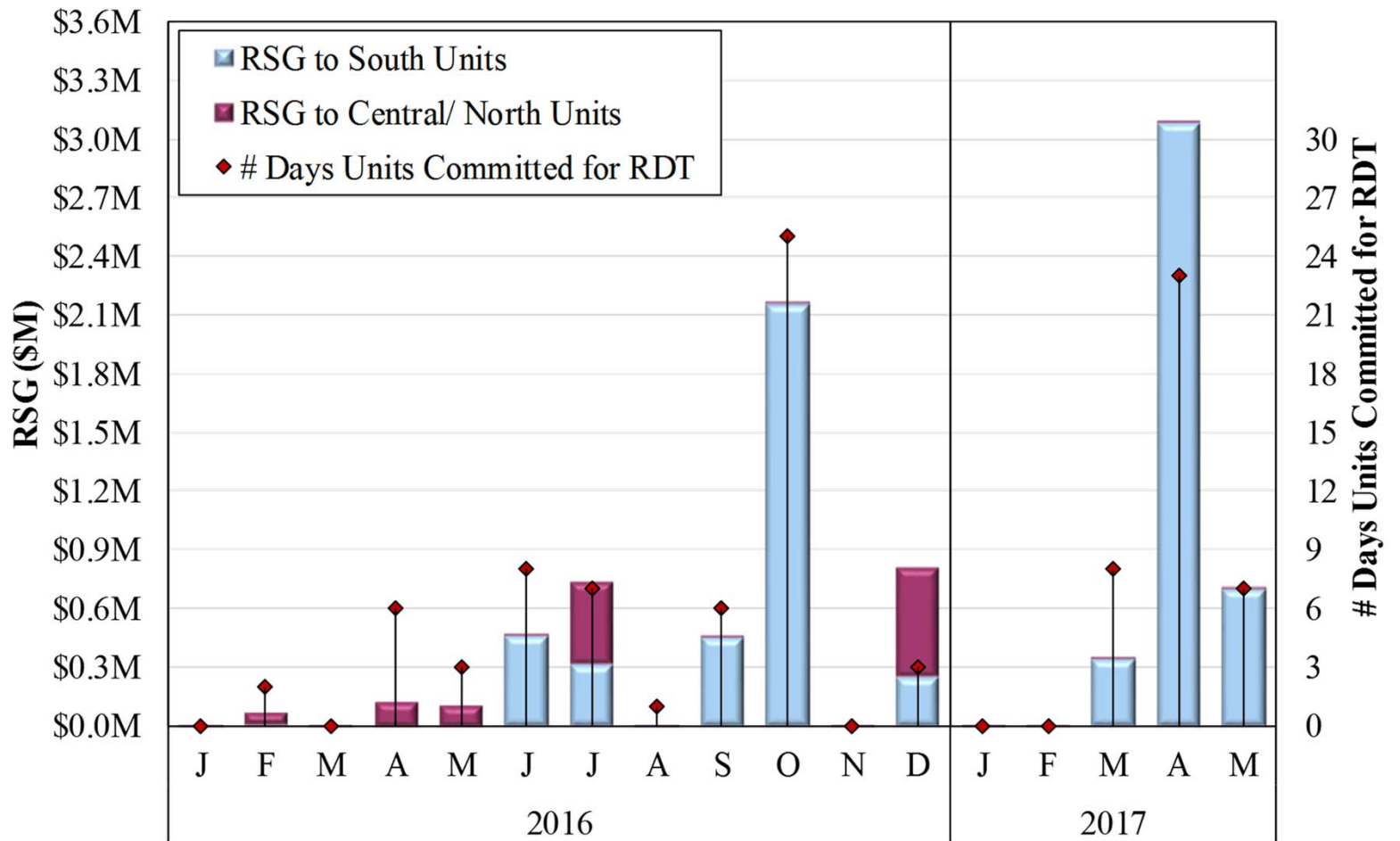


30 Minute Reserve Capability in MISO South Load Pockets





RDT – Associated RSG June 2016 – April 2017





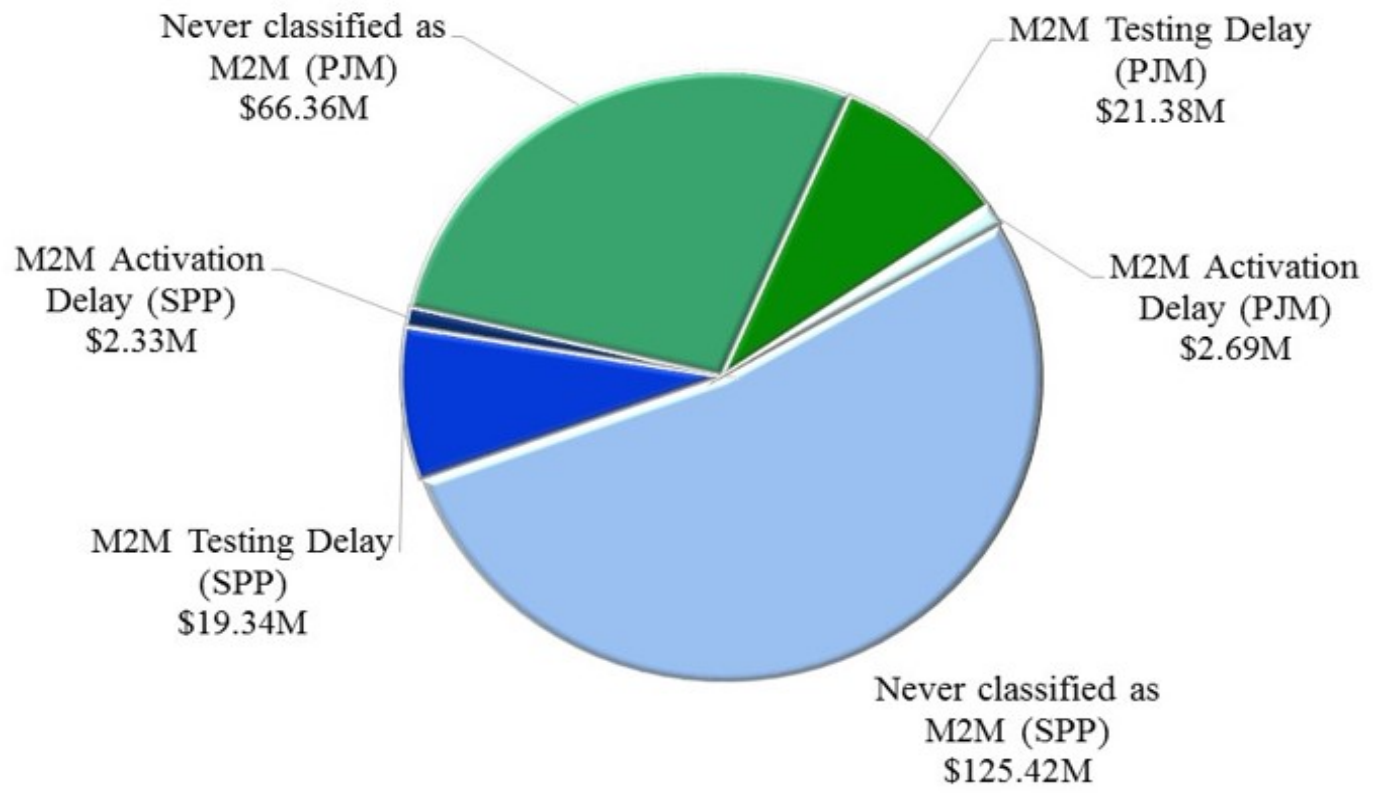
IMM Recommendation 2016-2: *Improve Procedures for M2M Activation and Coordination, including Identifying, Testing, and Transferring Control*

- Procedural issues have caused coordinated congestion management between MISO and its neighbors to not be fully efficient.
 - ✓ In 2016, more than \$238 million of congestion could have been more efficiently managed through better M2M coordination procedures.
 - ✓ In Spring 2017, more than \$66 million of congestion accumulated on two coordinated MISO constraints that are dominated by PJM.
- Principle/Approach:
 - ✓ Principle: Least-cost resources should be dispatched to manage constraints.
 - ✓ Approach: Improve automation and logging of testing and activation of M2M constraints.
 - ✓ Approach: Develop criteria with JOA partners to transfer monitoring of M2M constraints to the RTO with the most dispatch relief.
 - ✓ Approach: Develop a JOA with TVA to coordinate congestion management.
- Benefits: Substantially reduce inefficient congestion and associated production costs.



Congestion Due to Inefficient Market-to-Market Coordination

Congestion due to Inefficient M2M Coordination = \$238M





Potential for Congestion Coordination with TVA

Status	Total Congestion Value (\$ Millions)	Re-dispatch Savings (\$ Millions)
MISO Constraints when TVA Generators had significant impact	\$169.6 M	\$16.9 M
TVA (TLR) Constraints when MISO Generators had significant impact	\$21.1 M	\$4.9 M
Total	\$190.7 M	\$21.8 M

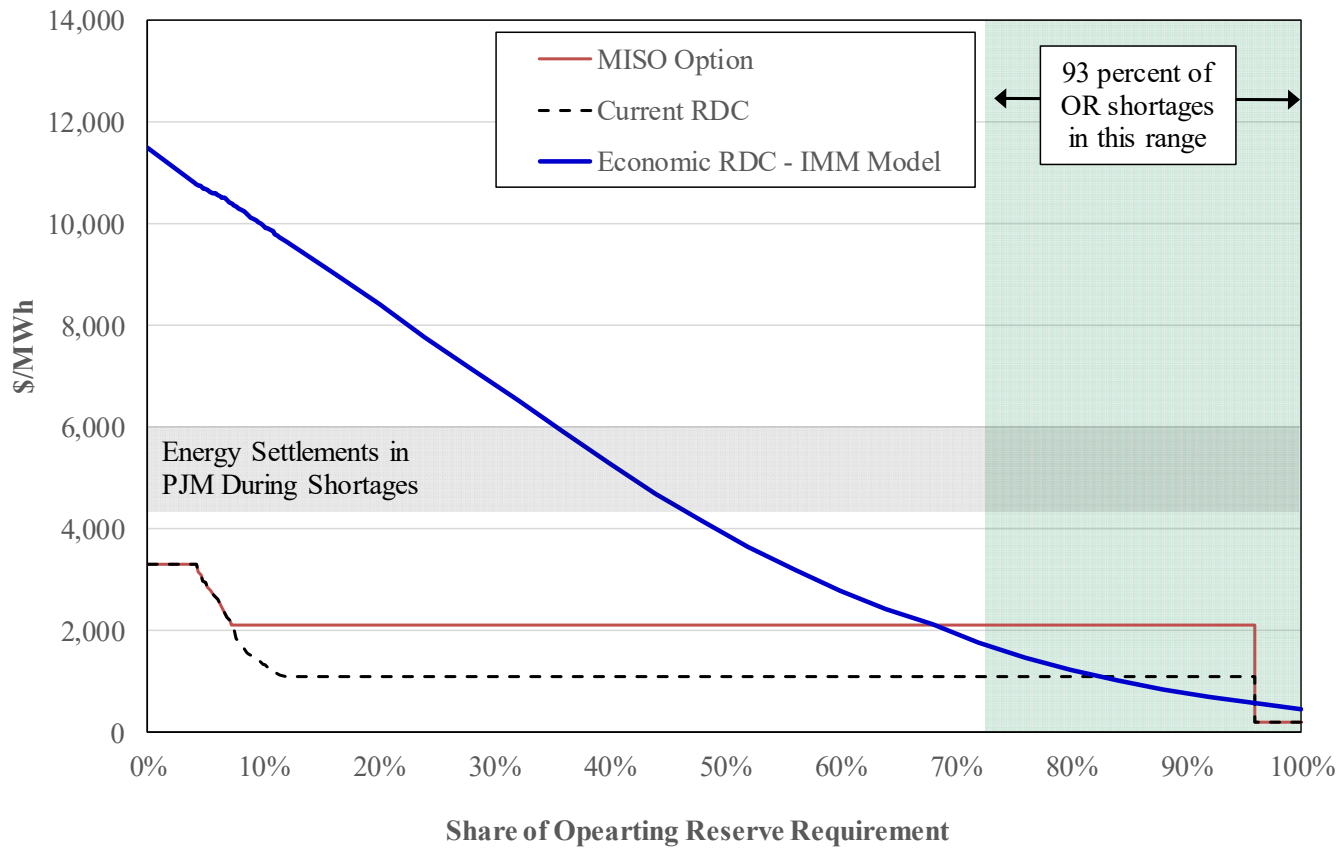


IMM Recommendation 2016-1: *Improve Shortage Pricing by Adopting an Improved Contingency Reserve Demand Curve that Reflects that Expected VOLL*

- Well-designed markets will produce efficient shortage pricing, which is based on properly-valued Reserve Demand Curves (RDC).
 - ✓ The marginal reliability value of reserves at any shortage level is equal to the expected value of the load that may not be served:
$$\text{Value of Lost Load (VOLL)} * \text{Probability of Losing Load}$$
 - ✓ MISO's current RDC results in overstated shortage prices for small shortages and understated shortage prices for larger shortages.
- Principle/Approach:
 - ✓ Principle: Energy and reserve prices should reflect the marginal reliability value of resources at any given level of shortage.
 - ✓ Approach: Increase the VOLL to better reflect the value of serving the highest value loads.
 - ✓ Approach: Develop RDCs whose slope is based on the probability of losing load at any particular level of reserves.
- Benefits: Efficient shortage prices will facilitate more efficient short-term decisions (commitment, import/export, etc.) and longer-term decisions (forward contracting, investment, etc.)



IMM Proposed Operating Reserve Demand Curve



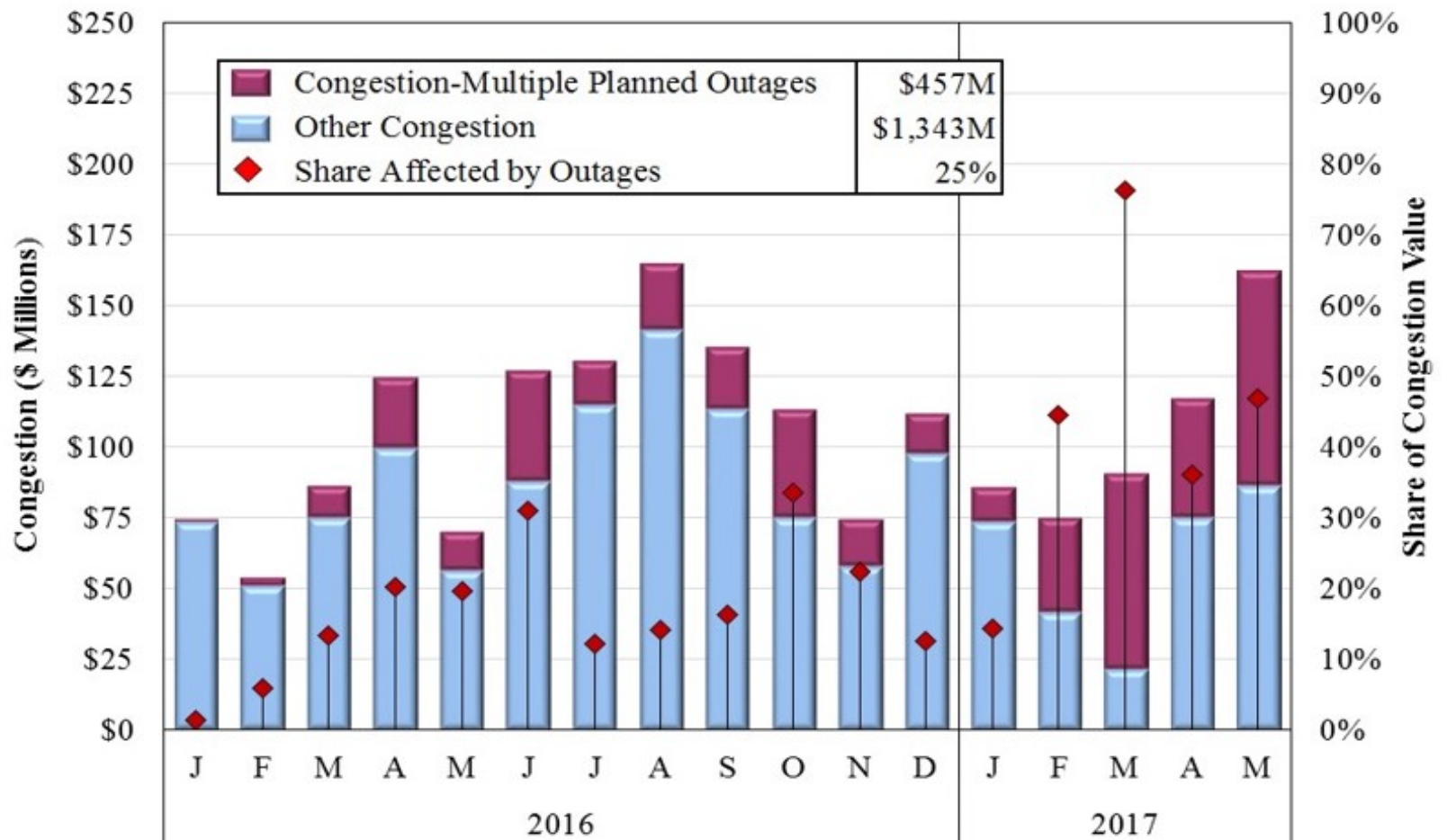


IMM Recommendation 2016-3: *Enhanced Transmission and Generation Planned Outage Approval Authority*

- MISO is responsible for approving the schedules of planned transmission and generation outages, but does not coordinate outage schedules to lower costs.
 - ✓ Approval process considers only reliability concerns associated with requested outages, not the potential economic costs.
 - ✓ One quarter of all real-time congestion (\$457 million) was attributable to concurrent generation outages from January 2016 to May 2017.
- Principle/Approach:
 - ✓ Principle: Outage scheduling and coordination should incorporate economic considerations to minimize unnecessary and inefficient congestion costs.
 - ✓ Approach: Expand outage approval/coordination authority to address economic congestion that does not raise clear reliability concerns.
- Benefits:
 - ✓ Outage-related congestion will be reduced during peak outage season.
 - ✓ Fewer instances of capacity-related emergency events during the shoulder months.

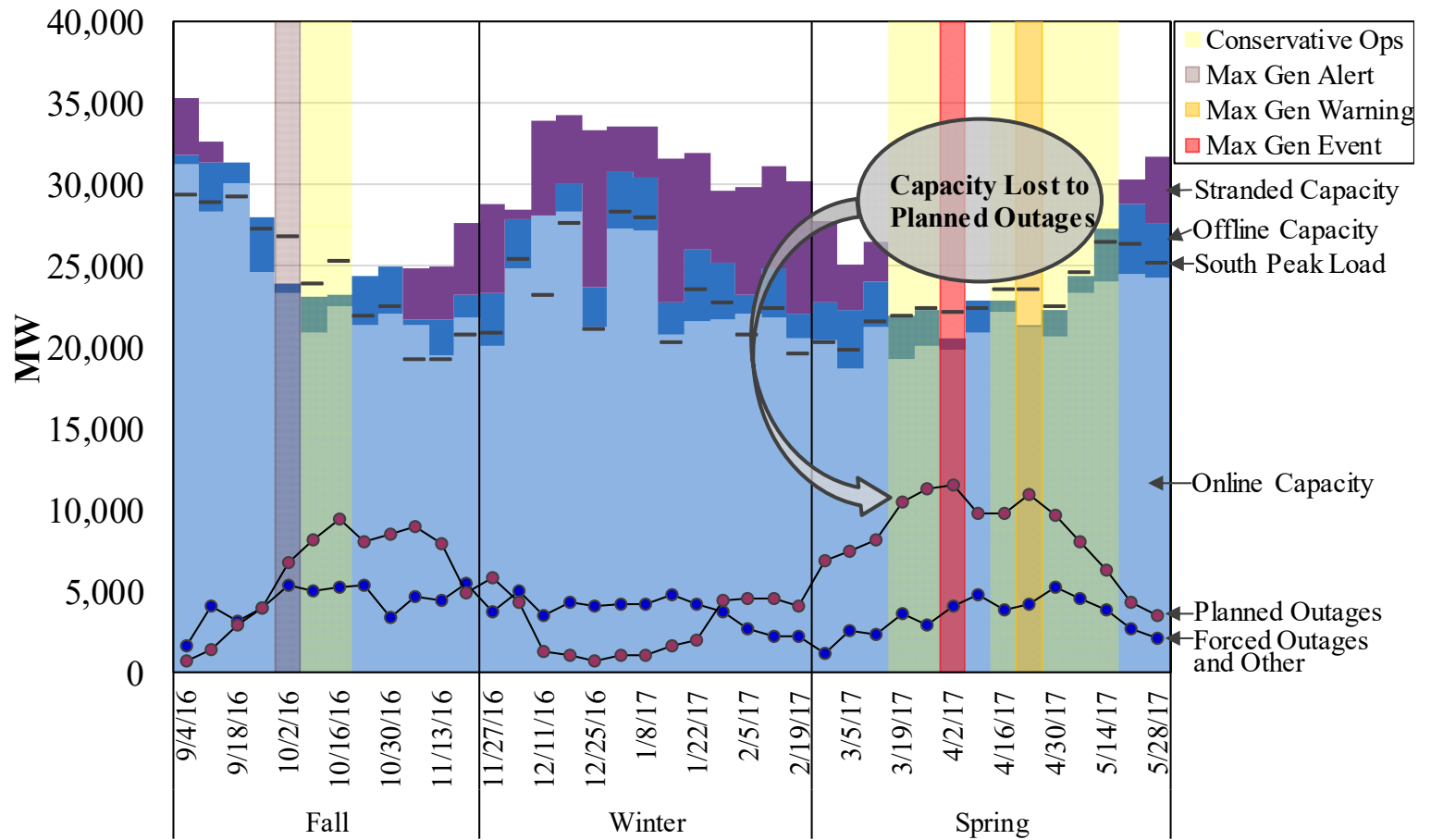


Outage-Related Congestion





Planned Outages and Associated MISO South Events



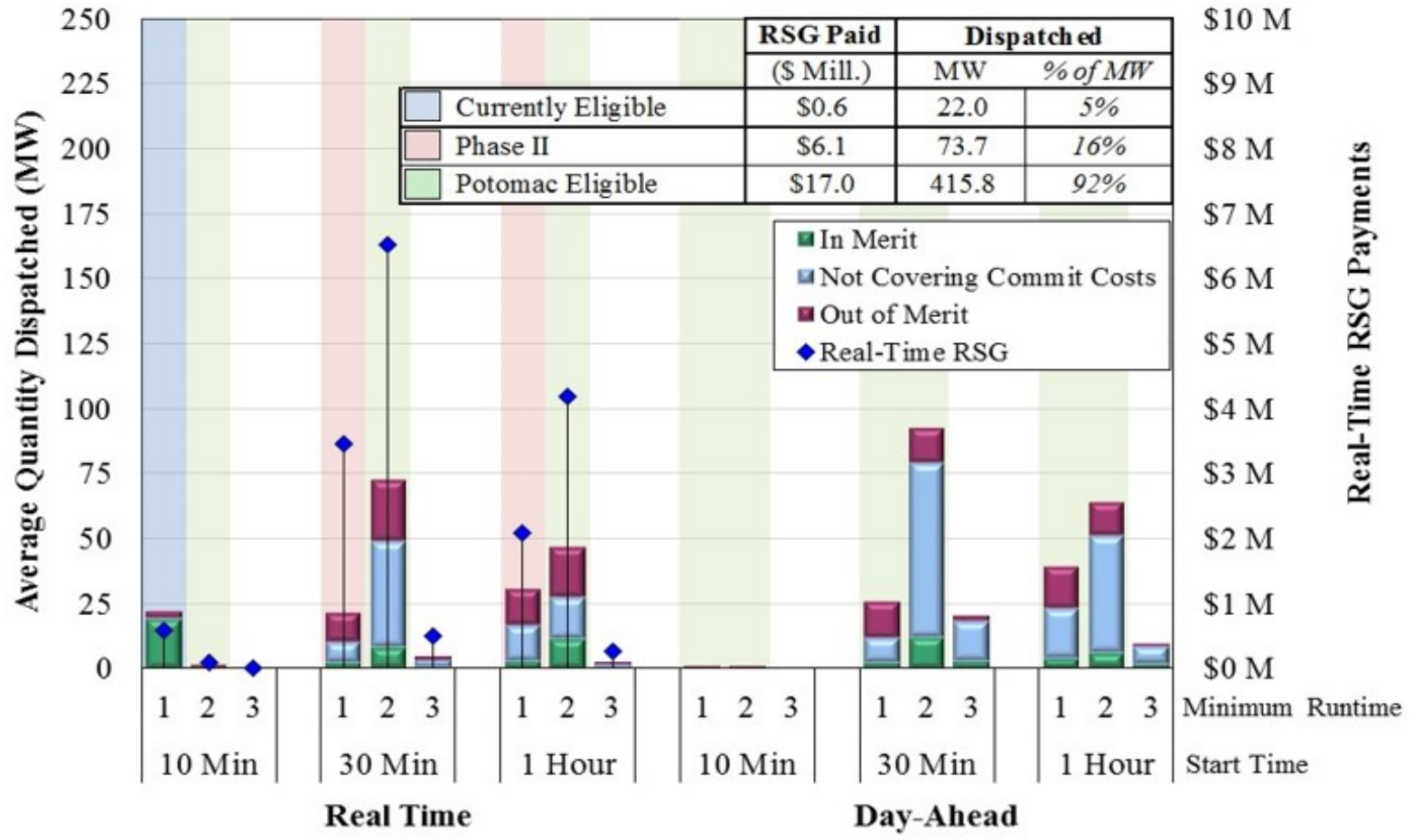


IMM Recommendation 2015-1: *Expand Eligibility for Online Pricing in ELMP and Disable Offline Price Setting*

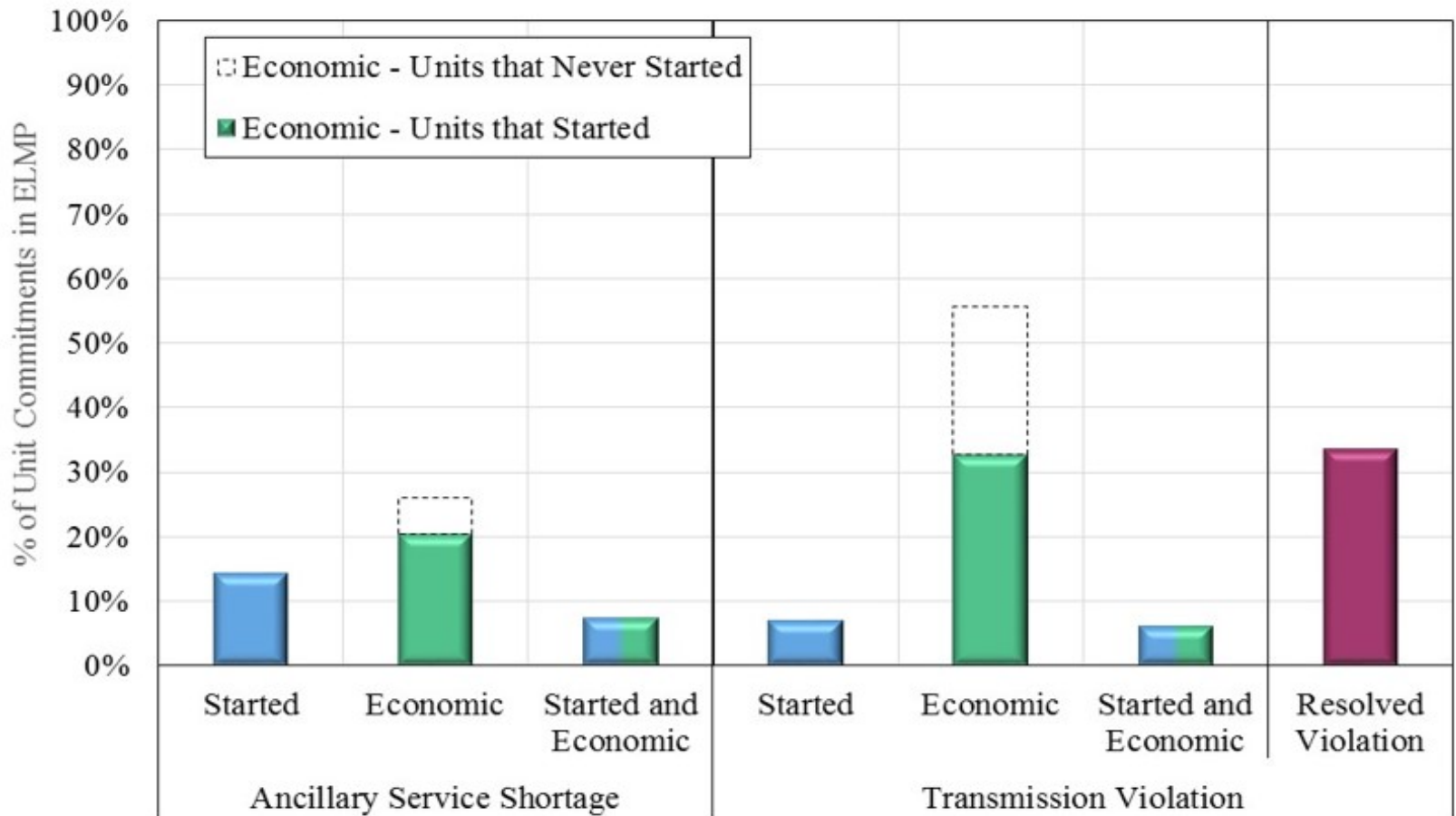
- Allowing fast-start peaking resources is essential for establishing efficient real-time energy and reserve prices.
- Based on our evaluation of the performance of Phase I the ELMP model:
 - ✓ The price effects of the online resources averaged 9 cents per MWh because a very small share of MISO's peaking resources were eligible under ELMP.
 - ✓ The offline price effects averaged a reduction of 11 cents per MWh, but our assessment indicates that these effects were generally inefficient.
- Principle/Approach:
 - ✓ Principle: Marginal economic sources of supply should set real-time prices.
 - ✓ Approach: Expand the price-setting eligibility for online resources to appropriately include as larger a share of peaking resources.
 - ✓ Approach: Disable the offline price-setting logic in ELMP.
- Benefits:
 - ✓ Improved real-time price formation will improve the day-ahead market scheduling and prices, ultimately lower overall production costs.



ELMP Online Pricing Eligibility



ELMP Offline Pricing



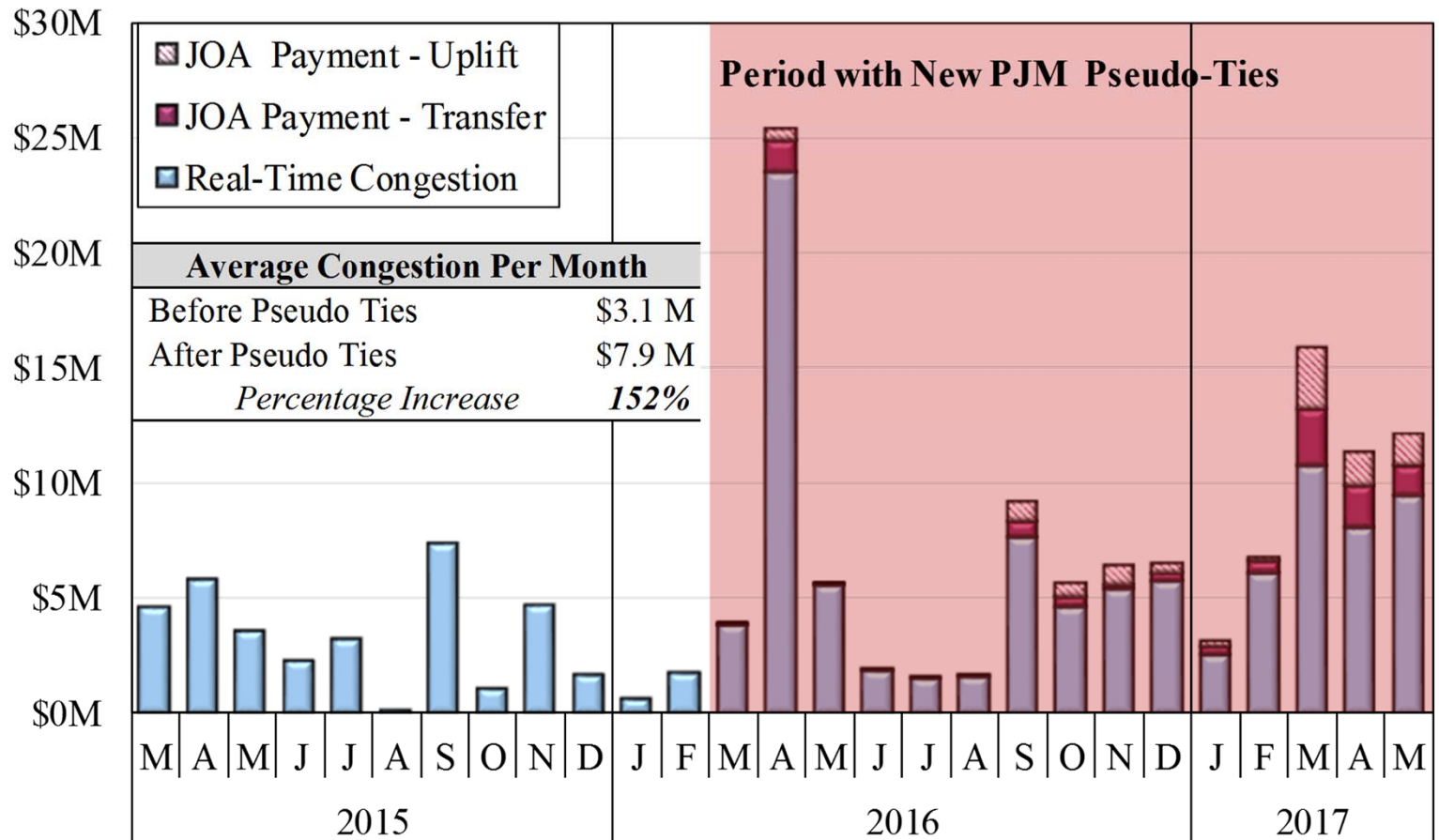


IMM Recommendation 2015-5: *Implement Firm Capacity Delivery Procedures with PJM*

- PJM requires external capacity resources to be pseudo-tied to PJM.
 - ✓ 12 units have been pseudo-tied to PJM in March and June of 2016.
 - ✓ Transferring dispatch control to PJM reduces the efficiency of the dispatch and impairs reliability because these units affect flows over MISO's network.
 - ✓ The RTOs must rely on market-to-market coordination and >100 new M2M constraints have been defined so far.
- Principle/Approach:
 - ✓ Principle: Accommodate capacity exports without undermining the economic real-time dispatch in MISO.
 - ✓ Approach: Replace the PJM pseudo-tie requirement with procedures to guarantee delivery of the capacity that has been exported to PJM.
- Benefits:
 - ✓ PJM receives the full benefits of its capacity imports and avoids market-to-market congestion costs they will otherwise incur.
 - ✓ MISO will retain the ability to dispatch its system efficiently.



Effects of Pseudo-Tying MISO's Generators to PJM





Other Key Recommendations: Improvements to the Planning Resource Auction

- MISO's PRA is not providing efficient economic signals to facilitate investment, retirement, and capacity import/export decisions. As a result, margins are falling.
 - ✓ This is troubling for the competitive loads and supply that rely on the wholesale markets (no regulatory backstop).
 - ✓ The most important recommendation is to *implement capacity demand curves that reflect reliability value, at least for competitive load and supply.*
 - ✓ MISO's proposal to address this issue was rejected by FERC, but more reasonable and efficient alternatives should be pursued.
- In addition, we've identified some concerns with the current PRA that have prompted the following new recommendations:
 - ✓ 2015-6 and 8: Improve the modeling of transmission constraints and the transfer constraint between subregions in the PRA.
 - ✓ 2015-7: Modify the mitigation measures to address uneconomic retirements.
 - ✓ 2016-9: Disqualify resources not expected to be available during peak conditions.
- Benefits:
 - ✓ Ensure efficient locational price separation to reflect true transmission constraints
 - ✓ Establish efficient price signals to facilitate long-term decisions to invest, retire, and import/export capacity, which will lower costs for MISO's loads.



List of Recommendations

SOM Number	Focus Area	Recommendations	High Benefit	Feasible in ST
Energy Pricing and Transmission Congestion				
2012-2	3,4	Implement a five-minute real-time settlement for generation.	✓	
2012-5	1,2	Introduce a virtual spread product.		
2015-1	3	Expand eligibility for online units to set prices in ELMP and suspend offline pricing.	✓	
2015-2	2,3	Expand utilization of temperature-adjusted and short-term emergency ratings for transmission facilities	✓	
2014-3	2	Improve external congestion related to TLRs by developing a JOA with TVA.		
2016-1	1,3,7	Improve shortage pricing by adopting an improved contingency reserve demand curve that reflects the expected value of lost load.	✓	
2016-2	3,4	Improve procedures for M2M Activation and Coordination including identifying, testing, and transferring control of M2M Flowgates.	✓	
2016-3	2,7	Enhanced Transmission and Generation Planned Outage Approval Authority.		



List of Recommendations

SOM Number	Focus Area	Recommendations	High Benefit	Feasible in ST
Operating Reserves and Guarantee Payments				
2014-2	1,3,7	Introduce a 30-Minute reserve product to reflect VLR requirements and other local reliability needs.	✓	
2016-4	1,3,7	Establish regional reserve requirements and cost allocation.		
2016-5	1,5	Reform DAMAP and RTORSGP rules to improve performance incentives, and reduce gaming opportunities and unjustified costs.	✓	
Improve Dispatch Efficiency and Real-Time Market Operations				
2012-12	1,5	Improve thresholds for uninstructed deviations.	✓	✓
2012-16	1,3	Re-order MISO's emergency procedures to utilize demand response efficiently.		✓
2015-4	1	Enhanced tools and procedures to address poor dispatch performance.		✓
2016-6	1	Improve the accuracy of the LAC recommendations.		✓
2016-7	1,5	Improve forecasting incentives for wind resources by modifying deviation thresholds and settlement rules.		
2016-8	1,7	Validation of wind suppliers' forecasts and use results to correct dispatch instructions.		✓



List of Recommendations

SOM Number	Focus Area	Recommendations	High Benefit	Feasible in ST
Resource Adequacy				
2010-14	7	Introduce a sloped demand curve in the RAC to replace the current vertical demand curve.	✓ ✓	
2013-4	7	Improve alignment of the PRA and the Attachment Y process governing retirement and suspensions.		✓
2014-5	7	Transition to seasonal capacity market procurements.		
2014-6	7	Define local resource zones primarily based on transmission constraints and local reliability requirements.		
2015-5	7	Implement Firm Capacity Delivery Procedures with PJM.	✓ ✓	
2015-6	7	Improve the modeling of transmission constraints in the PRA.	✓	
2015-8	7	Improve the limit on the transfer constraint between MISO South and Midwest in the PRA.		✓
2016-9	7	Qualification of planning resources.		✓