



IMM Quarterly Report: Summer 2016

MISO Independent Market Monitor

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Highlights and Findings: Summer 2016

- The summer was warmer overall than in recent years and resulted in higher average loads, although there were no significant operating reserve shortages.
- The market performed competitively and reliably this summer. Market power mitigation remained infrequent because conduct was generally competitive.
 - ✓ Irrational regulation offers by one supplier were mitigated more frequently.
- More peaking resources than necessary were committed on some days, which resulted in a significant increase in RSG.
 - ✓ Some of the excess commitments were due to load forecast errors.
 - ✓ Voluntary curtailments outside of MISO's control led to excess commitments and high RSG on the one day that MISO had a Max Generation Event.
 - ✓ Better control of load curtailments/DR would improve market performance.
- While MISO's new Ramp Product had a relatively small effect on prices, our analysis showed that it produced benefits and lowered price volatility.
- ELMP continued to have very small effects on prices as a result of the restrictive rules that limited set of participating resources.

Quarterly Summary

		Value	Change ¹		Value	Change ¹			
			Prior Qtr.	Prior Year		Prior Qtr.	Prior Year		
RT Energy Prices (\$/MWh)	●	\$31.46	44%	9%	FTR Funding (%)	●	106%	99%	103%
Fuel Prices (\$/MMBtu)					Wind Output (MW/hr)	●	3,445	-38%	18%
Natural Gas - Chicago	●	\$2.63	41%	-6%	Guarantee Payments (\$M)⁴	●	\$23.7	143%	17%
Natural Gas - Henry Hub	●	\$2.69	48%	-3%	Real-Time RSG	●	\$7.6	-10%	-60%
Western Coal	●	\$0.56	7%	-5%	Day-Ahead RSG	●	\$12.3	61%	57%
Eastern Coal	●	\$1.22	-1%	-20%	Day-Ahead Margin Assurance	●	\$2.3	22%	-10%
Load (GW)²					Real-Time Offer Rev. Sufficiency	●			
Average Load	●	84.6	26%	1%	Price Convergence⁵				
Peak Load	●	120.7	26%	1%	Market-wide DA Premium	●	-2.4%	-1.0%	0.4%
% Scheduled DA (Peak Hour)	●	98.7%	99.0%	98.8%	Virtual Trading				
Transmission Congestion (\$M)					Cleared Quantity (MW/hr)	●	12,032	-9%	26%
Real-Time Congestion Value	●	\$463.5	53%	35%	% Price Insensitive	●	29%	24%	34%
Day-Ahead Congestion Revenue	●	\$232.1	45%	18%	% Screened for Review	●	1%	1%	1%
Balancing Congestion Revenue ³	●	-\$6.4	-\$10.2	-\$4.7	Profitability (\$/MW)	●	\$0.70	\$0.57	\$0.87
Ancillary Service Prices (\$/MWh)					Dispatch of Peaking Units (MW/hr)	●	2,522	994	1062
Regulation	●	\$8.70	2%	22%	Output Gap- Low Thresh. (MW/hr)	●	78	79	110
Spinning Reserves	●	\$2.34	22%	6%	Other:				
Supplemental Reserves	●	\$1.45	150%	3%					

Key:

- Expected
- Monitor/Discuss
- Concern

Notes:

1. Values not in italics are the value for the past period rather than the change.
2. Comparisons adjusted for any change in membership.
3. Net real-time congestion collection, unadjusted for M2M settlements.
4. Includes effects of market power mitigation.
5. Values include allocation of RSG.



Summary of Summer 2016

- Summer 2016 was characterized by rising energy prices driven primarily by rising natural gas prices and periods of high load.
 - ✓ Gas prices rose sharply this summer, increasing 48 percent compared to the Spring but were 3 percent less than last summer.
 - ✓ Fuel price changes and hot weather led to higher energy prices, which rose 44 percent from the spring (to \$31.46 per MWh) and 9 percent from last year.
- The summer was hotter than in recent years, causing average and peak load to each rise by 1 percent from last year.
 - ✓ Cooling degree-days (measures A/C demand) were up 23 percent from last summer, higher in the South in June and footprint wide in July and August.
- Real-time congestion value rose 35 percent from last summer to \$464 million due to high loads and some key generation and transmission outages.
- MISO committed twice as much peaking resource capacity as it did last summer because of high loads and under-scheduling of load in the day-ahead market.
- Increased reliance on peaking resources and limited ELMP price setting contributed to real-time RSG rising by 17 percent from last summer.



Highlights from Summer 2016

Several Periods of Hot Weather (Slides 17-19)

- In June, high loads and outages in MISO South resulted in substantial congestion into the South (binding of the RDT constraint) and into Louisiana.
 - ✓ MISO declared Hot and Severe Weather Alerts and Conservative Operations and Local TOPs declared emergency conditions on several days.
 - ✓ On June 17 MISO issued Conservative Operations and a Maximum Generation Alert in the South.
- In July, interregional flows reversed, flowing South to North as MISO declared Severe and Hot Weather Alerts throughout the Central and North.
 - ✓ On July 21, MISO declared a Maximum Generation Event (Step 1) and remained in conservative operations through the evening of July 22.
 - ✓ On July 28, MISO went into an Operating Reserve shortage and system prices exceeded \$1,200 for one interval.
- MISO also experienced several hot periods in August and declared local Conservative Operations for severe flooding conditions in Amite South and the DSG load pockets.
- On August 29, MISO issued a Maximum Generation Alert for the North and Central Regions.



Highlights from Summer 2016

Maximum Generation Event & Emergency Pricing on July 21 (Slides 18-19)

- On July 21, MISO declared a Max Generation Event due to forecasted load of nearly 125 GW. Actual peak load was roughly 4 GW lower because:
 - ✓ Storms in Wisconsin, Michigan, and Northern Indiana reduced temperatures and loads in those areas; and
 - ✓ Market participants voluntarily curtailed loads of nearly 1,600 MW (according to data submitted by local balancing authorities).
- MISO committed 195 turbines, but because MISO's needs were over-forecasted, prices were low and real-time RSG exceeded \$1.6 million.
- Emergency Pricing rules implemented on July 1 called for MISO to apply a proxy offer floor price to all emergency MWs, but they didn't set prices.
 - ✓ The storms and voluntary load reductions reduced load so the emergency capacity was not deemed necessary by ELMP.
 - ✓ The turbines committed by MISO also did not set prices because very few are currently eligible under MISO's ELMP provisions.
 - ✓ We conducted a simulation that showed that expanding ELMP's eligibility rules would have raised prices in the peak hours by 38 percent on July 21 and lowered MISO's real-time RSG by 14 percent.



Highlights for Summer 2016

Significant Increases in Congestion (Slides 20-24)

- Unusually high levels of planned and forced generation outages and transmission outages led to higher congestion, particularly in the South.
 - ✓ In June, uneconomic production by some units exacerbated the congestion.
 - ✓ Planned and forced generation outages in late July also led to high congestion in the load pockets in Texas and Louisiana.
- On August 8, MISO declared a Local Transmission Emergency (LTE) in the South when forced transmission outages led to high regional congestion.
 - ✓ A single constraint led to \$11 million in real-time congestion on that day.
 - ✓ MISO declared the LTE in order to access the emergency ranges of generating resources in the South.
- Gas prices in the South were slightly higher than in the North, in contrast to prior quarters.
 - ✓ LNG exports, significant increases in exports to Mexico and net storage withdrawals (uncommon in the summer) put upward pressure on South region gas prices.



Highlights for Summer 2016

Evaluation of MISO Day-Ahead and Real-Time Ramp Product (Slide 31)

- MISO's ramp product went into effect May 1 and resulted in the following:
 - ✓ On average the real-time clearing price of ramp up and ramp down products was \$0.13 and \$0.00, respectively, as a result of excess ramp capability.
 - ✓ During the summer, the ramp product cleared at \$0 in the off-peak hours.
- Although the prices have been low, we conducted a simulation that showed that the ramp product has been beneficial.
 - ✓ Our simulation included every interval in July when the ramp product cleared above zero and showed a slight reduction in total production costs.
 - ✓ The results showed that the ramp product reduced price volatility by 5 percent and LMPs overall by one percent.
- However, the day-ahead ramp product has not converged well with the real-time ramp product prices.
 - ✓ Real-time ramp demands cannot be consistently defined in the day-ahead market because it is an hourly market (ramp is a 10-minute product).
 - ✓ The day-ahead ramp price premium is counter intuitive and we will be investigating the cause of this issue.



Highlights for Summer 2016

Evaluation of ELMP in 2016 (Slide 35-37)

- ELMP continues to have small effects on prices and we recommend that MISO expand the pool of peaking resources eligible to set price.
 - ✓ ELMP lowered market-wide prices by \$0.01 per MWh this quarter overall.
 - ✓ The online pricing component of ELMP raised real-time prices in 9.8 percent of intervals market-wide, increasing average prices by \$0.18 per MWh.
 - ✓ The offline pricing component has affected only 0.8 percent of intervals, lowering prices on average by \$0.19 per MWh.
 - ✓ At congested locations, ELMP affected real-time prices in 11 percent of the intervals, resulting in larger effects at some locations.
- Expanding eligibility as much as possible without software changes would increase eligible peaking output from 3 percent to 19 percent.
 - ✓ The IMM recommendation would increase eligible output to 89 percent.
- We estimated the effects of implementing our ELMP recommendations on peak day results by re-running real-time market intervals on July 21 and 22.
 - ✓ Average real-time system marginal price would have increased by 31 percent and real-time congestion values by 25 percent, while real-time RSG would have fallen by 14 percent.



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 recommended a sanction for uneconomic production that led to significant episodes of congestion in June.
 - ✓ We also investigated conduct that may have been intended to avoid physical withholding mitigation and may constitute a market violation.
- We presented our Spring Quarterly Report to stakeholders at the MSC.
- We continued to evaluate the preliminary results of the Ramp Product and are developing recommendations for potential adjustments.
- We continued working with MISO and transmission owners to improve transmission ratings to more fully utilize the network.
 - ✓ An ongoing pilot program has reduced congestion with no reliability concerns, and we recommend expanding these efforts.
- We participated in the Reliability Subcommittee discussions on generator performance and have provided detailed data to MISO to support our recommended improvements in generator deviation thresholds.

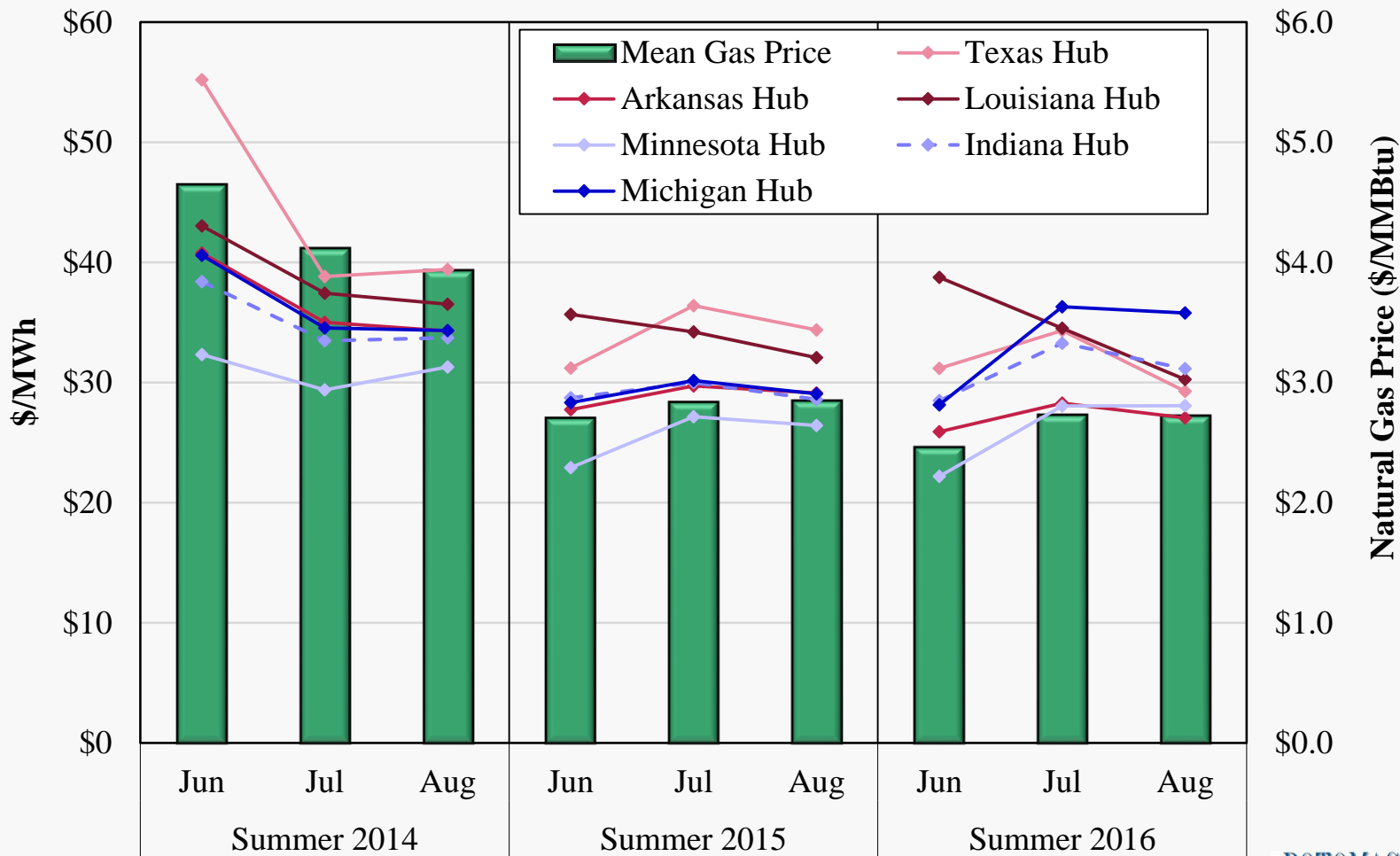


Submittals to External Entities and Other Issues

- We continued to be very concerned about the increasing quantities of MISO generators that are pseudo-tying to PJM
 - ✓ The pseudo-ties to date have contributed to 47 new market-to-market constraints, each coordinated for the first time after March 1.
 - ✓ We continue to support developing procedures for firm capacity delivery as a more efficient and reliable alternative to pseudo-tying resources to PJM.
 - ✓ PJM has announced it will not consider this alternative but will further limit participation of external resources to address some of issues with pseudo-ties.
- MISO and PJM have decided to implement a Common Interface for the RTO's interface prices.
 - ✓ We believe that this is a mistake that would result in inefficient transaction scheduling and other unintended consequences.
 - ✓ We will monitor the results of these changes to document these inefficiencies and work with the RTOs to develop better solutions over the long term.

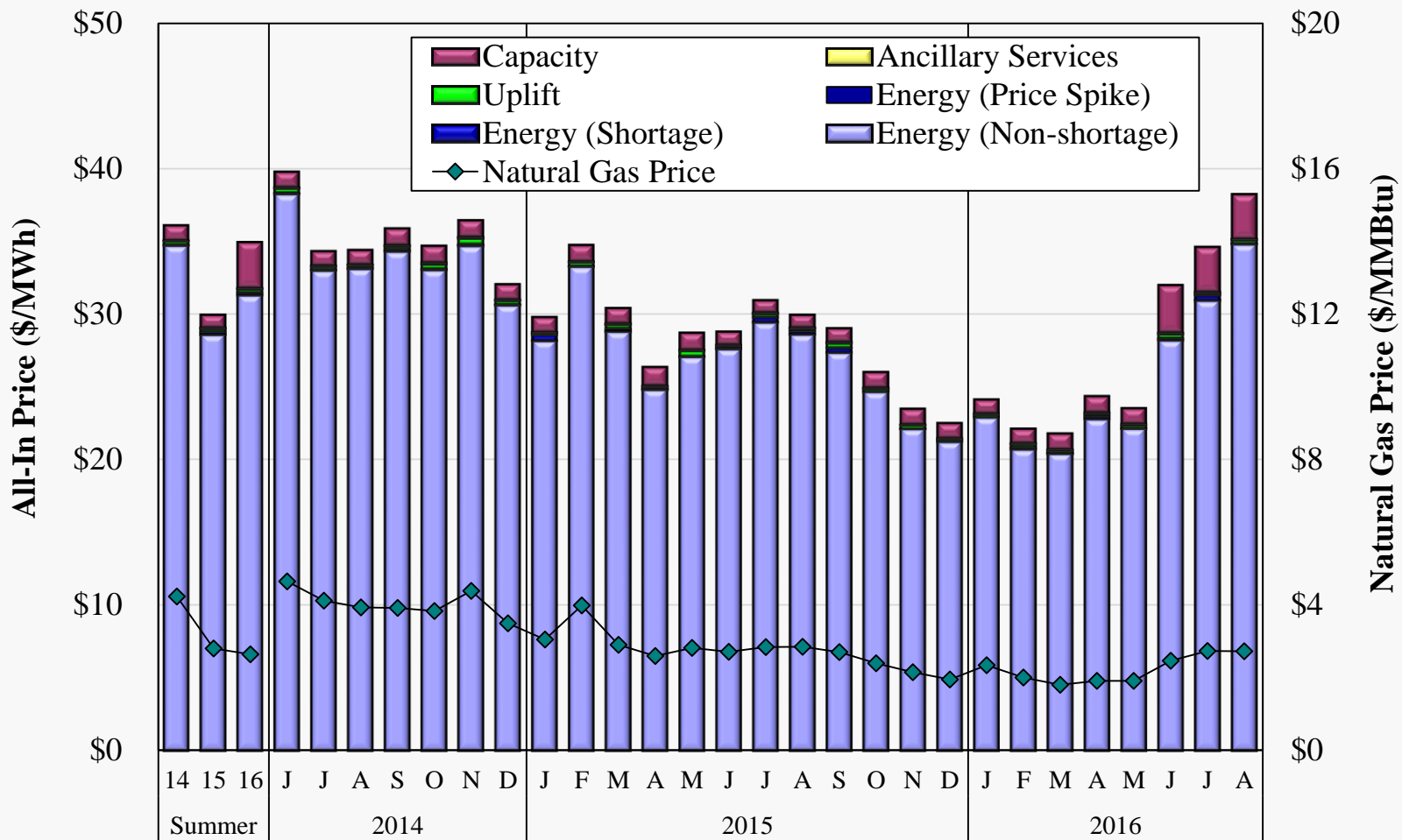


Day-Ahead Average Monthly Hub Prices Summer 2014–2016

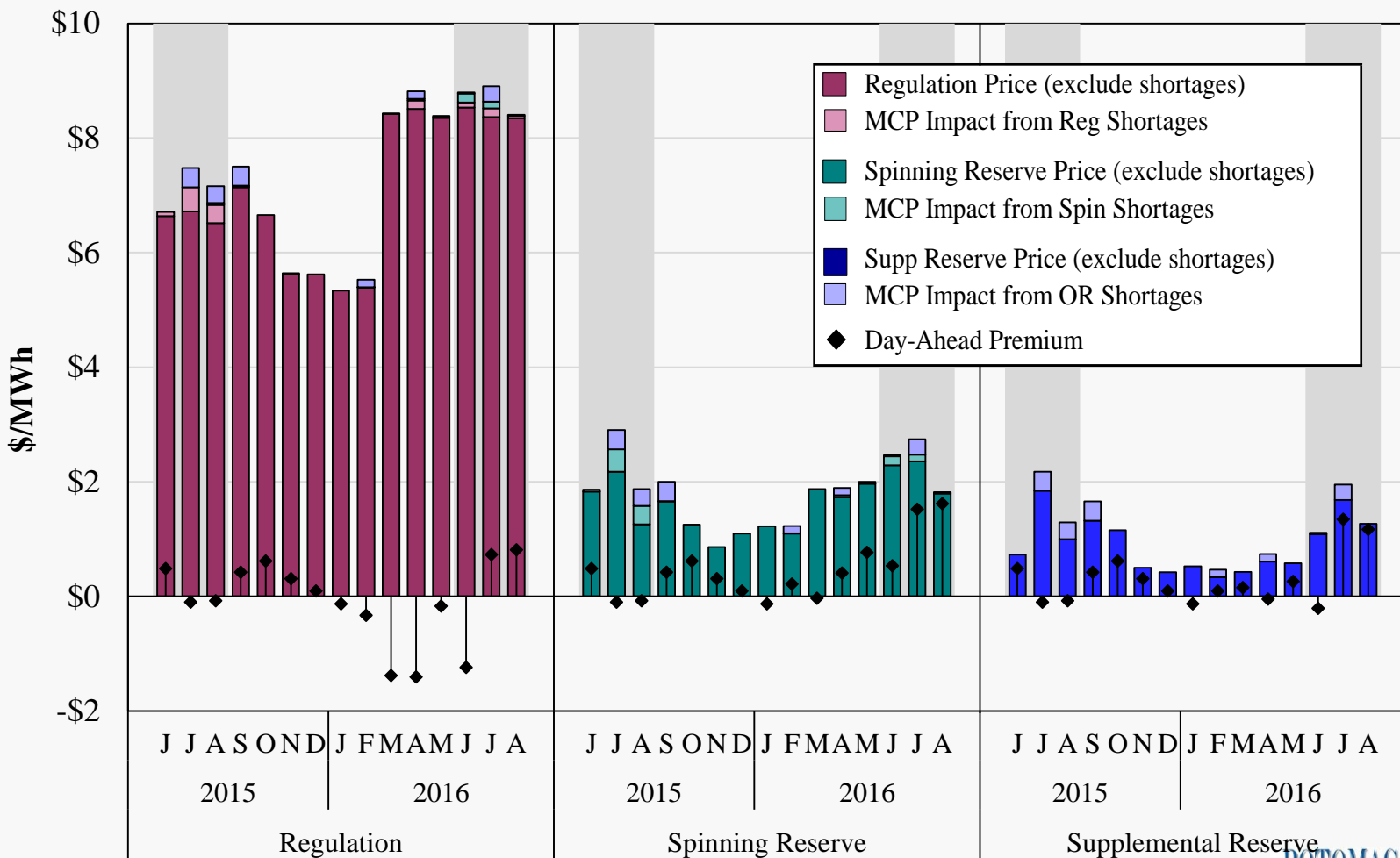




All-In Price Summer 2014 –2016

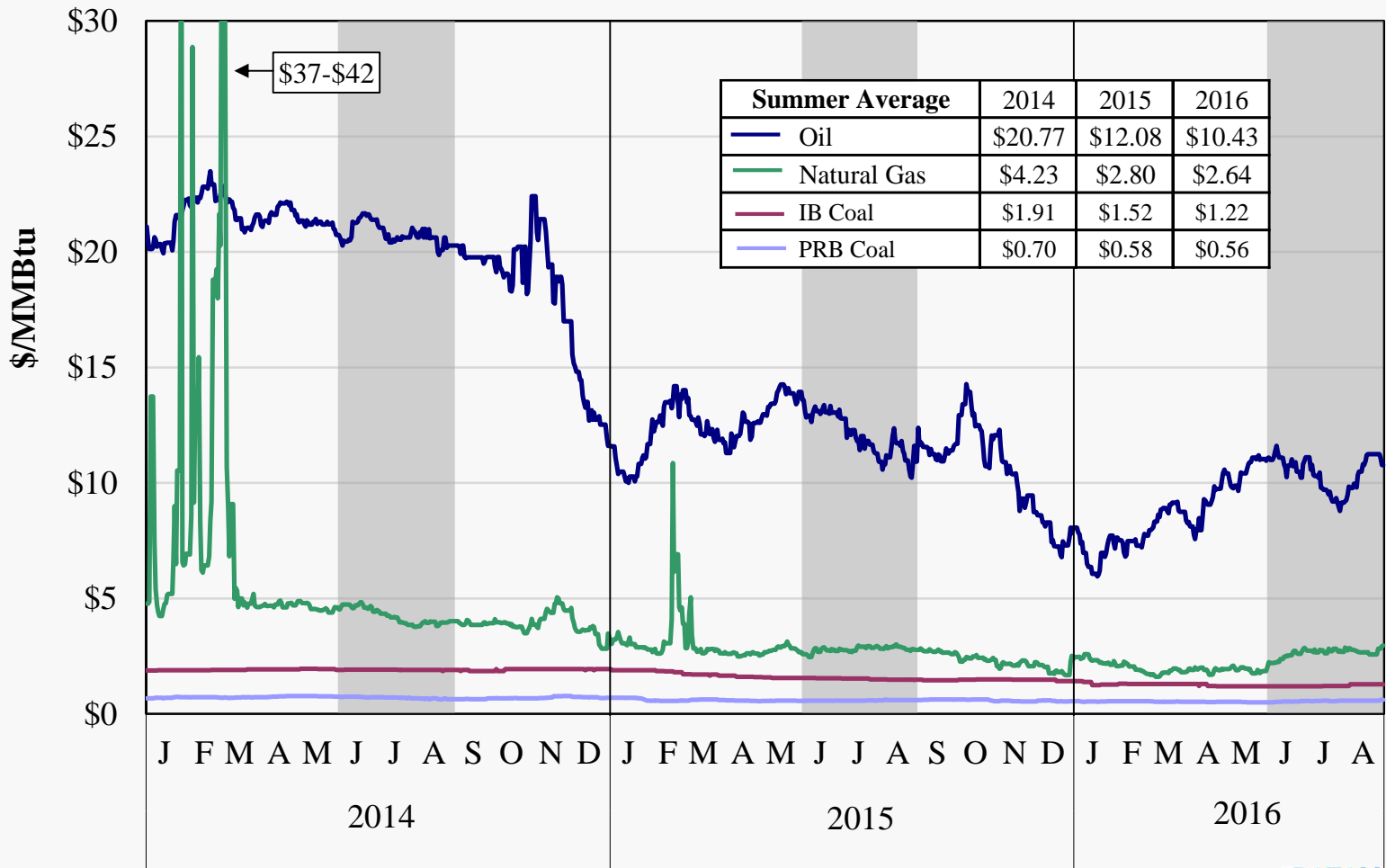


Monthly Average Ancillary Service Prices Summer 2015 –2016



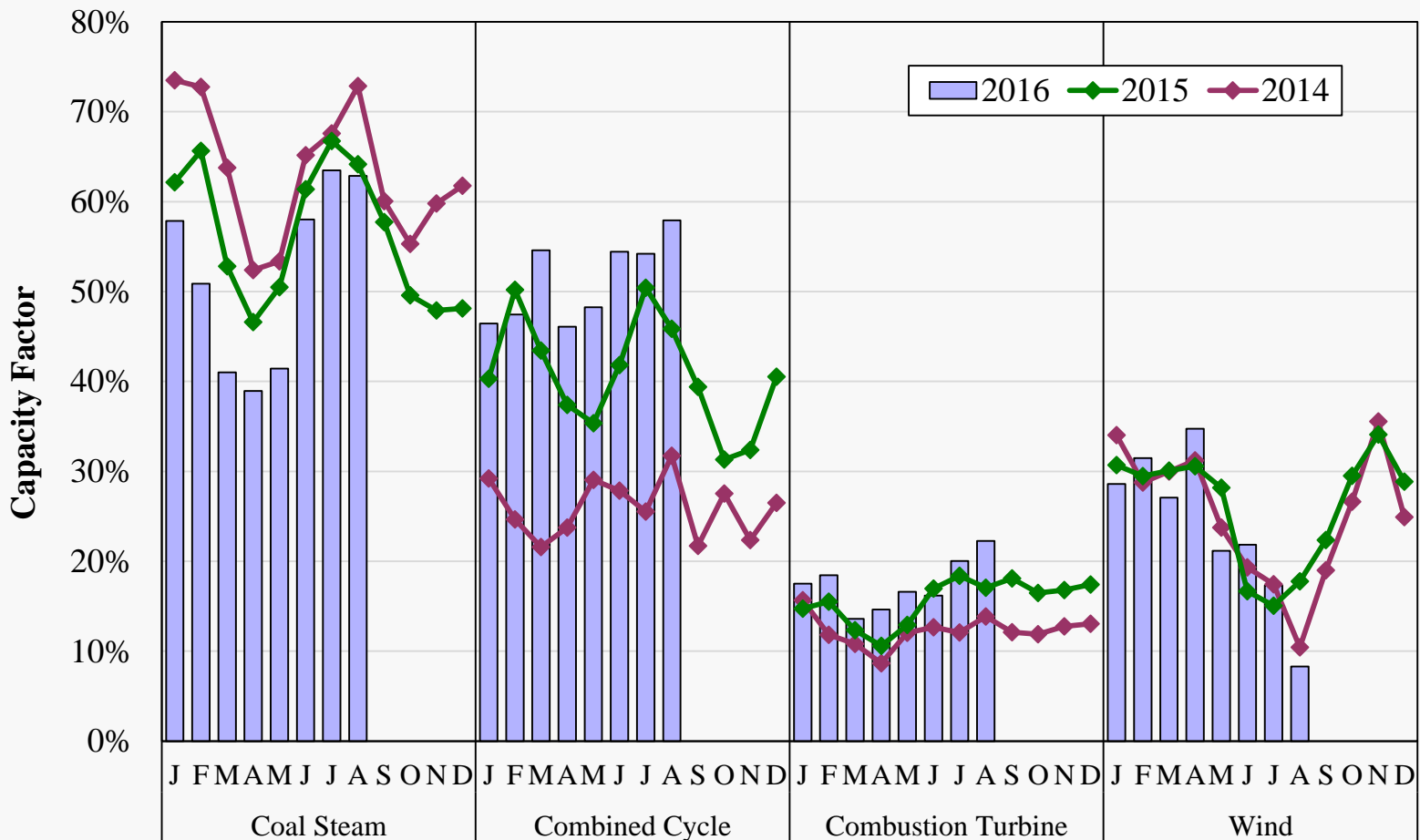


MISO Fuel Prices 2014–2016



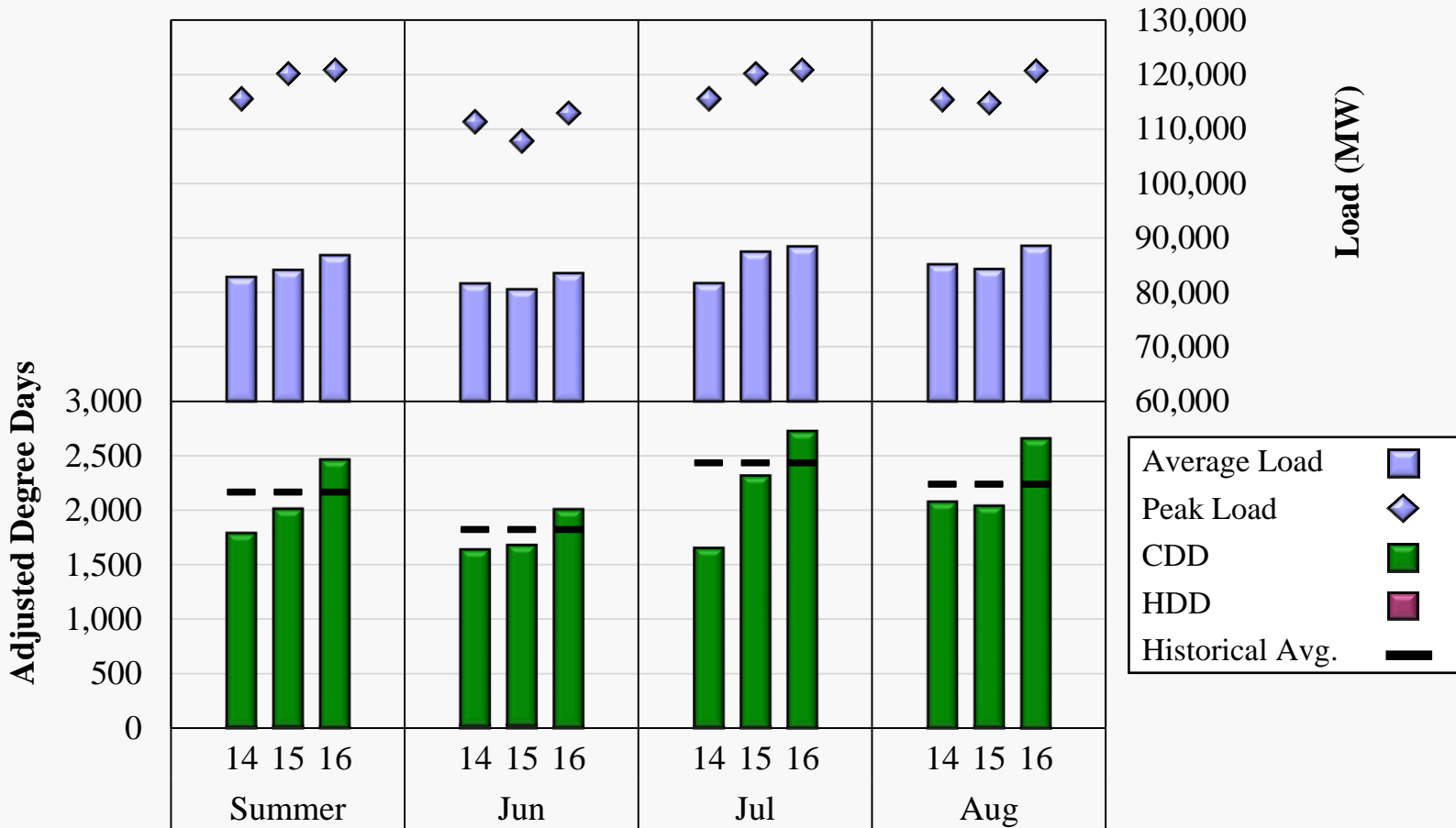


Capacity Factors By Fuel Type 2014–2016





Load and Weather Patterns Summer 2014–2016



Note: 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.

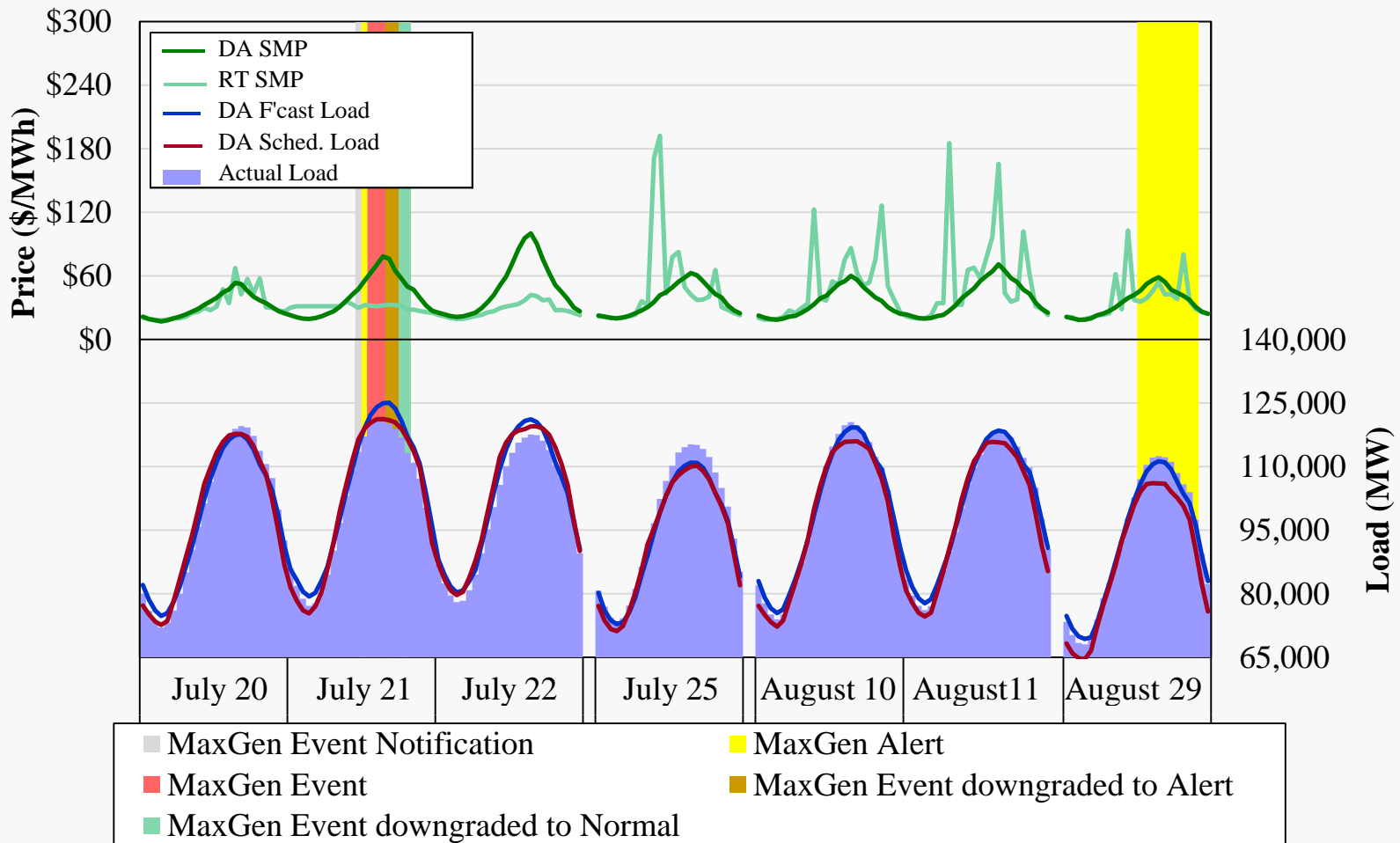
Temperature, Load Scheduling, Energy Prices, RSG Summer 2016

	Hist.	July				August		
	Avg.	20	21	22	25	10	11	29
Detroit	81	86	91	93	91	95	91	82
Indianapolis	84	87	90	90	90	86	93	90
Milwaukee	79	93	93	90	89	88	94	83
Minneapolis	82	93	95	97	87	91	84	86
Little Rock	93	98	99	98	94	95	95	95
New Orleans	90	98	99	91	93	93	97	95
Number of GTs Committed		71	195	80	172	136	198	157
RT RSG (\$K)		\$122	\$1,676	\$123	\$967	\$561	\$1,038	1,659*
Day-Ahead Forecasted Peak (GW)		118	125	121	111	119	118	111
Actual Peak Load (GW)		120	121	118	115	121	118	112
Max RT Energy Price (\$/MWh)		\$68	\$36	\$42	\$192	\$127	\$185	\$103
Max DA Energy Price (\$/MWh)		\$53	\$78	\$100	\$63	\$60	\$71	\$59

* Estimated Max Gen Event Max Gen Alert

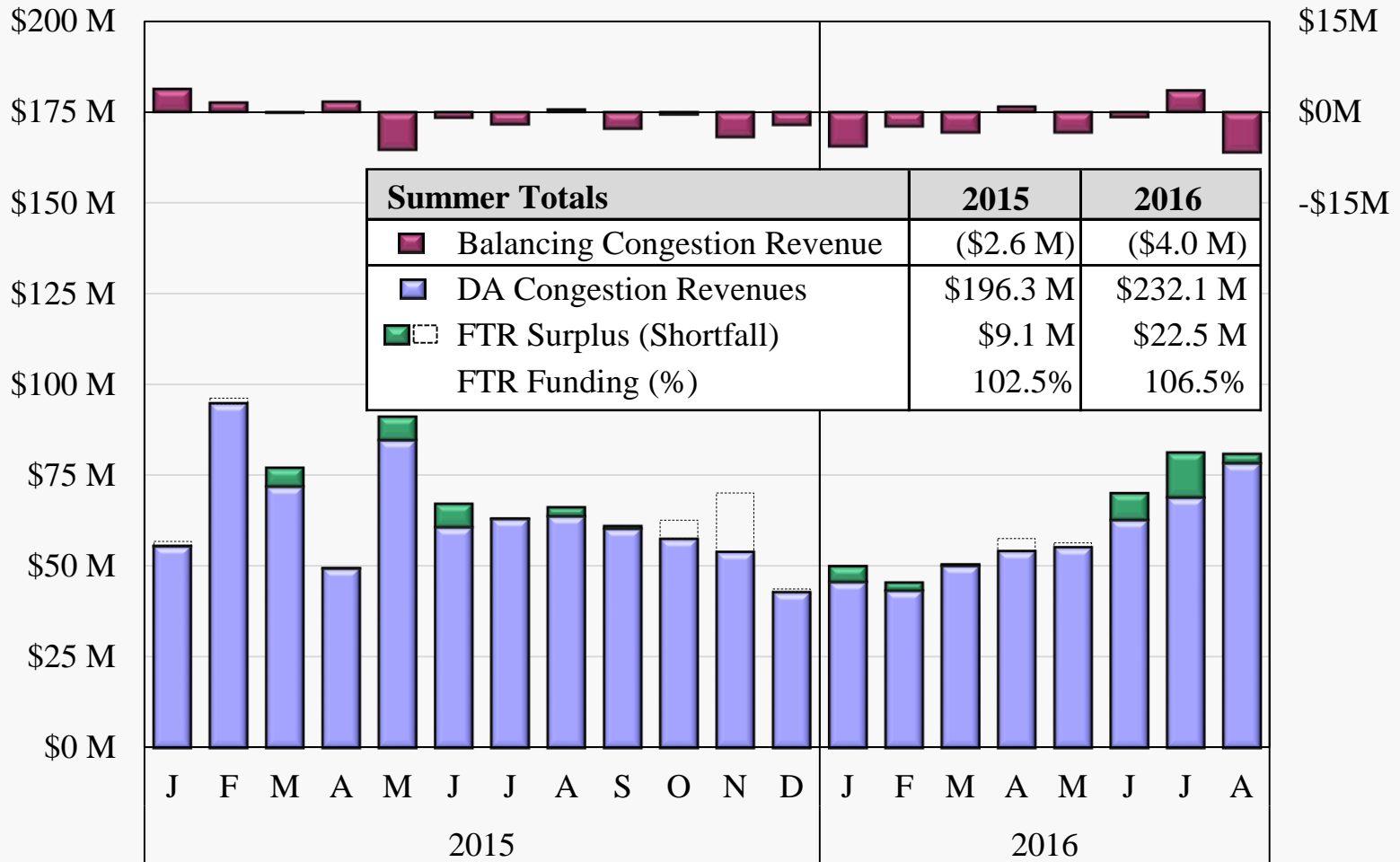


DART Load Scheduling and Energy Prices High Load Days



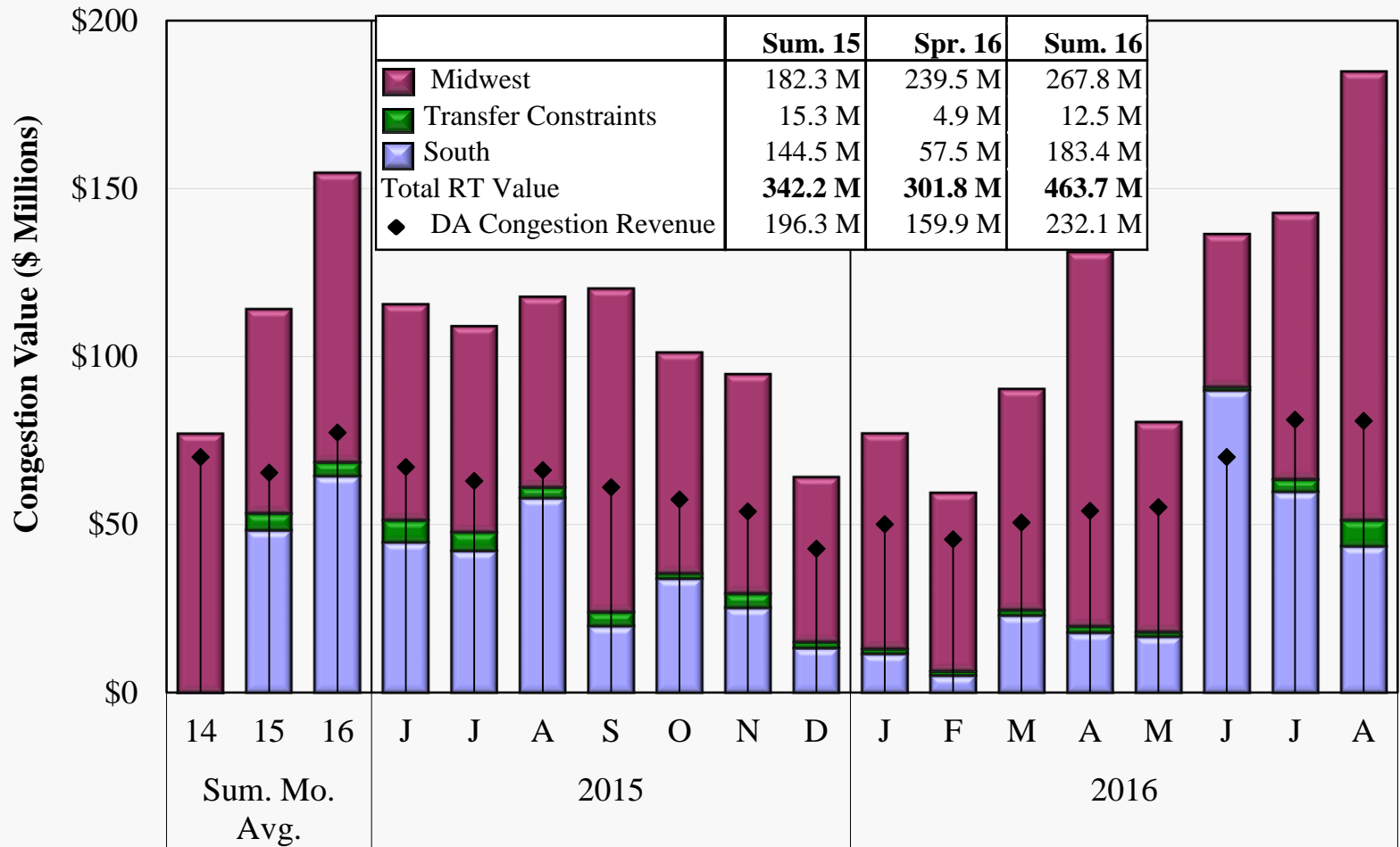


Day-Ahead Congestion, Balancing Congestion and FTR Underfunding, 2015–2016



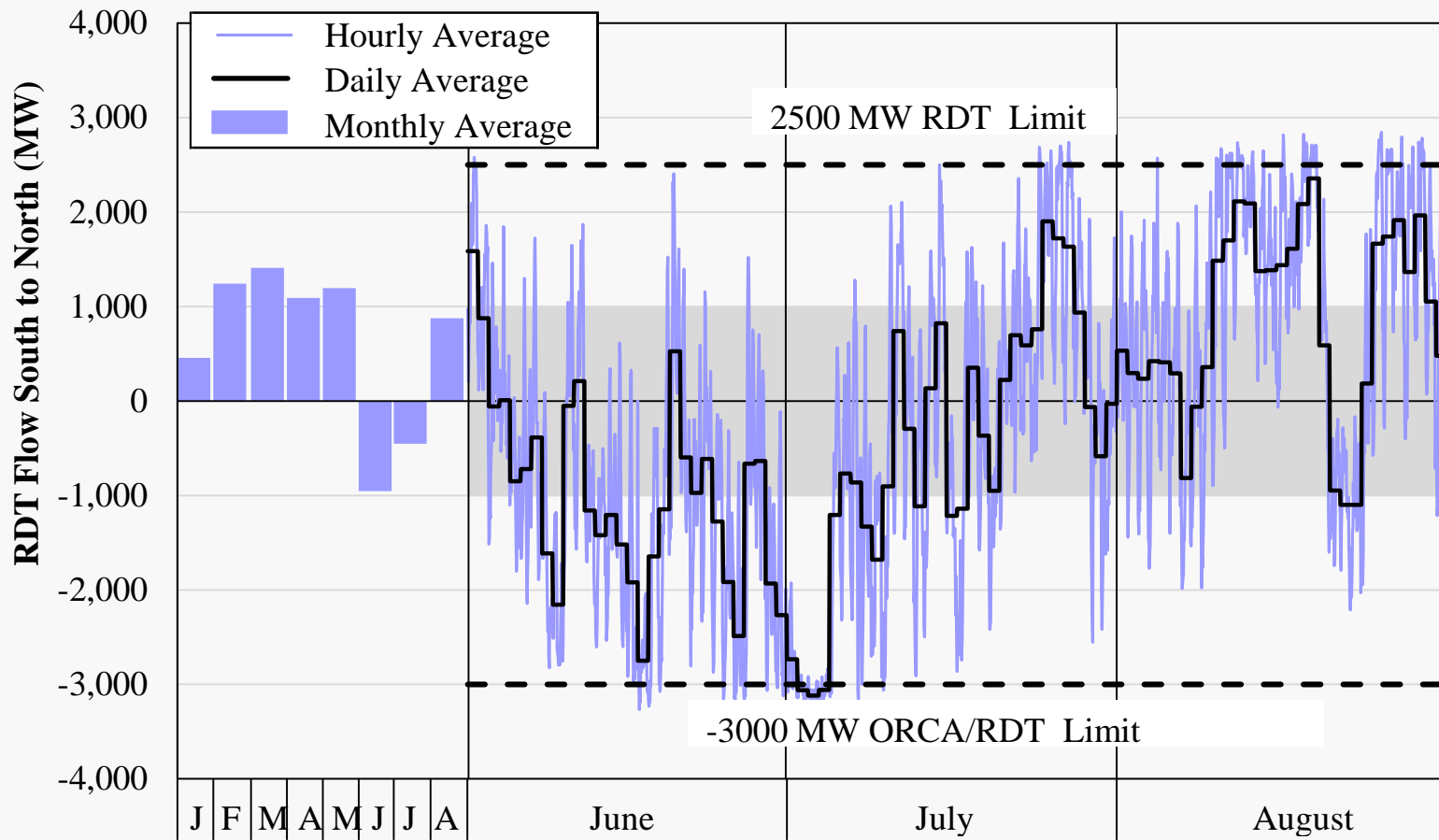


Value of Real-Time Congestion Summer 2015–2016



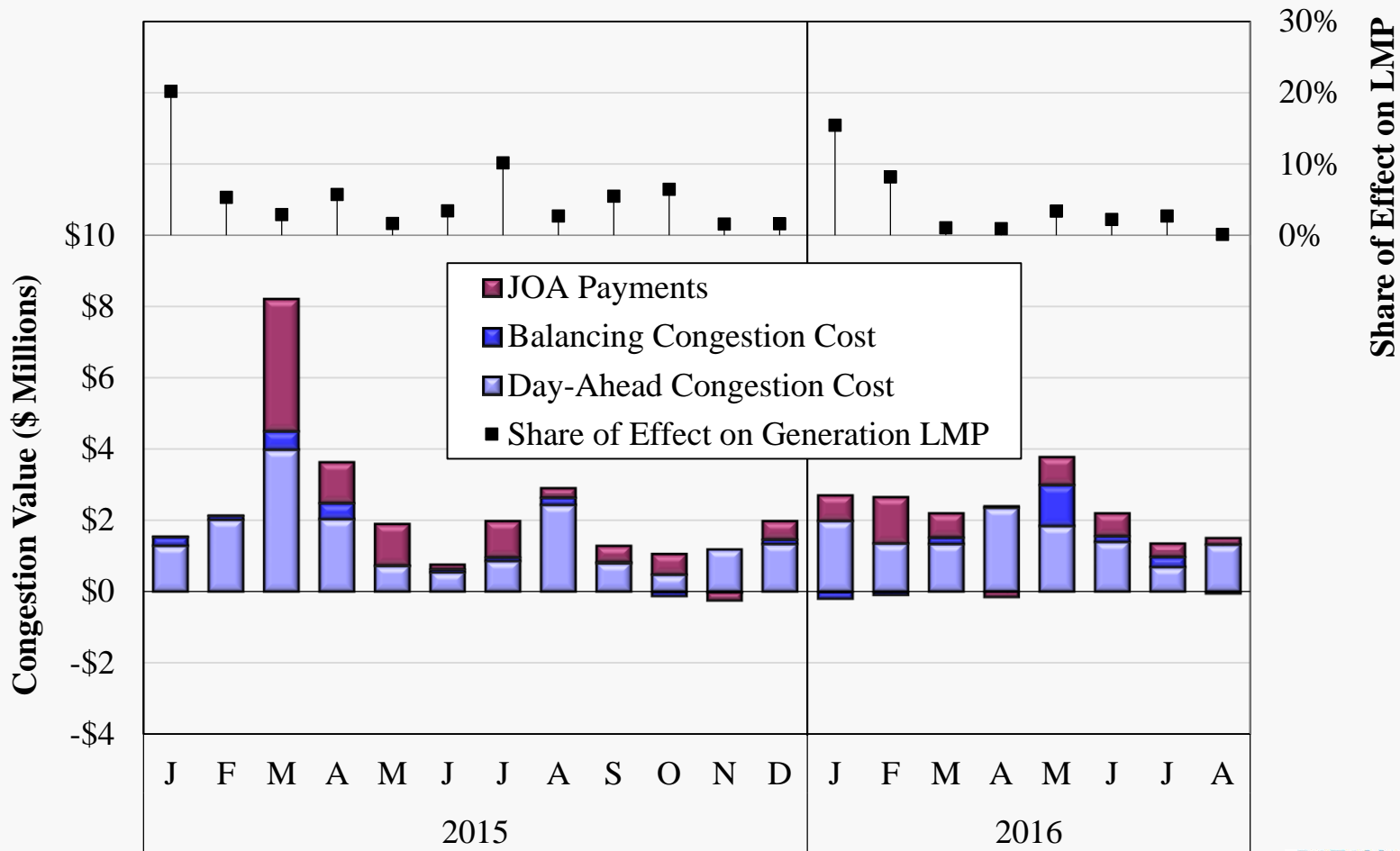


Real-Time Hourly Inter-Regional Flows 2016



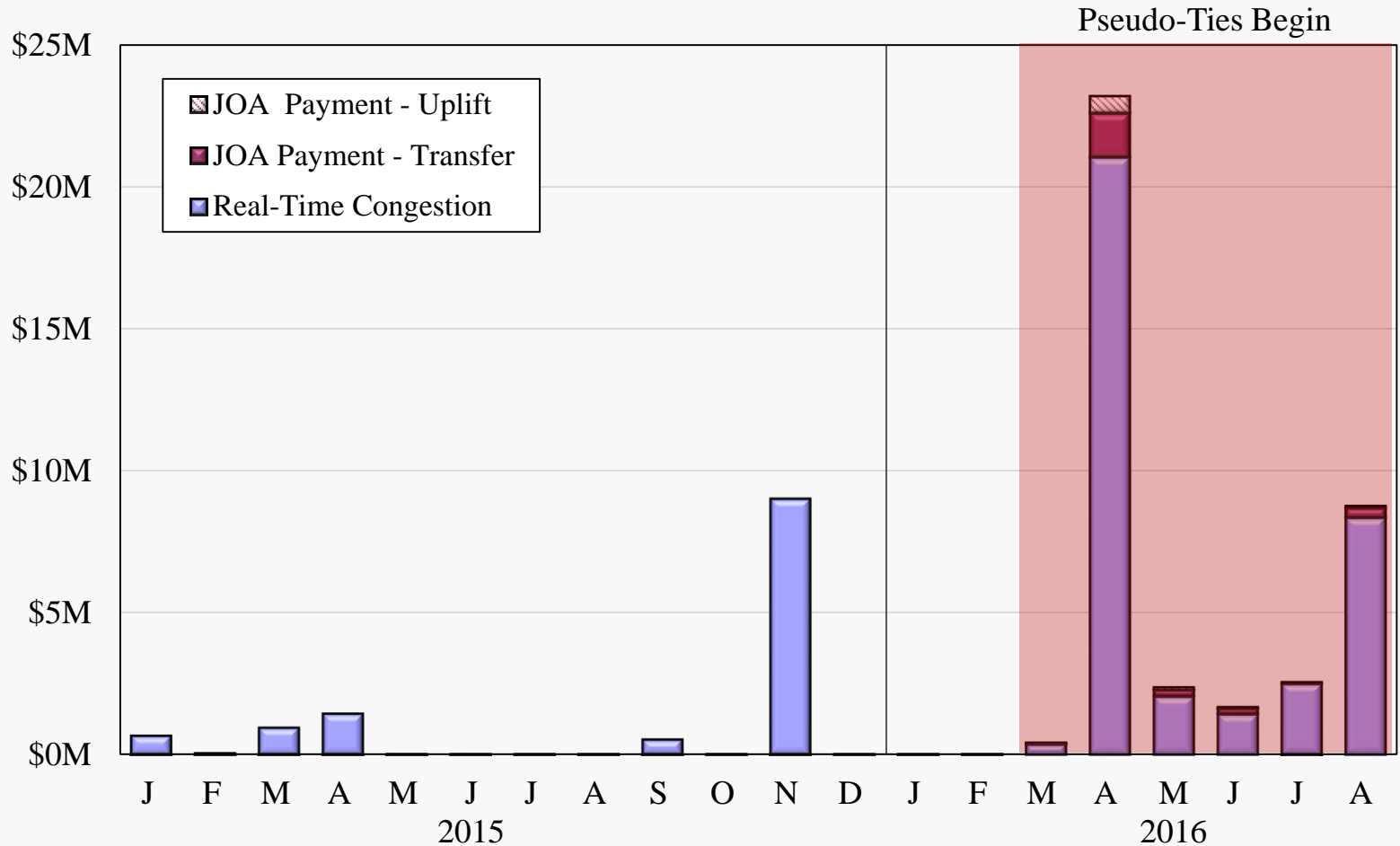


Congestion Costs on SPP Flowgates 2015 – 2016



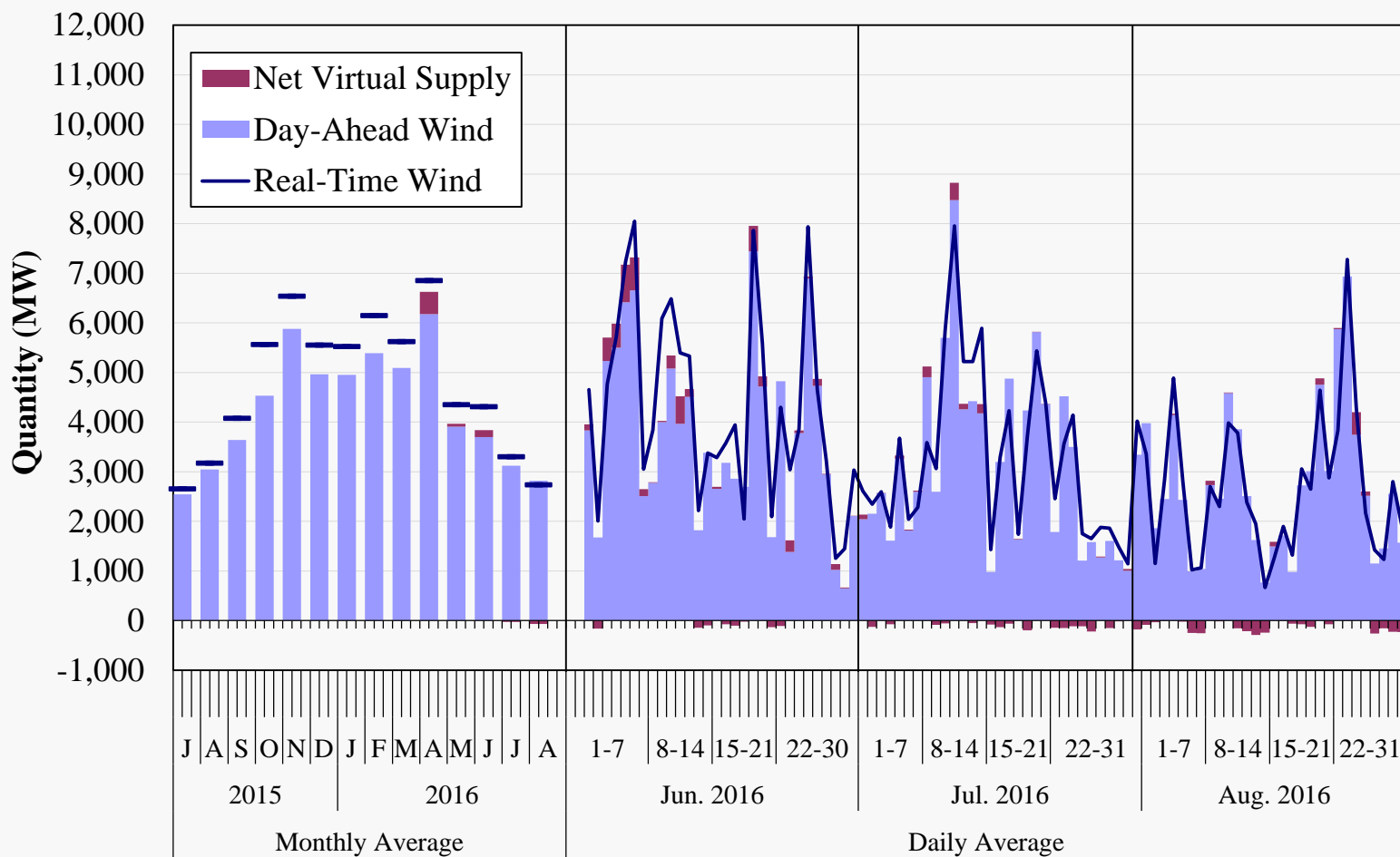


MISO Congestion Value and JOA Settlement Constraints Impacted by Pseudo-Ties



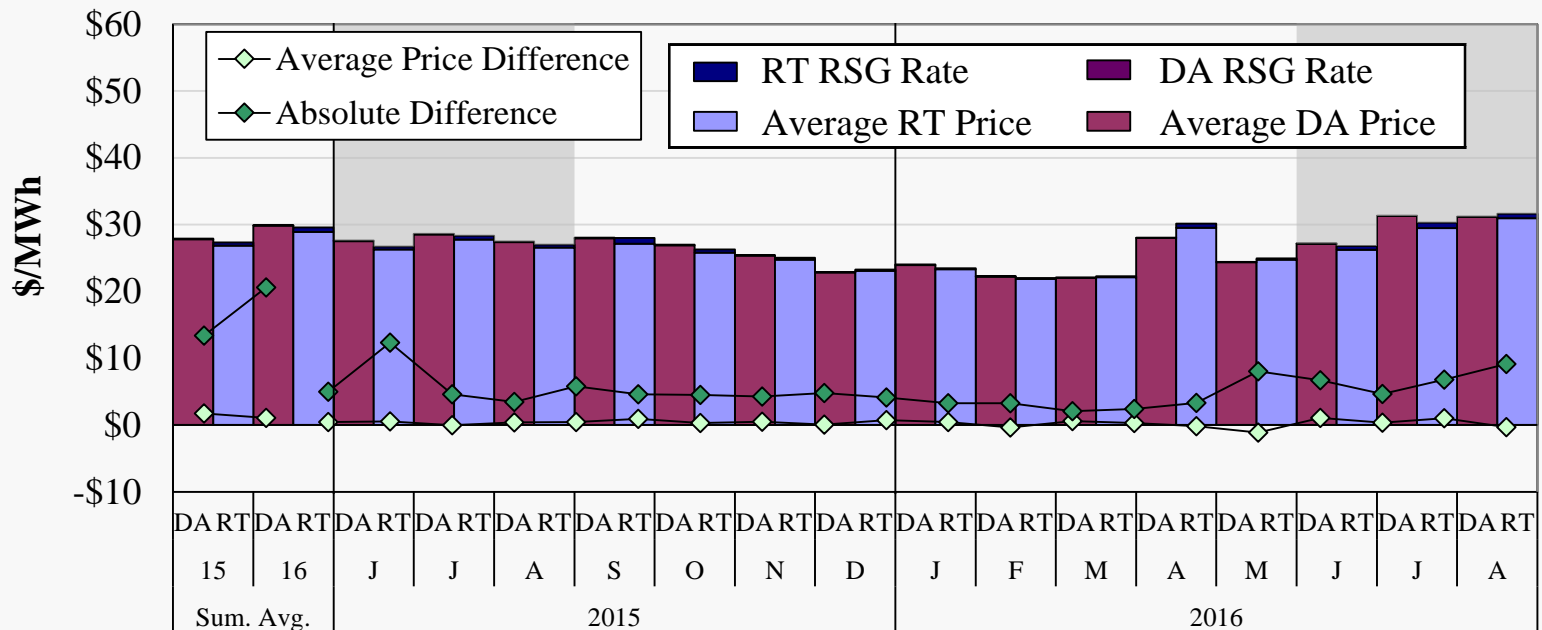


Wind Output in Real-Time and Day-Ahead Markets Monthly and Daily Average





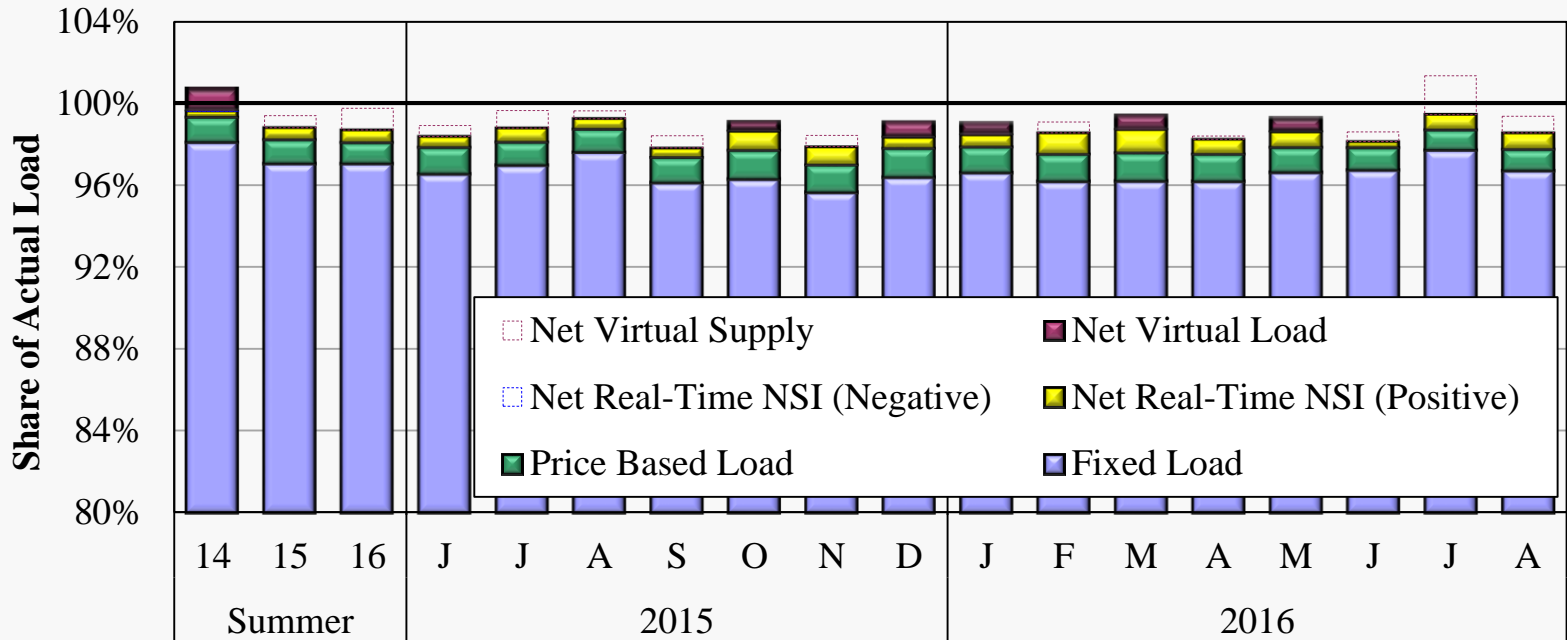
Day-Ahead and Real-Time Price Convergence Summer 2015–2016



Average DA-RT Price Difference Including RSG (% of Real-Time Price)

Indiana Hub	2	1	3	1	2	0	3	2	-2	2	1	-1	-7	-2	1	3	-1
Michigan Hub	0	-2	0	0	0	-3	2	3	0	4	3	-1	-6	4	0	5	-10
Minnesota Hub	1	-4	-1	3	0	-2	14	5	3	4	5	-3	2	7	-5	0	-6
WUMS Area	2	-5	3	3	0	1	1	-1	0	4	3	0	0	0	-3	-5	-7
Arkansas Hub	0	1	3	-3	0	0	0	6	4	2	2	-3	-3	6	4	-1	1
Louisiana Hub	-5	-6	-10	1	-5	0	0	-1	4	2	3	-2	2	0	-14	-1	-4
Texas Hub	-1	0	4	0	-7	-2	-12	-15	3	1	6	3	-19	12	2	-3	2

Day-Ahead Peak Hour Load Scheduling Summer 2015–2016

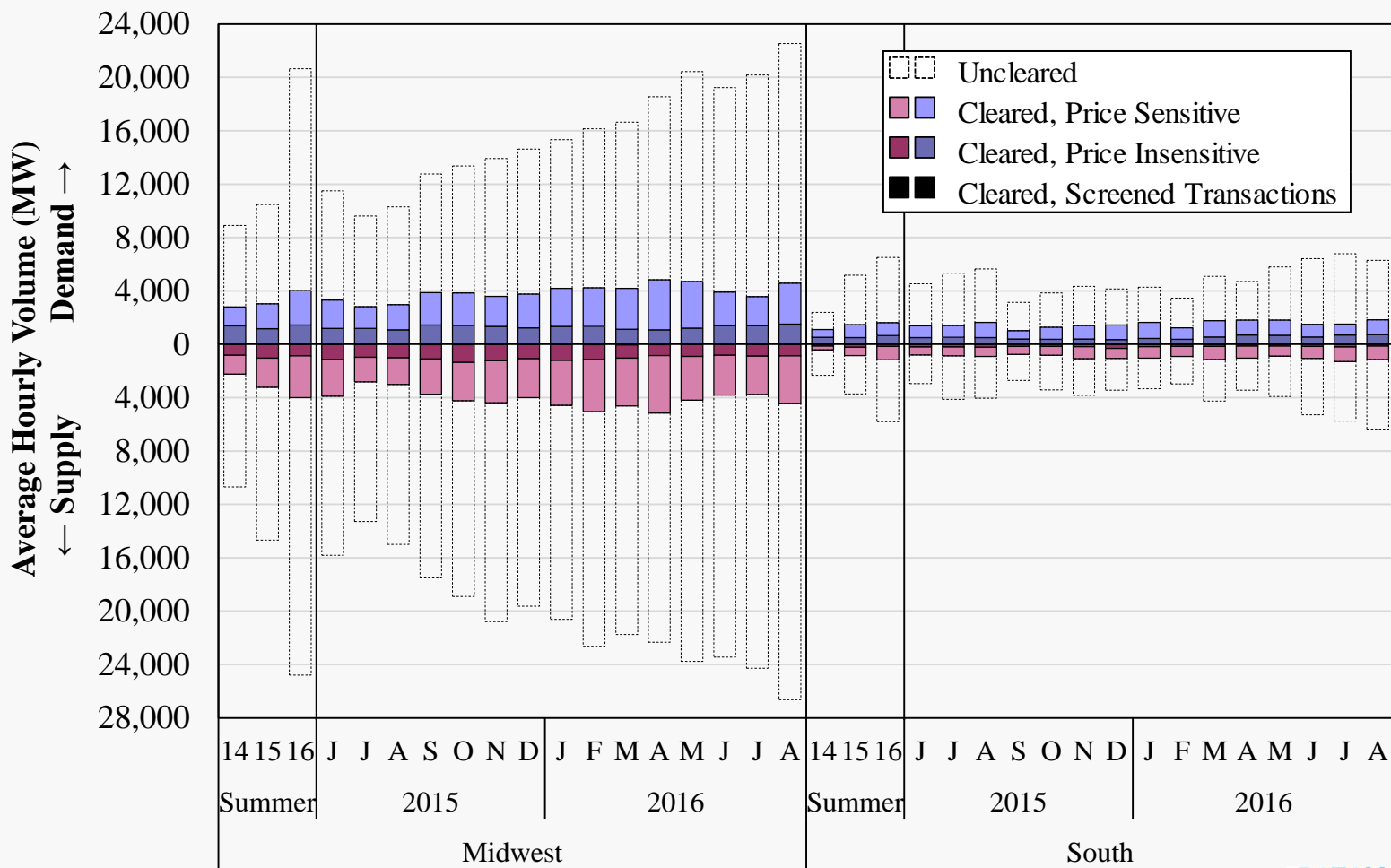


Share of Actual Load (%)

All Hours	100.9	99.2	99.4	98.5	99.4	99.6	98.5	98.2	97.9	98.4	99.0	98.2	98.3	98.7	99.6	98.6	100.1	99.4
Peak Hours Midwest	100.9	99.2	99.4	98.3	97.9	98.2	97.0	98.6	99.2	99.7	99.2	98.8	99.4	97.5	98.6	96.9	98.8	97.6
Peak Hours South	100.9	99.2	99.4	98.1	100.6	101.4	99.9	101.0	96.8	99.5	99.1	98.9	99.7	100.6	101.8	101.5	101.8	101.4

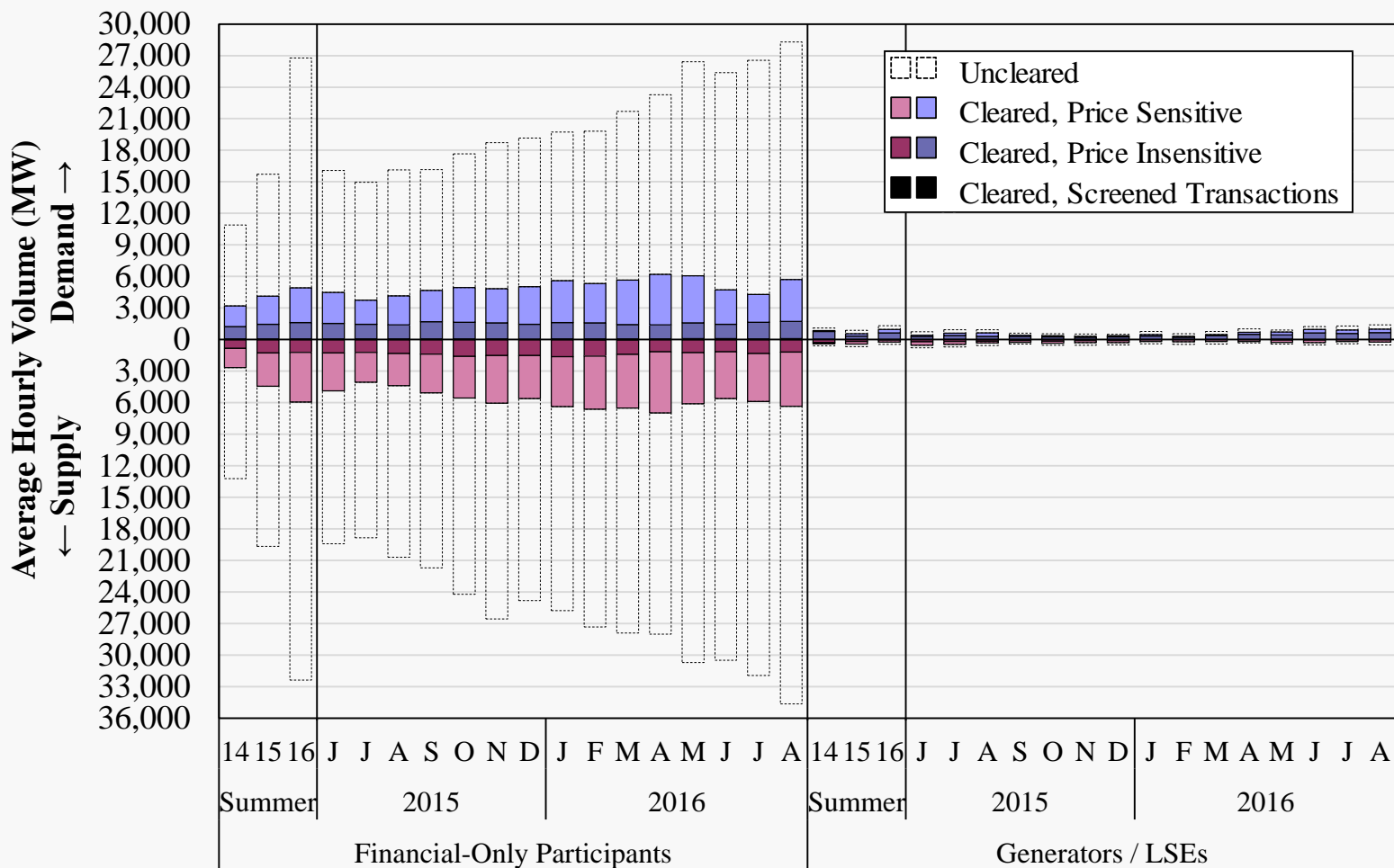


Virtual Load and Supply Summer 2015–2016



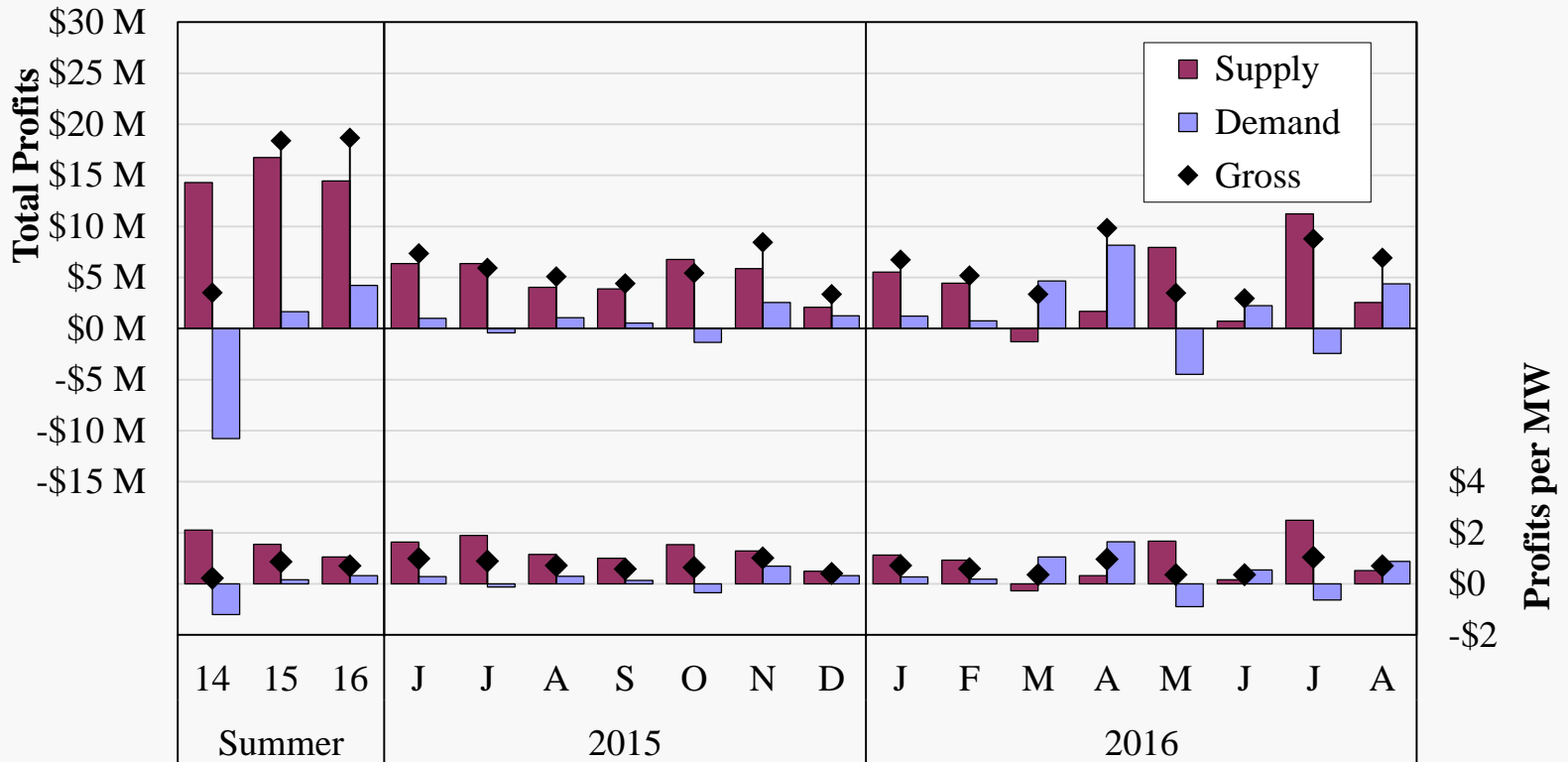


Virtual Load and Supply by Participant Type Summer 2015–2016





Virtual Profitability Summer 2015–2016

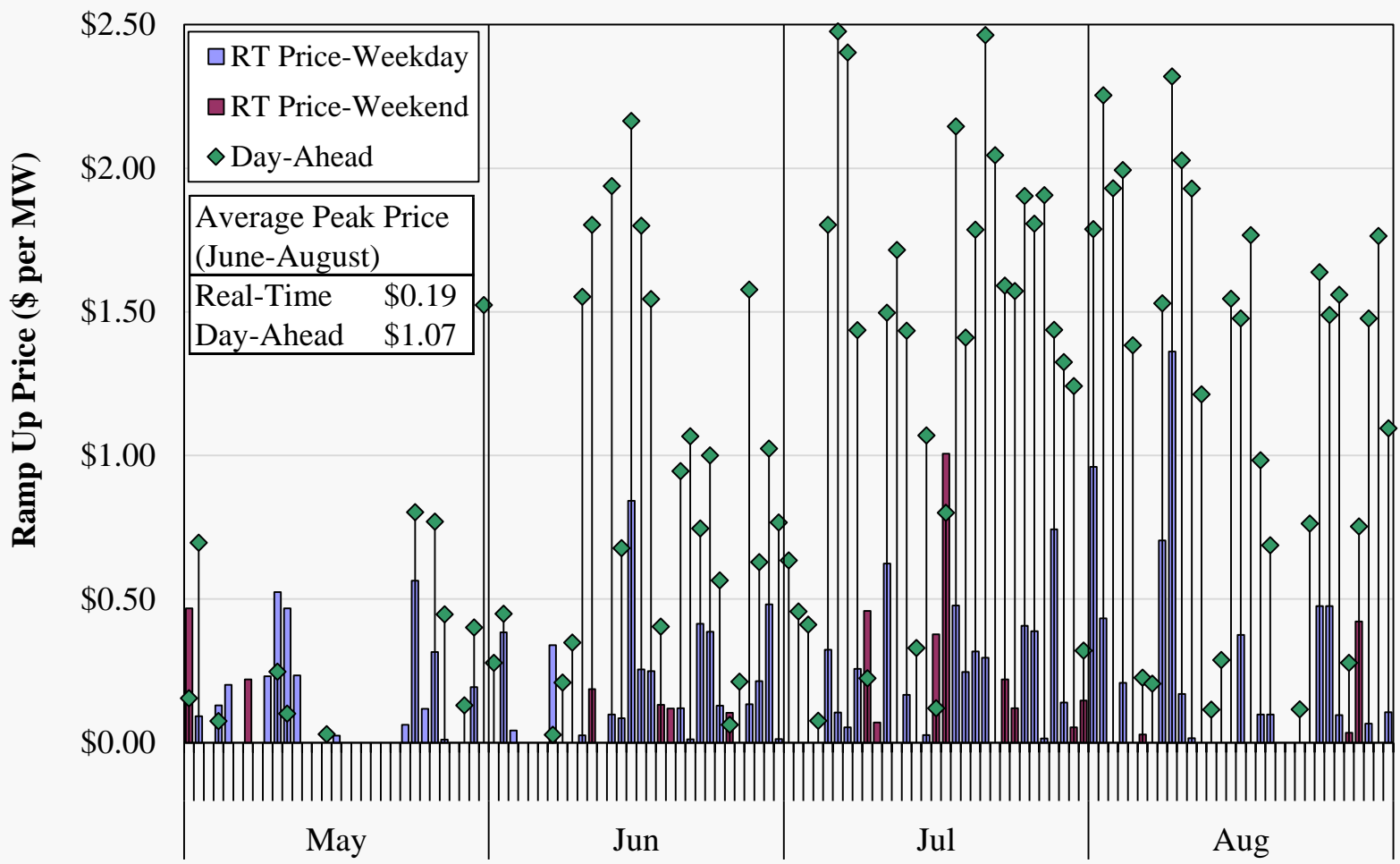


Percent Screened

Demand	2.3	1.6	1.3	1.6	1.6	1.7	1.0	1.1	1.4	0.6	0.8	1.0	1.0	1.2	1.6	1.5	1.2	1.3
Supply	0.8	0.3	0.3	0.4	0.4	0.2	0.5	0.5	0.4	0.2	0.4	0.5	0.9	0.4	0.3	0.2	0.3	0.3
Total	1.7	1.0	0.8	0.9	1.0	1.0	0.8	0.8	0.8	0.4	0.6	0.7	0.9	0.8	1.0	0.8	0.7	0.8

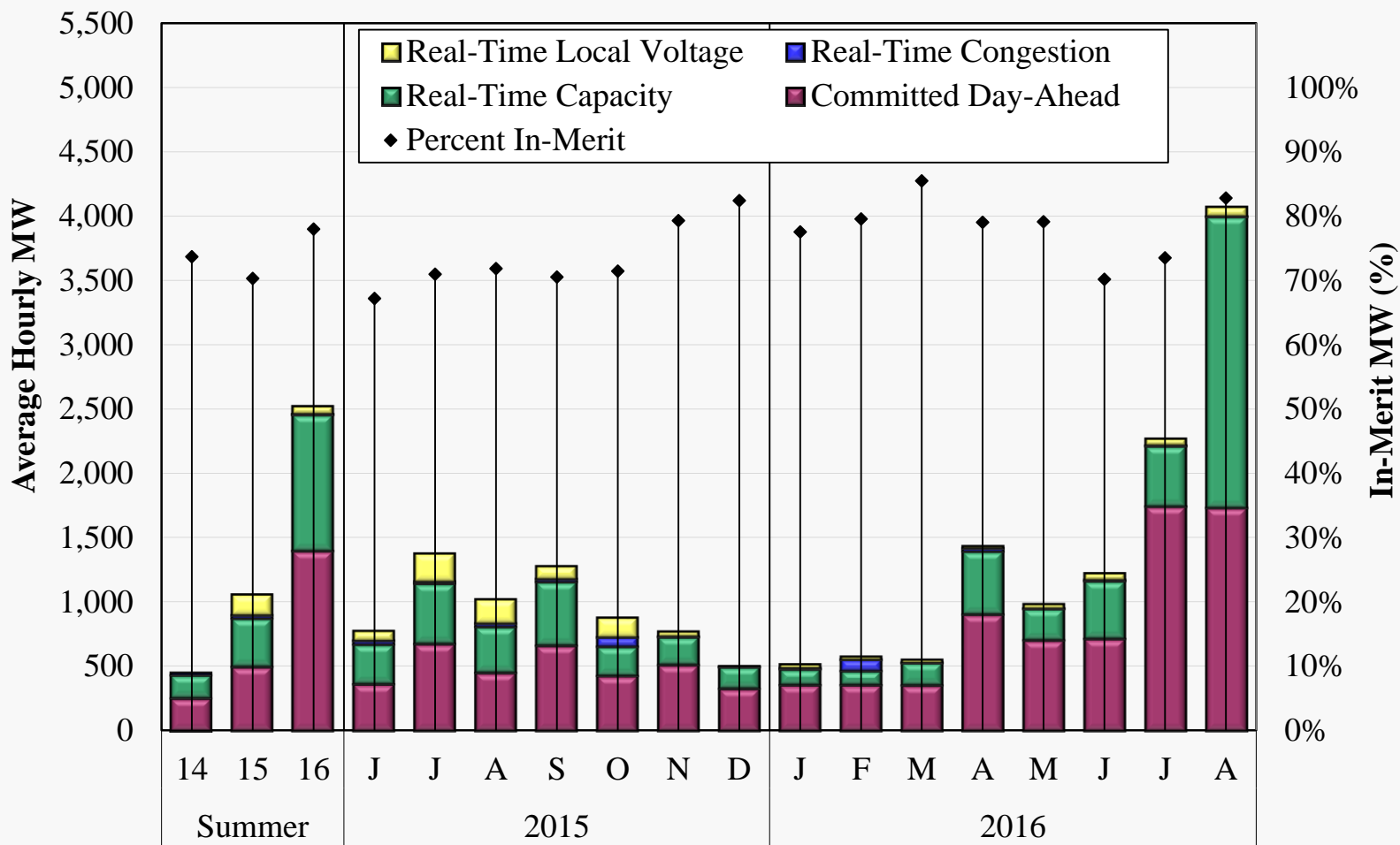


Ramp Up Price May – August 2016



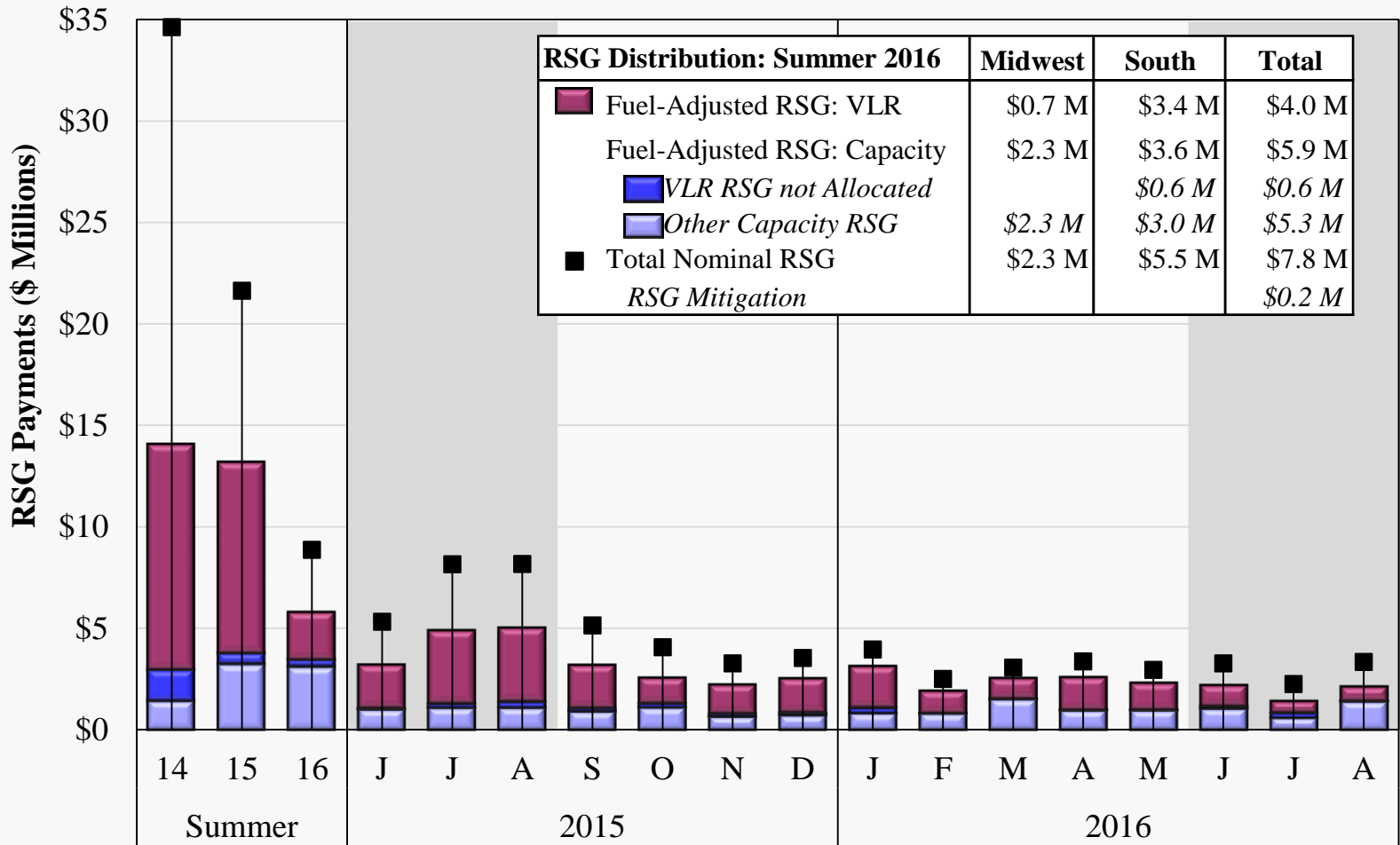


Peaking Resource Dispatch 2015–2016



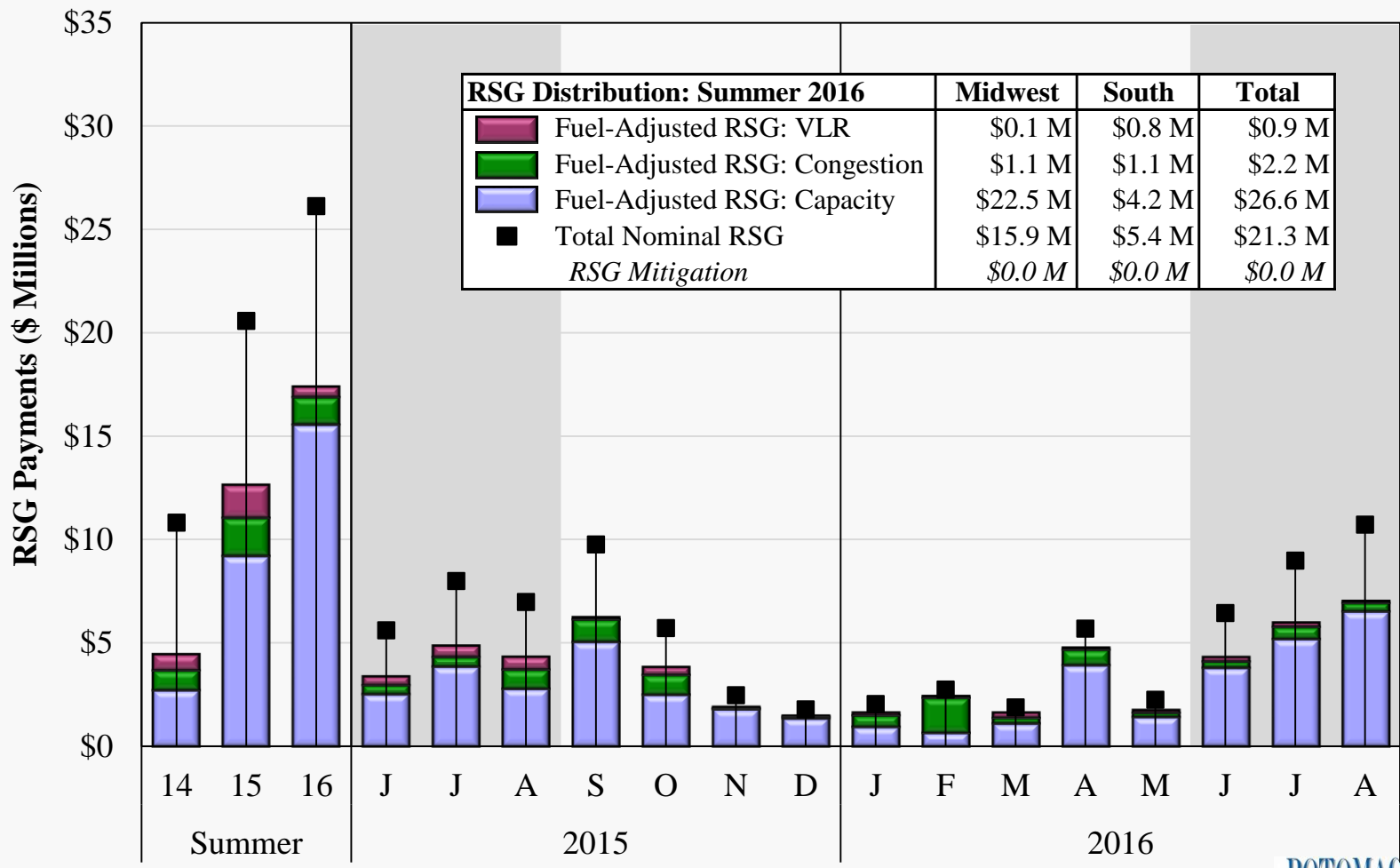


Day-Ahead RSG Payments 2015–2016



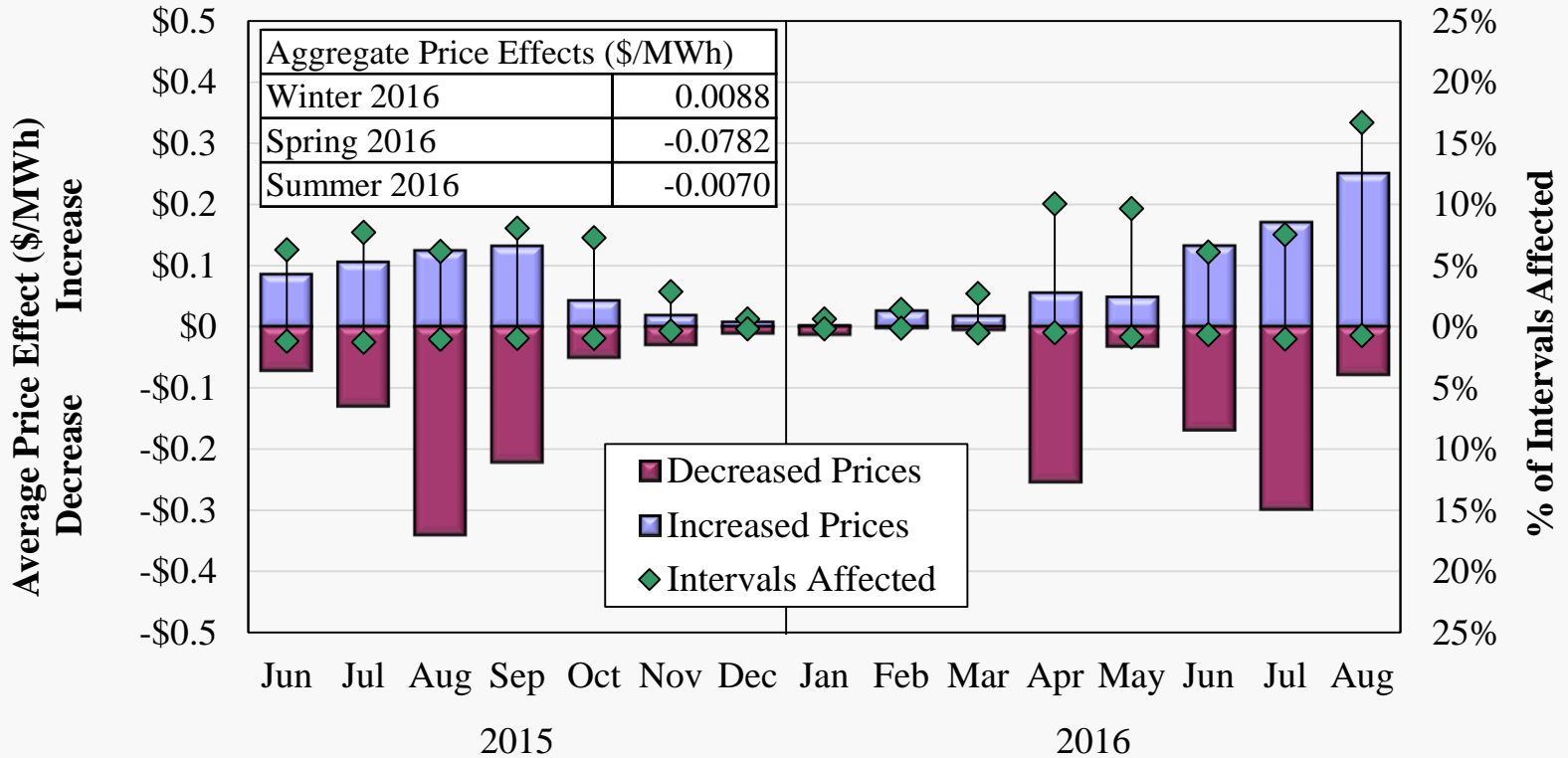


Real-Time RSG Payments 2015–2016





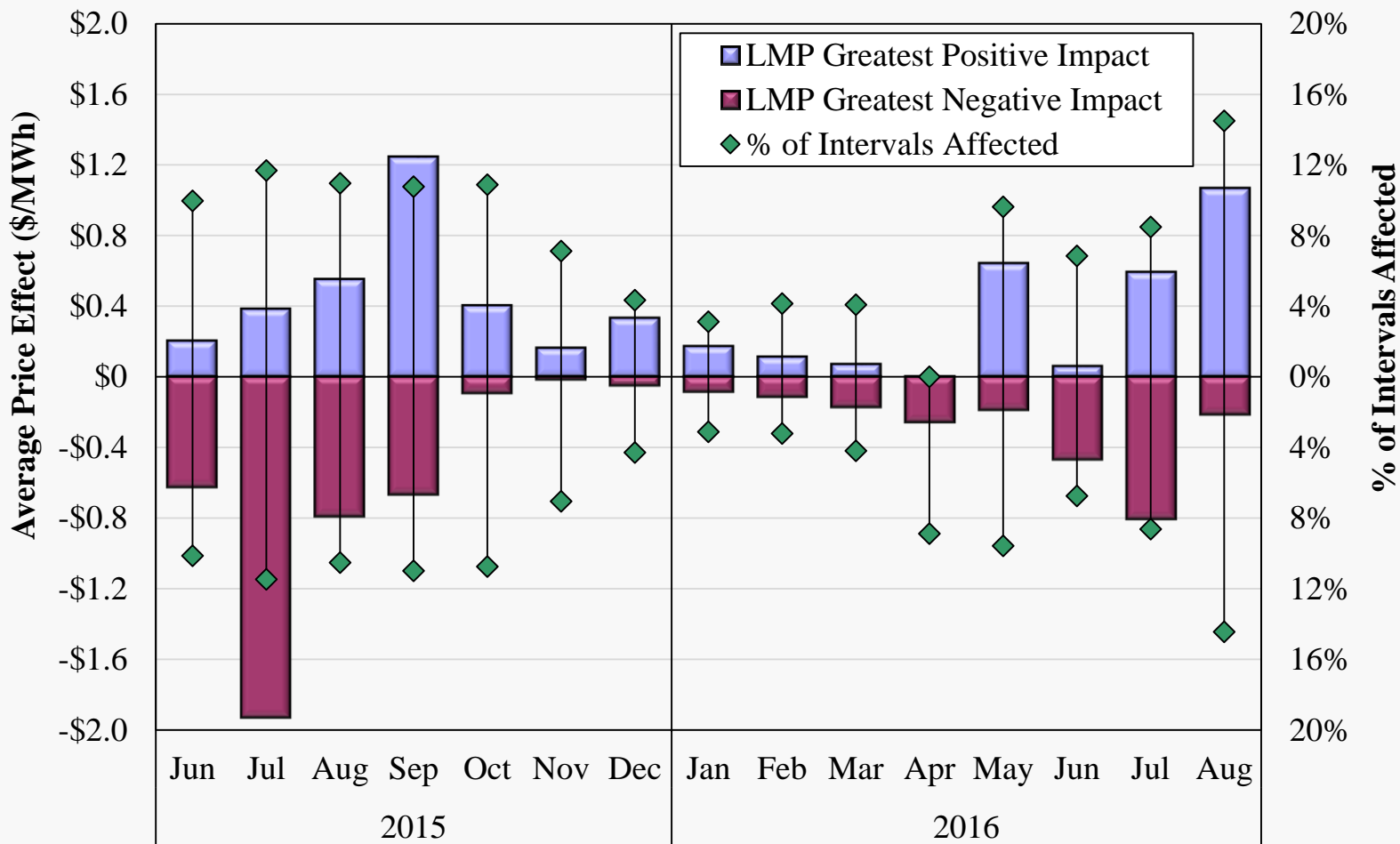
ELMP Price Effects on SMP 2015–2016



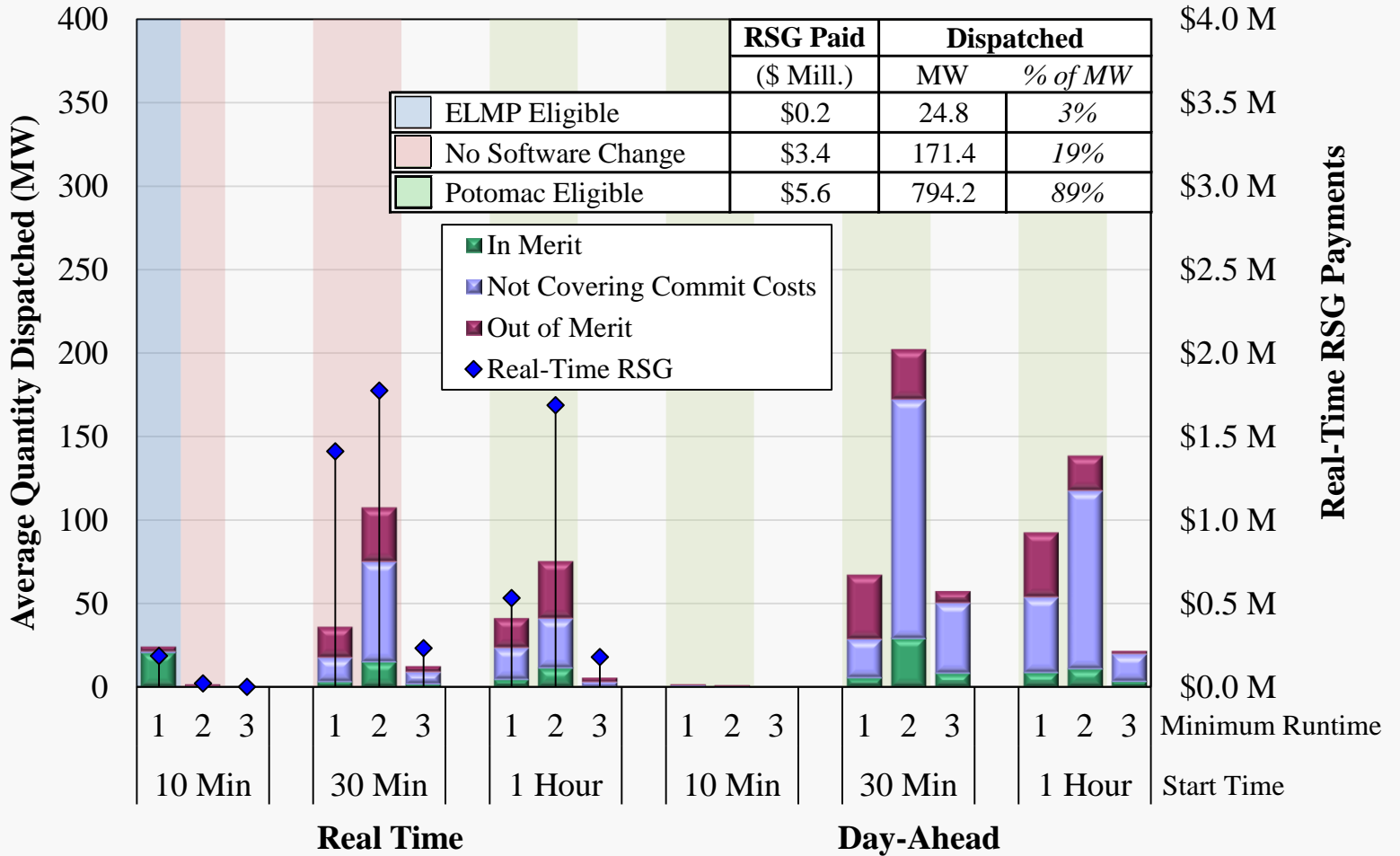
Change in Affected Intervals (\$/MWh)

SMP Increase	1.4	1.4	2.0	1.6	0.6	0.7	1.5	0.5	2.0	0.7	0.6	0.5	2.2	2.3	1.5
SMP Decrease	-6.2	-10.4	-33.5	-23.2	-5.3	-9.0	-7.2	-7.9	-2.3	-1.2	-53.1	-3.9	-26.4	-29.7	-11.3

ELMP Price Effects at Most-Affected Location 2015–2016

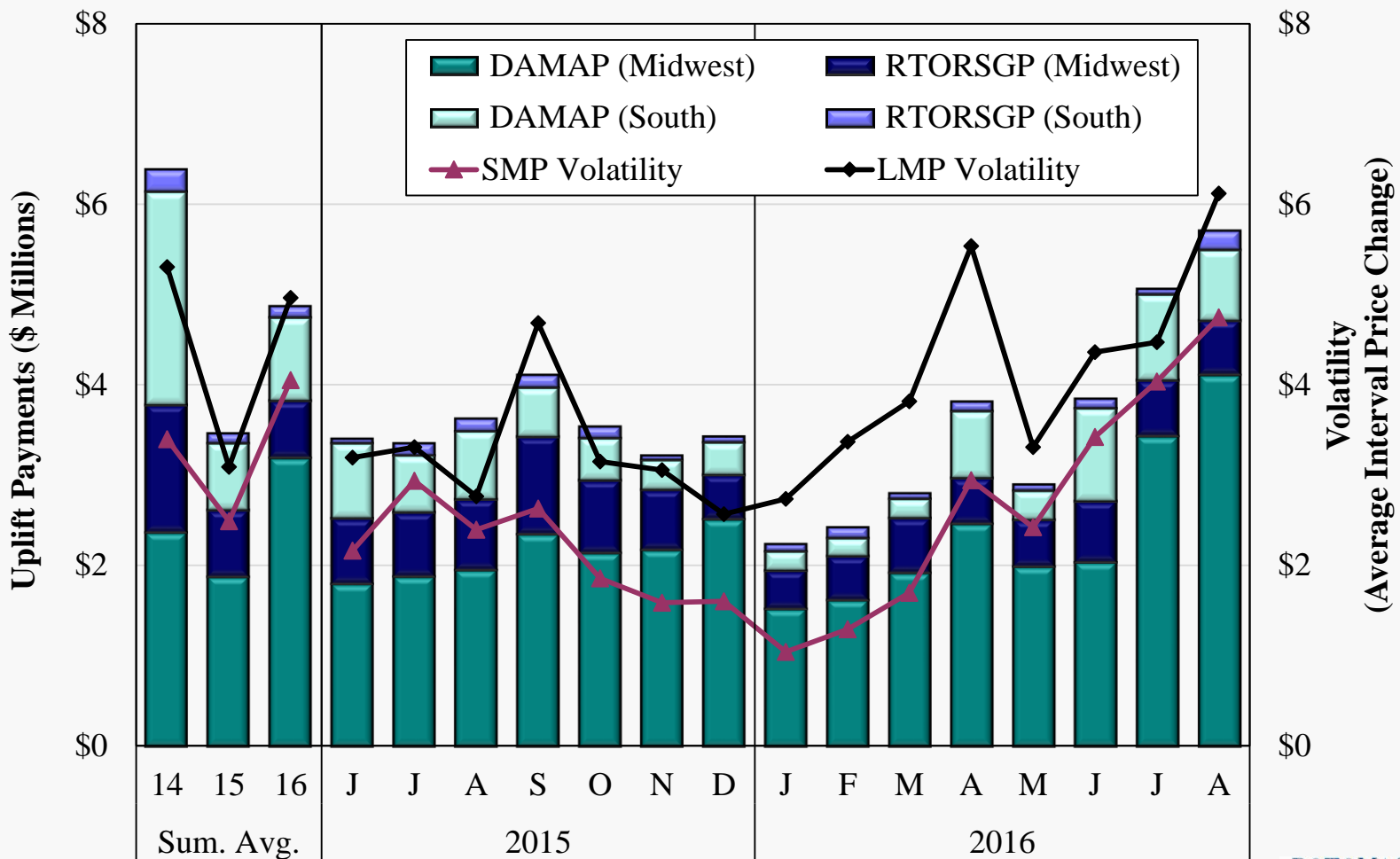


Evaluation of ELMP Eligibility



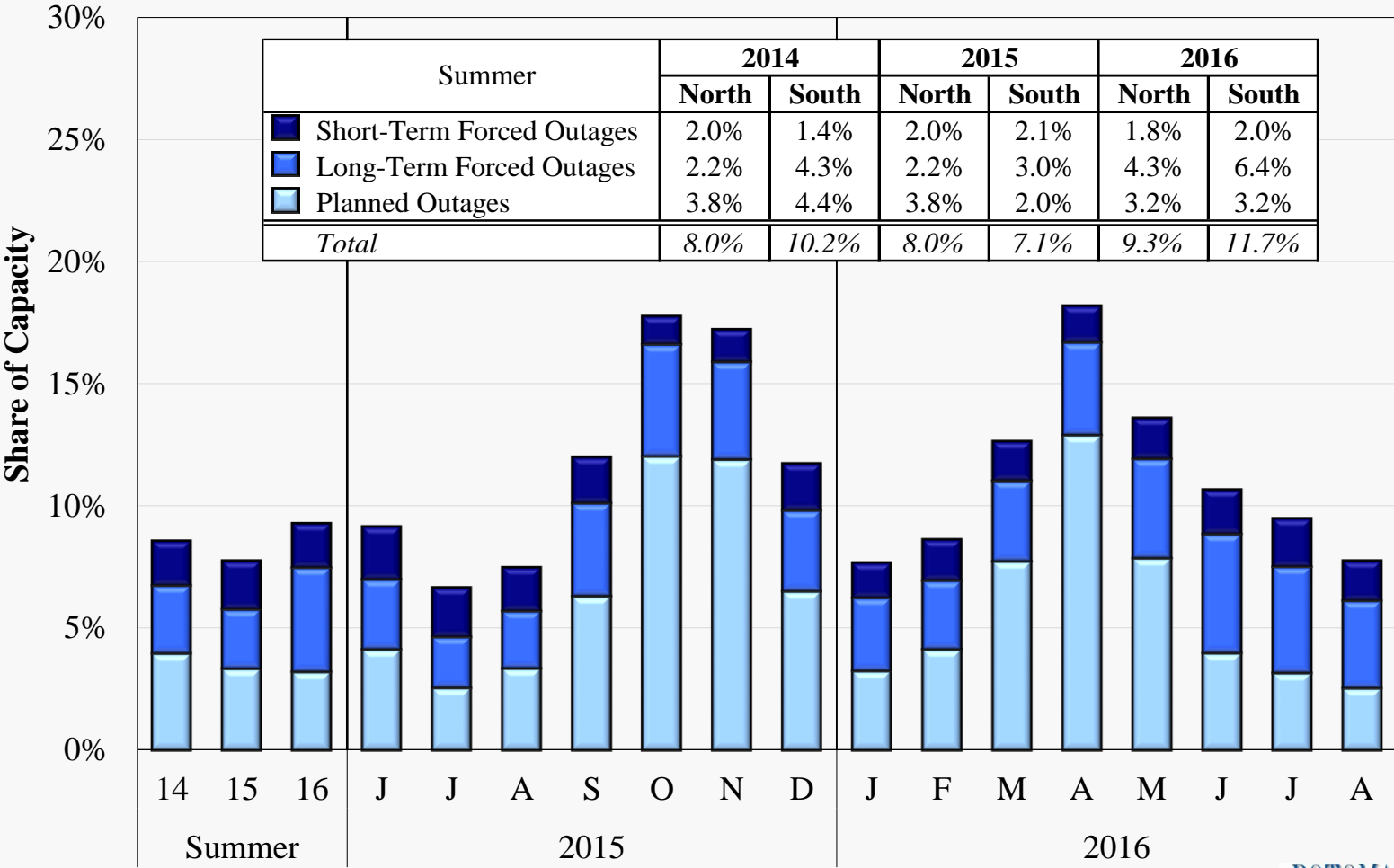


Price Volatility Make Whole Payments 2015–2016



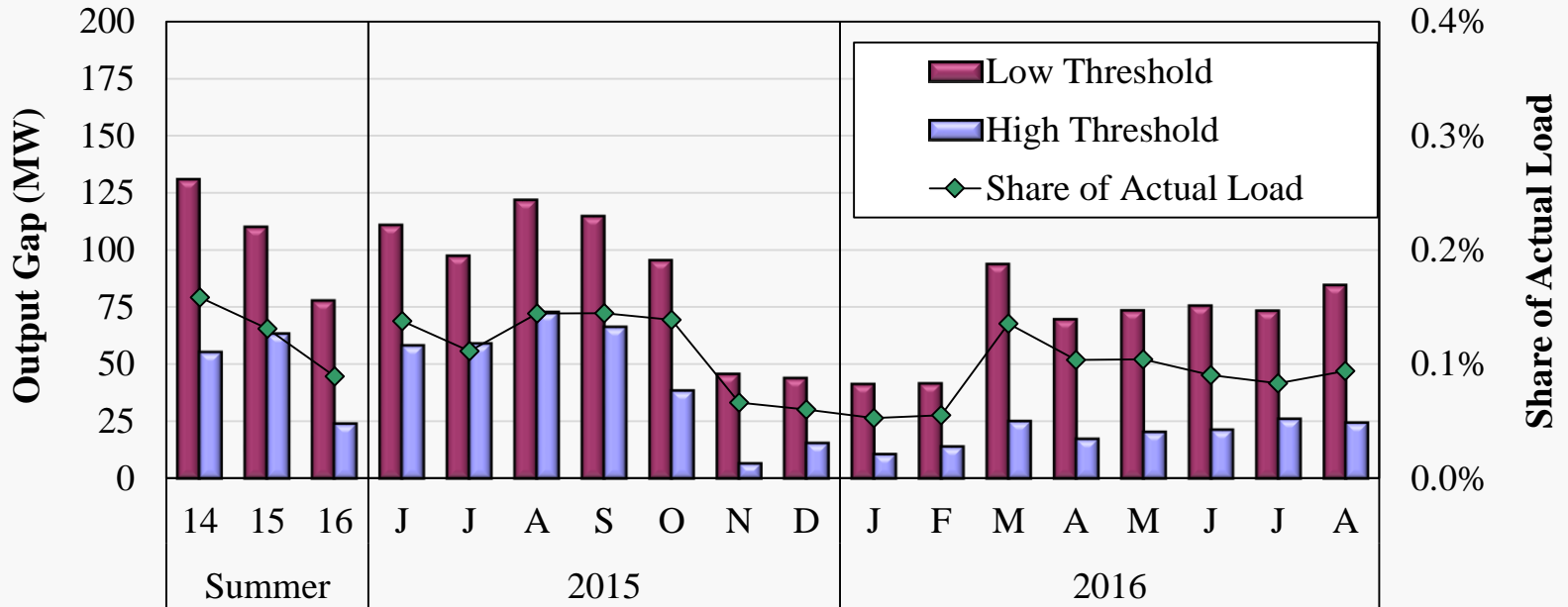


Generation Outage Rates 2015–2016





Monthly Output Gap 2015–2016



High Threshold Results by Unit Status (MW)

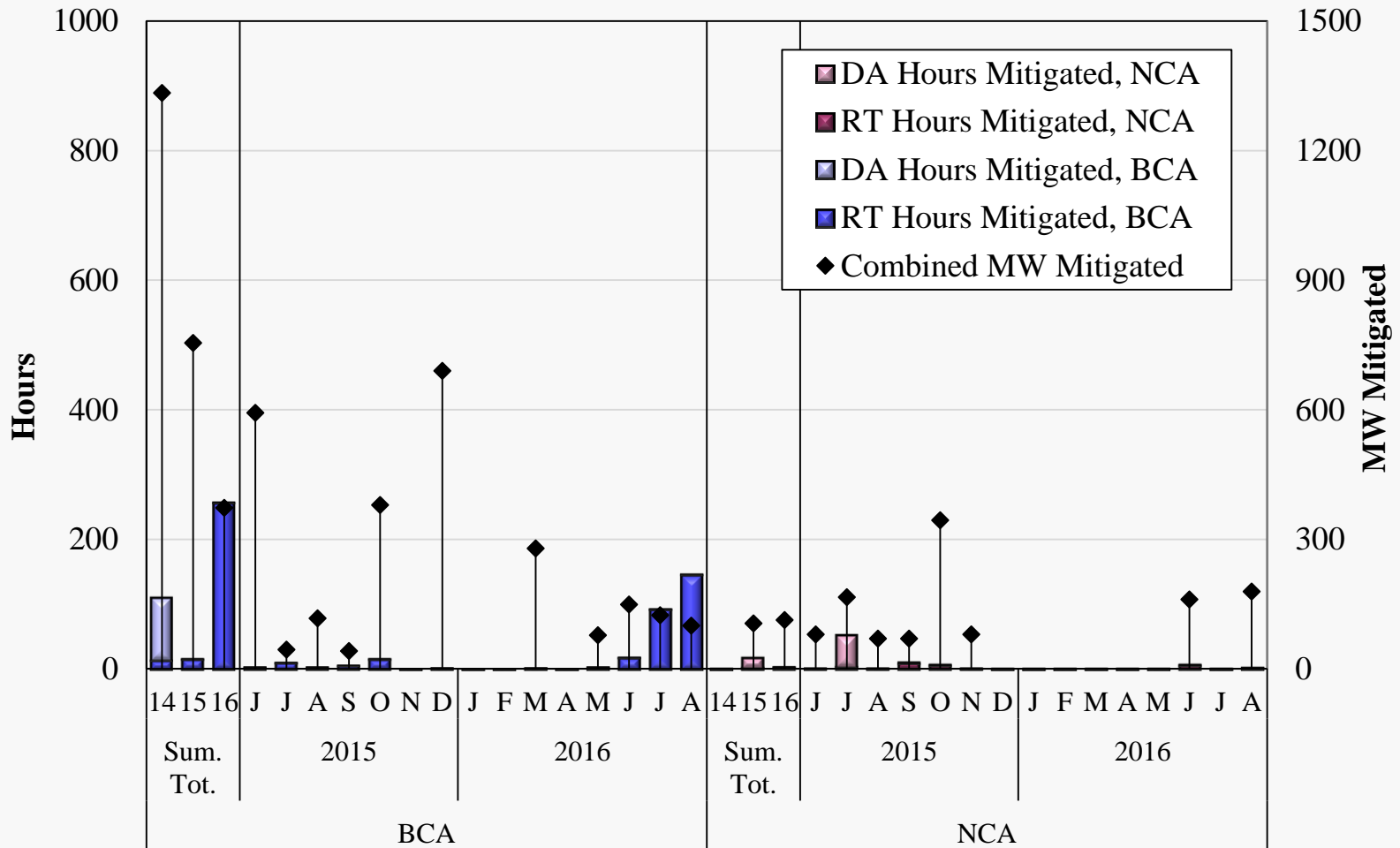
Offline	17	47	9	34	49	58	50	25	0	7	5	10	0	1	0	1	15	11
Online	39	16	15	24	9	14	16	14	6	8	6	5	25	16	20	20	11	14

Low Threshold Results by Unit Status (MW)

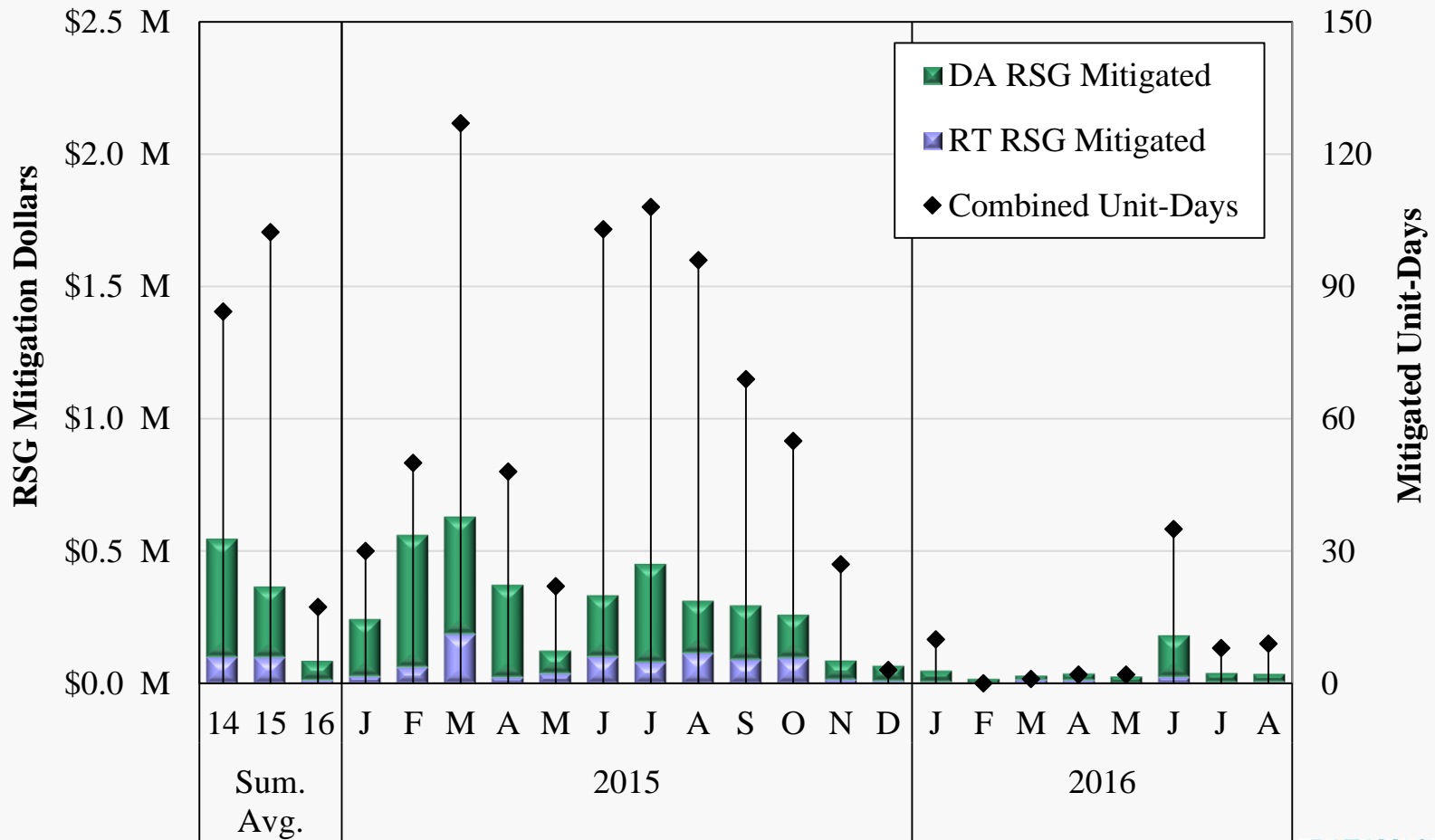
Offline	23	54	10	43	54	66	57	32	0	10	6	11	0	1	0	1	15	13
Online	107	56	68	68	43	56	57	63	45	34	36	31	94	69	73	74	58	72



Day-Ahead And Real-Time Energy Mitigation 2015–2016



Day-Ahead and Real-Time RSG Mitigation 2015–2016





List of Acronyms

- AMP Automated Mitigation Procedures
- BCA Broad Constrained Area
- CDD Cooling Degree Days
- CMC Constraint Management Charge
- DAMAP Day-Ahead Margin Assurance Payment
- DDC Day-Ahead Deviation & Headroom Charge
- DIR Dispatchable Intermittent Resource
- HDD Heating Degree Days
- 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
- ORCA Operations Reliability Coordination Agreement
- 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
- SRPBC Sub-Regional Power Balance Constraint
- TLR Transmission Line Loading Relief
- TCDC Transmission Constraint Demand Curve
- VCA Voluntary Capacity Auction
- VLR Voltage and Local Reliability
- WPP Weekly Procurement Process
- WUMS Wisconsin Upper Michigan System