



IMM Quarterly Report: Spring 2017

MISO Independent Market Monitor

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Highlights and Findings: Spring 2017

- The MISO markets performed competitively this spring.
 - ✓ Natural gas prices increased 57 to 65 percent over last Spring, which led to corresponding increases in real-time energy prices of 37 percent.
 - ✓ Market power mitigation was infrequent and offer conduct was competitive.
- The value of real-time congestion increased more than 50 percent over last winter and the prior spring quarter.
 - ✓ A quarter of real-time congestion was related to planned generation and transmission outages and volatile load in MISO Central.
- Transmission and generation outages and extreme weather in the South led to:
 - ✓ 22 days of Conservative Operations in the load pockets.
 - ✓ 3 days with Maximum Generation Alerts in April.
 - ✓ On April 4, the loss of a large nuclear unit in the South, high load, and transmission and generation outages led to an Emergency Max Gen Event.
- On May 1, MISO initiated ELMP Phase II that allows additional peaking resources to set prices, resulting in modest impacts on RSG and pricing.

Quarterly Summary

		Value	Change ¹			Value	Change ¹	
			Prior Qtr.	Prior Year			Prior Qtr.	Prior Year
RT Energy Prices (\$/MWh)	●	\$29.90	4%	37%	FTR Funding (%)	●	103%	99%
Fuel Prices (\$/MMBtu)					Wind Output (MW/hr)	●	6,506	-6%
Natural Gas - Chicago	●	\$2.94	-10%	57%	Guarantee Payments (\$M)⁴			
Natural Gas - Henry Hub	●	\$3.02	-7%	65%	Real-Time RSG	●	\$16.1	37%
Western Coal	●	\$0.66	-3%	26%	Day-Ahead RSG	●	\$9.9	-27%
Eastern Coal	●	\$1.45	-6%	17%	Day-Ahead Margin Assurance	●	\$13.2	22%
Load (GW)²					Real-Time Offer Rev. Sufficiency	●	\$1.7	30%
Average Load	●	69.5	-8%	1%	Price Convergence⁵			
Peak Load	●	92.9	-9%	-3%	Market-wide DA Premium	●	-2.5%	0.2%
% Scheduled DA (Peak Hour)	●	98.5%	99.0%	99.0%	Virtual Trading			
Transmission Congestion (\$M)					Cleared Quantity (MW/hr)	●	13,465	13%
Real-Time Congestion Value	●	\$467.0	57%	55%	% Price Insensitive	●	27%	30%
Day-Ahead Congestion Revenue	●	\$230.5	55%	44%	% Screened for Review	●	1%	1%
Balancing Congestion Revenue ³	●	\$15.1	-11.4	\$6.3	Profitability (\$/MW)	●	\$1.06	\$0.55
Ancillary Service Prices (\$/MWh)					Dispatch of Peaking Units (MW/hr)	●	874	450
Regulation	●	\$10.83	14%	27%	Output Gap- Low Thresh. (MW/hr)	●	105	92
Spinning Reserves	●	\$3.82	91%	99%	Other:			
Supplemental Reserves	●	\$1.97	167%	240%				

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.



Highlights for Spring 2017

Energy Pricing and ELMP Phase II (Slides 17, 18)

- Real-time energy prices were substantially higher this spring, rising 28 percent in the North and 64 percent in the South from last spring.
 - ✓ Higher natural gas prices were the principle cause of the increase, rising 57 percent in the North and 65 percent in the South from last year.
 - ✓ Tight conditions in the South caused by outages and storms this spring led to larger price increases and congestion in that region.
- Phase II of ELMP was implemented on May 1, 2017.
 - ✓ This expands the portion of MISO's peaking resources that can set real-time energy prices to 15-20 percent of all online peaking resources.
 - ✓ In May, ELMP raised MISO-wide energy prices by roughly \$0.30 per MWh.
 - ✓ Phase I effects were much lower because it allowed less than 5 percent of peaking resources to set prices.
 - ✓ Further expansion is warranted, but will unfortunately require software changes because certain eligibility rules were hard-coded.
 - ✓ Increased energy prices reduced real-time RSG by 10 percent in May.



Highlights for Spring 2017

Transmission Congestion (Slides 14, 15)

- Real-time value congestion increased 52 percent this quarter because of:
 - ✓ Increased natural gas prices – gas-fired units are often marginal when generation must be redispatched to manage network flows.
 - ✓ Planned transmission and generation outages.
 - ✓ Generation and transmission outages and non-conforming loads that contributed to roughly \$50 million in congestion in the Central Region.
- Two MISO constraints that were difficult to manage contributed to more than \$66 million in congestion (a large share of the quarterly increase).
 - ✓ The bulk of controllable flow on these constraints is from PJM resources.
 - ✓ One constraint was affected by suboptimal market-to-market coordination.
 - ✓ PJM wind units account for most of the flow on the other constraint and it would be a candidate for PJM to monitor.
 - ✓ We continue to recommend the RTOs develop a streamlined process for transferring the monitoring of market-to-market constraints.



Highlights for Spring 2017

High Outages in MISO South (Slides 33, 34)

- Outages in MISO South contributed to increases in energy and ASM prices:
 - ✓ A third of all capacity was on outage, which led to tight supply conditions.
 - ✓ Forced outages contributed to high prices at the Texas Hub in March.
 - ✓ Severe weather on multiple days contributed to forced transmission outages and episodes of severe congestion.
 - ✓ On April 1, a Contingency Reserve constraint bound in the South due to generation and transmission outages, resulting in high local ancillary prices.
- We recommend MISO seek expanded authority to approve/coordinate outages (currently limited to a reliability review).
 - ✓ Resources tend to schedule outages in the shoulder months (spring and fall), but this led to multiple declarations of Conservative Operations and Maximum Generation Alerts, Warnings, and Events in MISO.
 - ✓ In winter months, capacity often exceeds load in the South by so much that it becomes “stranded” because of the RDT that limits South-to-North transfers.
 - ✓ Economic opportunities likely exist to shift outages from shoulder to winter months.



Highlights for Spring 2017

Sub-regional Capacity Commitments and Shortages (Slides 18, 30)

- Sub-regional capacity commitments were frequently made to ensure sufficient capacity in MISO South.
 - ✓ These commitments do not correspond to a market requirement so they generate RSG and are generally allocated MISO-wide.
 - ✓ These commitments resulted in \$3.3 million in RSG payments in April.
 - ✓ We recommend that MISO develop an operating reserve product to reflect these requirements and allocate the associated RSG locally.
- The other effect of not having this local operating reserve product is that MISO cannot price sub-regional shortages such as occurred on April 4:
 - ✓ MISO issued a Maximum Generation Event related to an overnight trip of a 1,400 MW nuclear unit, high temperatures and high loads.
 - ✓ At 3 pm, MISO implemented LMR/LMM Stage 1 – the first LMR implementation in MISO South – and > 700 MW responded by 9 pm.
 - ✓ MISO's emergency pricing allowed its emergency resources to set prices for one interval.



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 made one new referral of a supplier associated with an unreported derate.
 - ✓ We responded to several data requests related to prior referrals.
 - ✓ We updated the NCA Conduct and Impact Thresholds and made related informational postings and an informational Filing with FERC.
- We worked with MISO staff on the procedures and draft tariff language for implementing our Dynamic NCA recommendation and presented the proposal to MISO stakeholders at the MSC in April and June.
- We participated in a number of other MISO stakeholder meetings including the MISO JOA meetings with PJM and SPP, as well as the MISO RASC.
- We also presented a number proposals for the MISO PRA related to our SOM recommendations to the RASC and the LOLEWG.
 - ✓ The changes will enhance both efficiency and reliability by bringing PRA modeling and results in line with how MISO actually operates in real-time.
- In May, we presented a summary of MISO South market results to the ERSC.

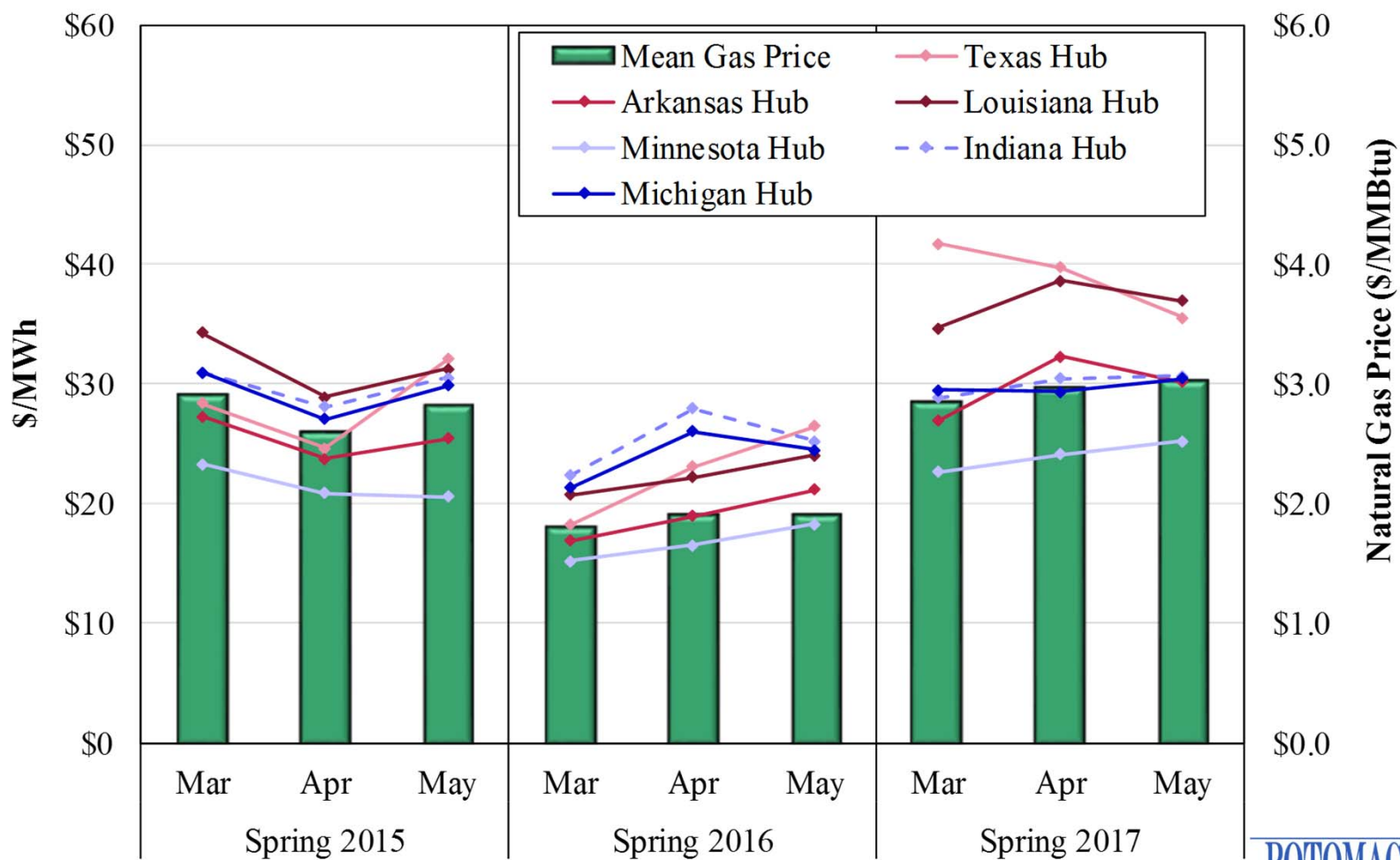


Submittals to External Entities and Other Issues: Psuedo Tie Update

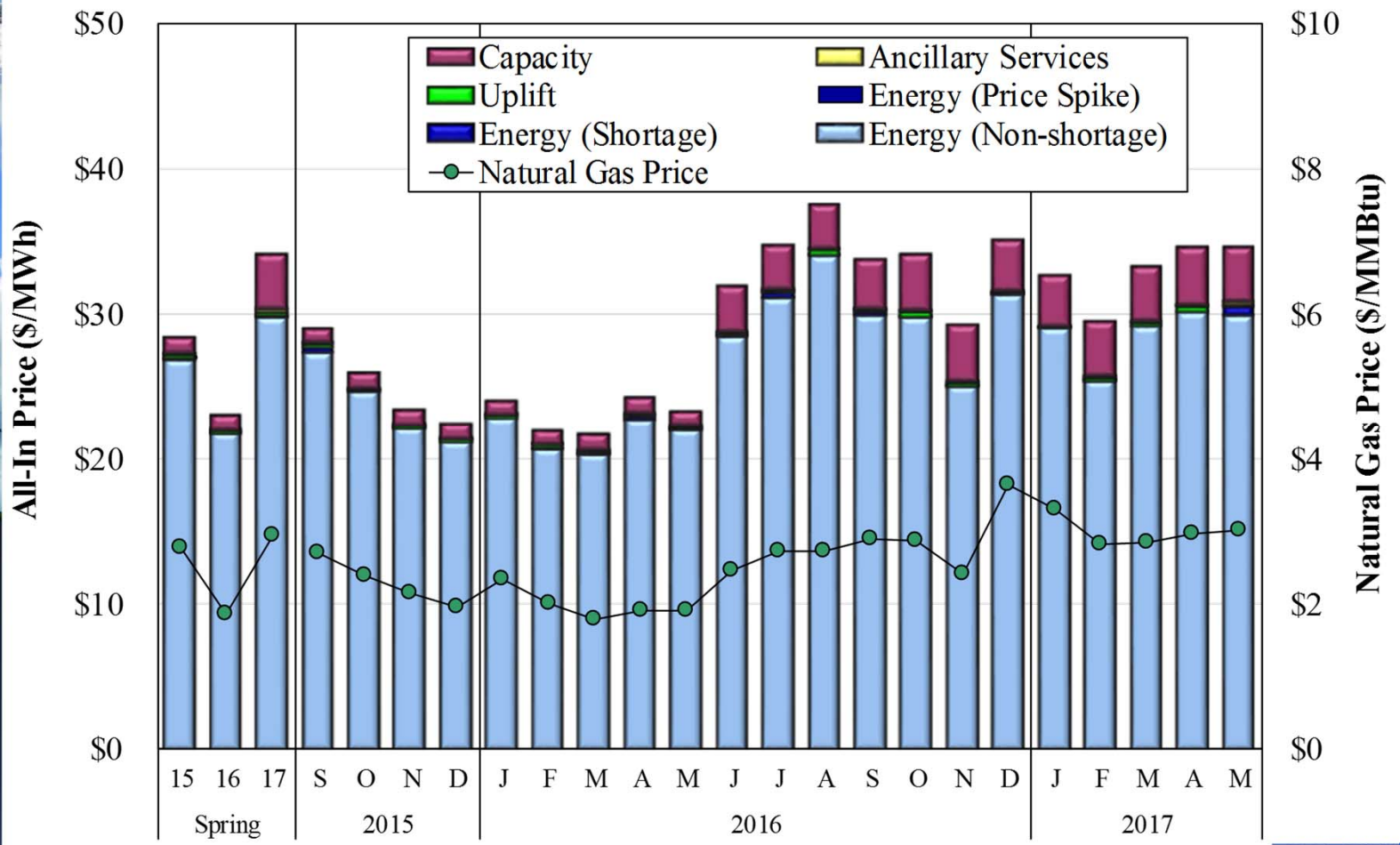
- Both MISO and PJM made 205 filings to add criteria for accepting pseudo-ties.
 - ✓ MISO's changes addressed specific reliability concerns that we have observed.
 - ✓ In its 205, PJM made added new qualification criteria and restrictions needed to address unintended negative impacts of pseudo ties on PJM.
 - ✓ We have consistently raised concerns about these impacts of pseudo ties.
- We filed comments on PJM's proposed restrictions that would make pseudo-ties in the future nearly impossible and will likely phase out existing pseudo ties.
 - ✓ While this would reduce the adverse effects of the pseudo ties, it erects barriers that will prevent efficient capacity trading between the RTOs.
 - ✓ It trades one problem (in the energy market) for another (in the capacity market).
- Only real solution: eliminate the requirement for resources to pseudo tie to PJM.
 - ✓ Hence, we a filed a 206 complaint against PJM's Tariff to eliminate the requirement that external capacity suppliers pseudo-tie their resources to PJM.
 - ✓ The filing was strongly supported the New York ISO, OMS, and a number of generators currently pseudo-tying under this requirement.
 - ✓ MISO did not support our complaint, but has filed comments asking for a Technical Conference in the 205 dockets to address the pseudo-tie issues.



Day-Ahead Average Monthly Hub Prices Spring 2015–2017

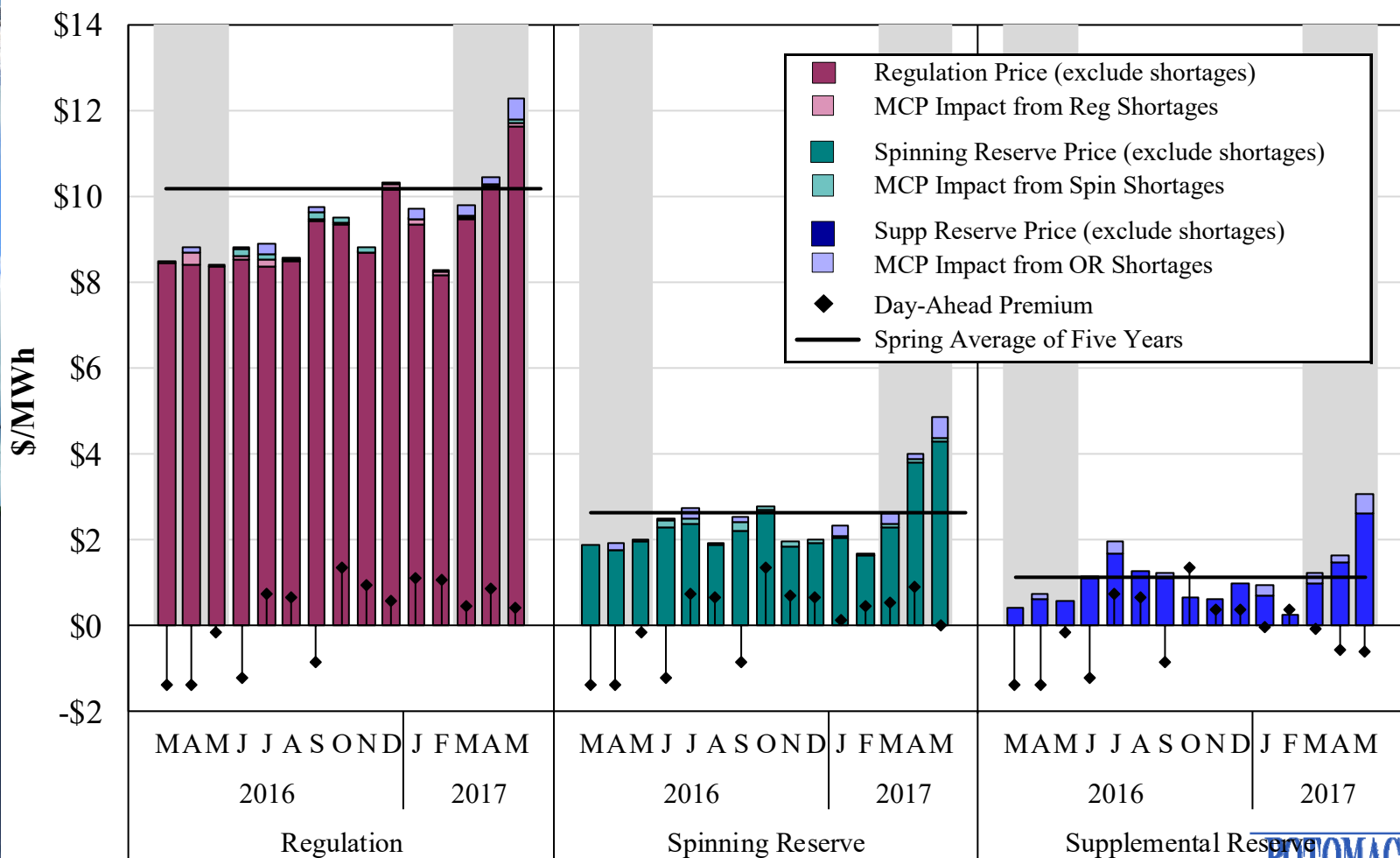


All-In Price Spring 2015 –2017



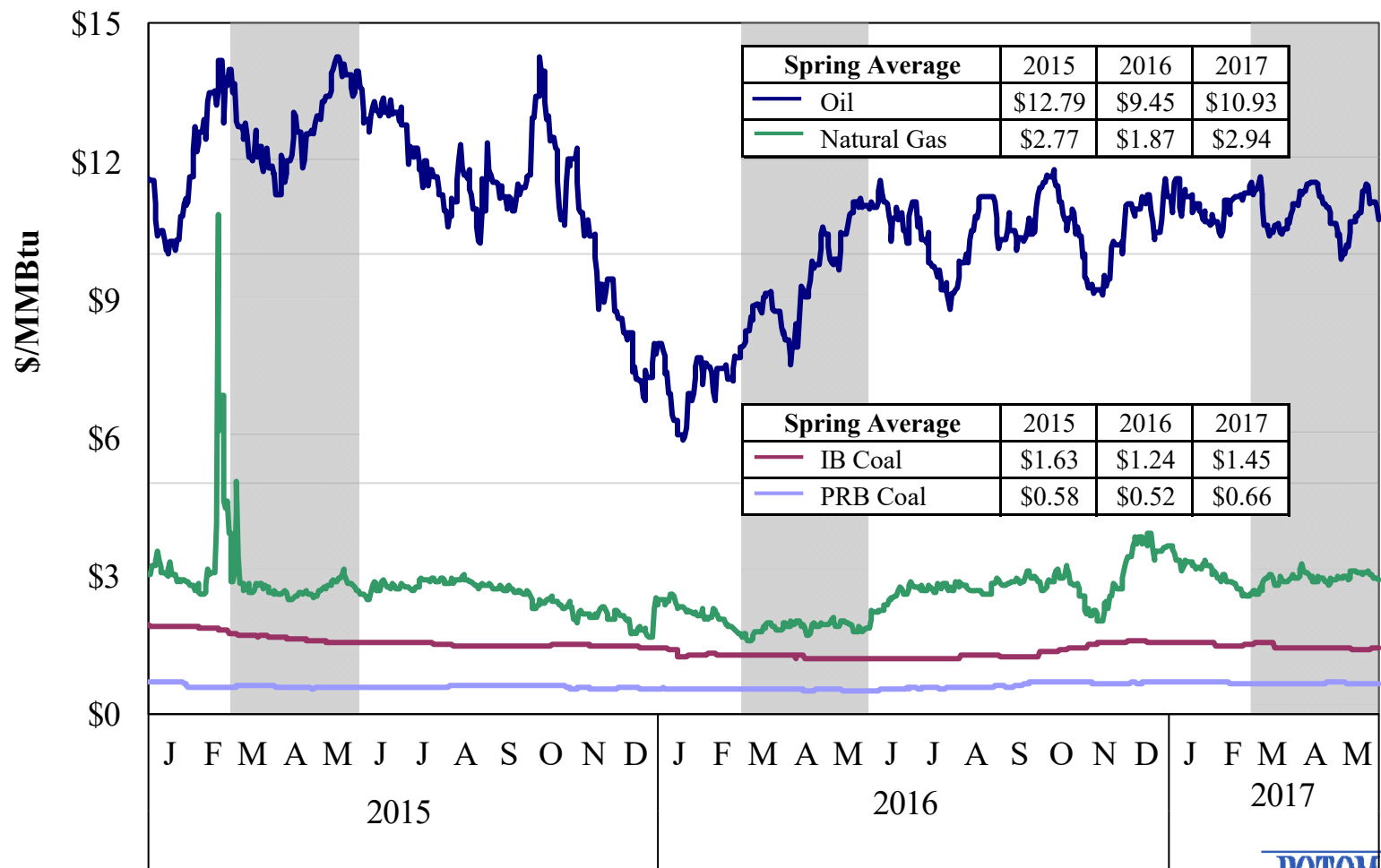


Monthly Average Ancillary Service Prices Spring 2016 –2017



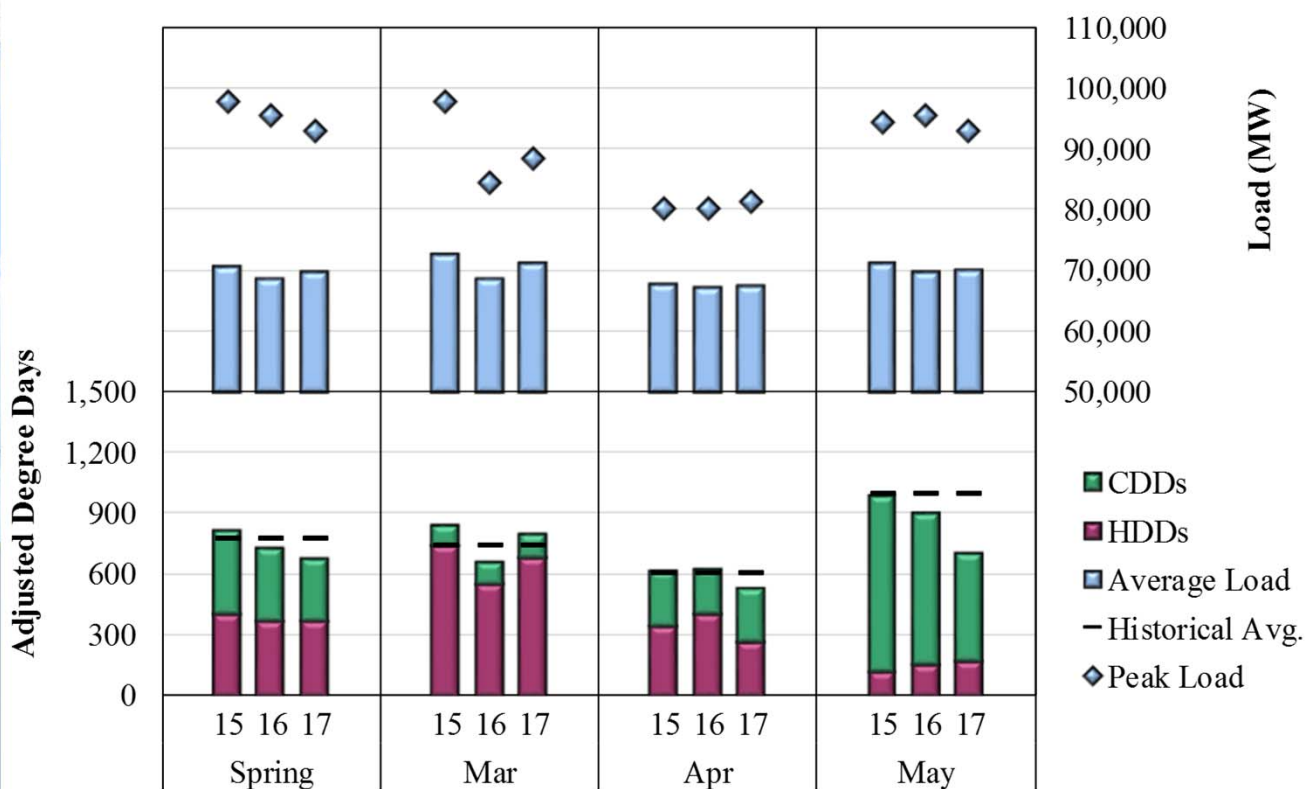


MISO Fuel Prices 2015–2017





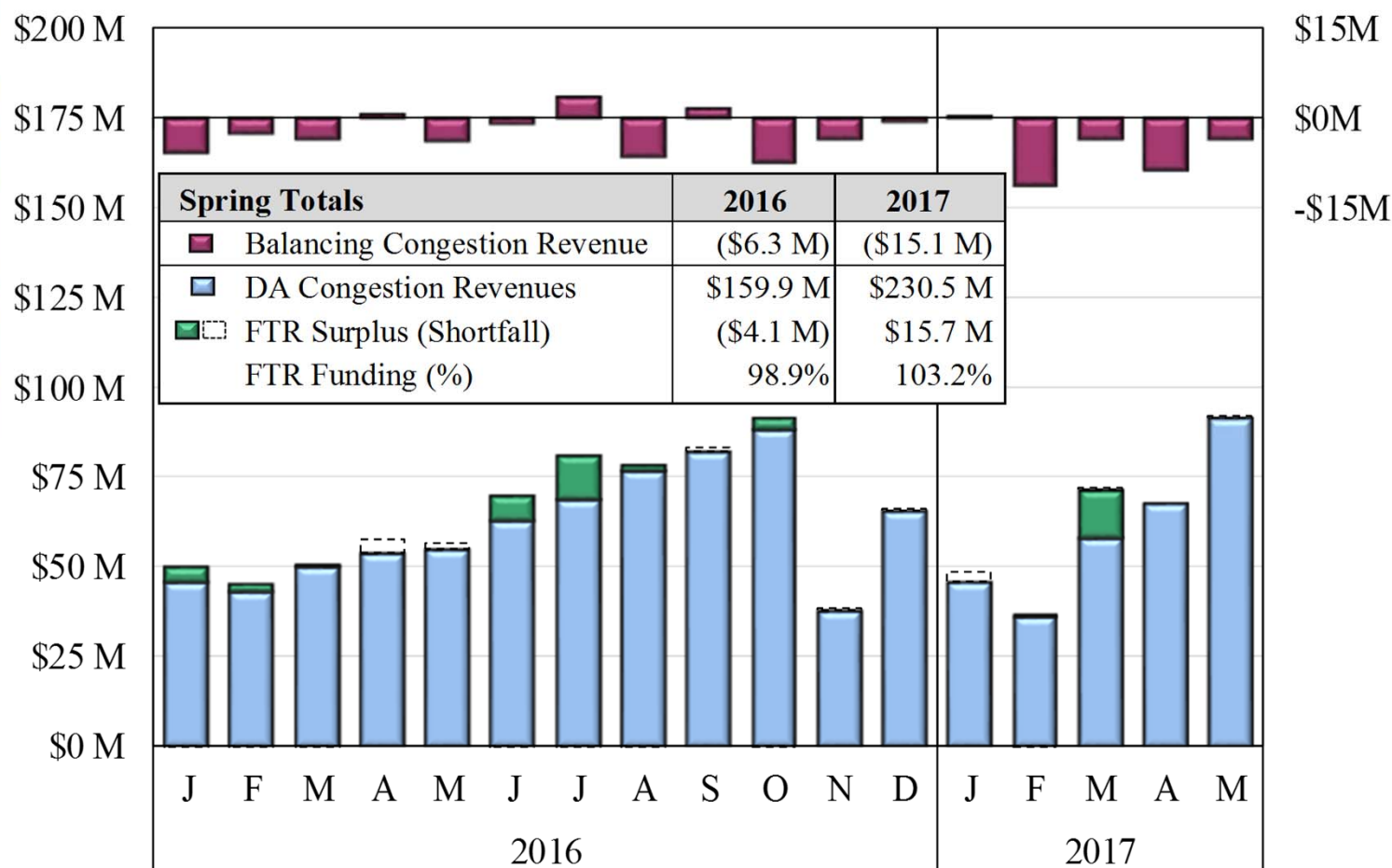
Load and Weather Patterns Spring 2015–2017



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.

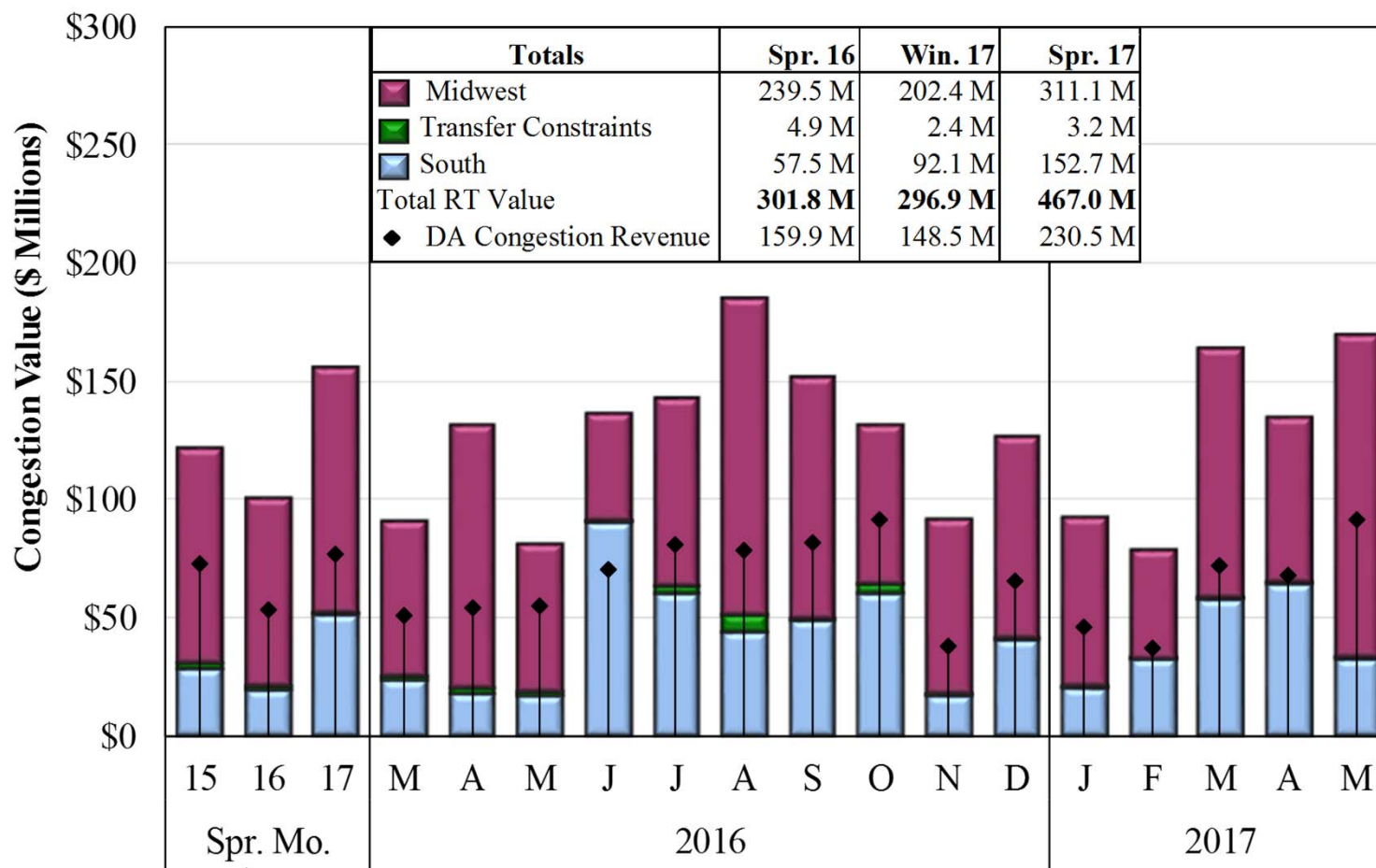


Day-Ahead Congestion, Balancing Congestion and FTR Underfunding, 2016–2017

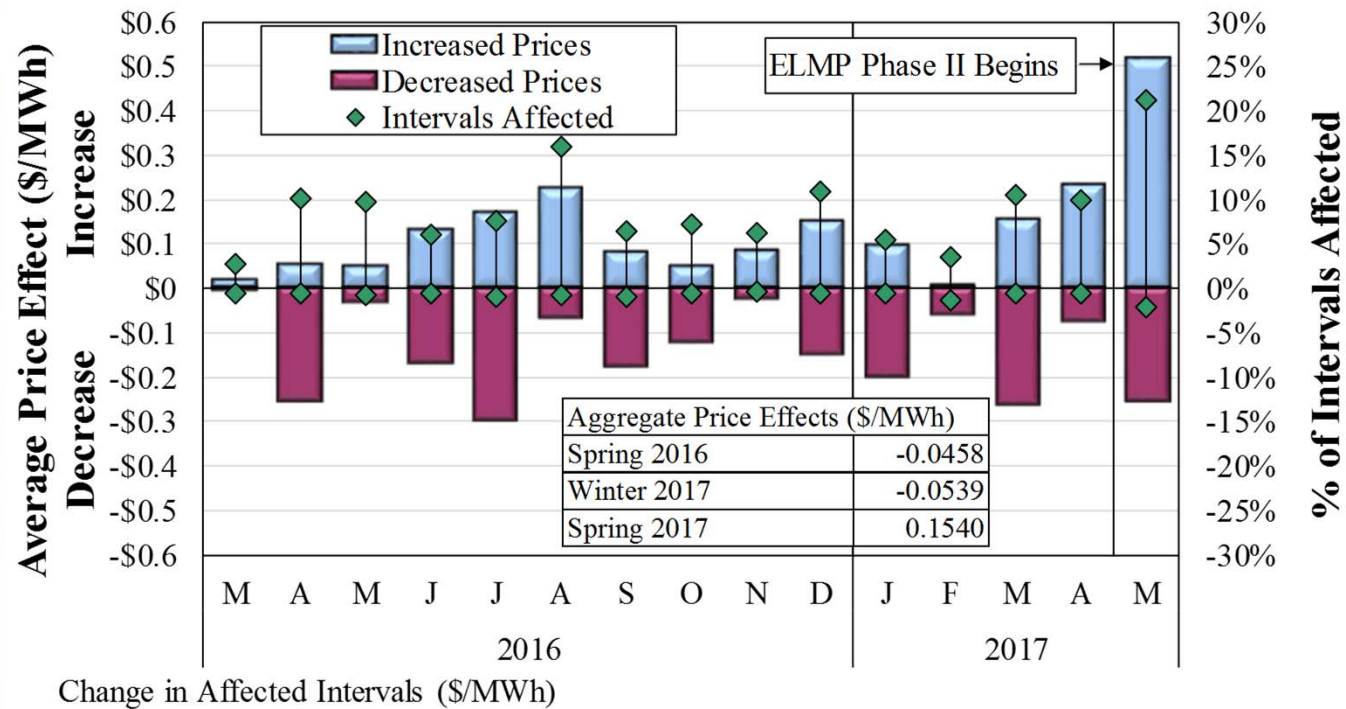




Value of Real-Time Congestion Spring 2016–2017

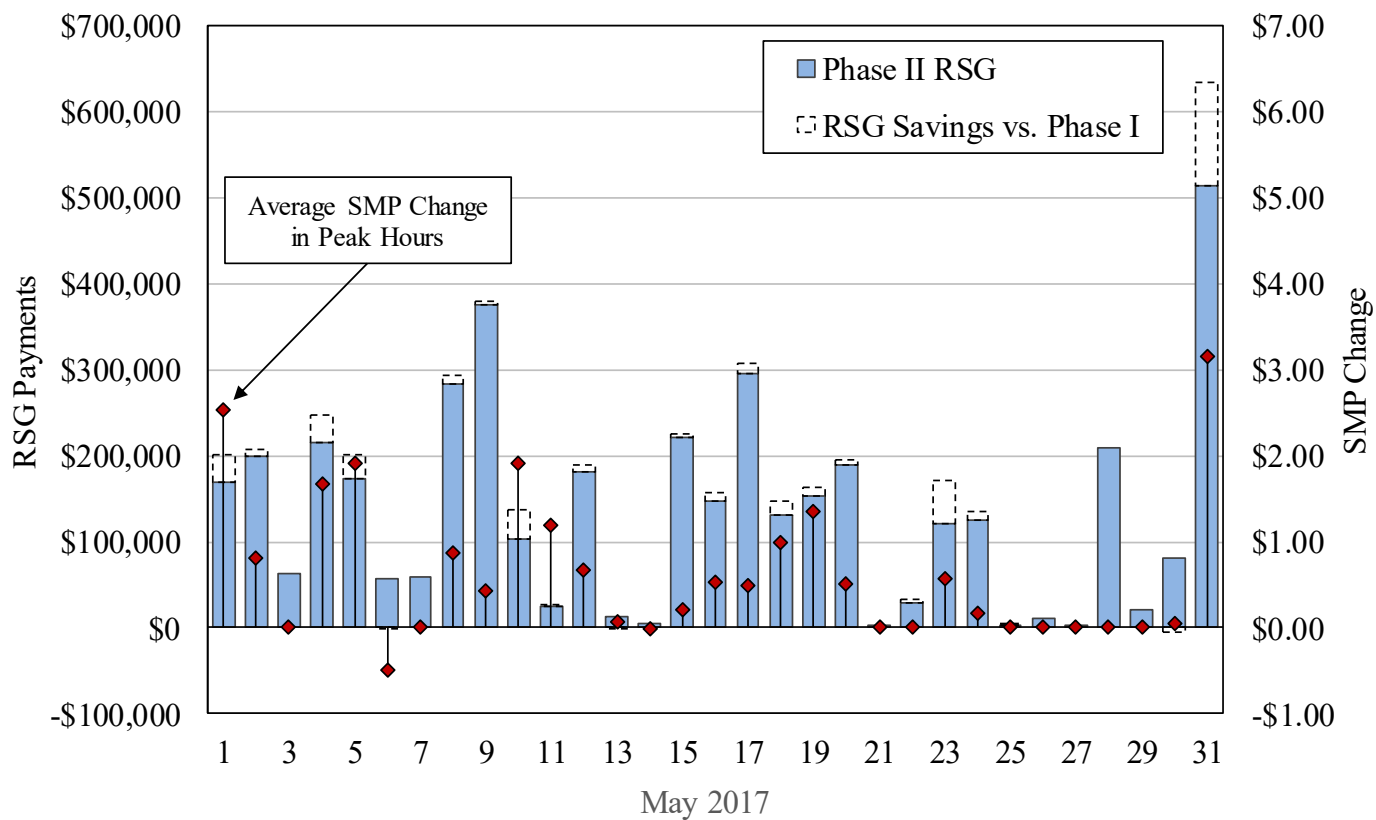


ELMP SMP Impacts 2016 – 2017



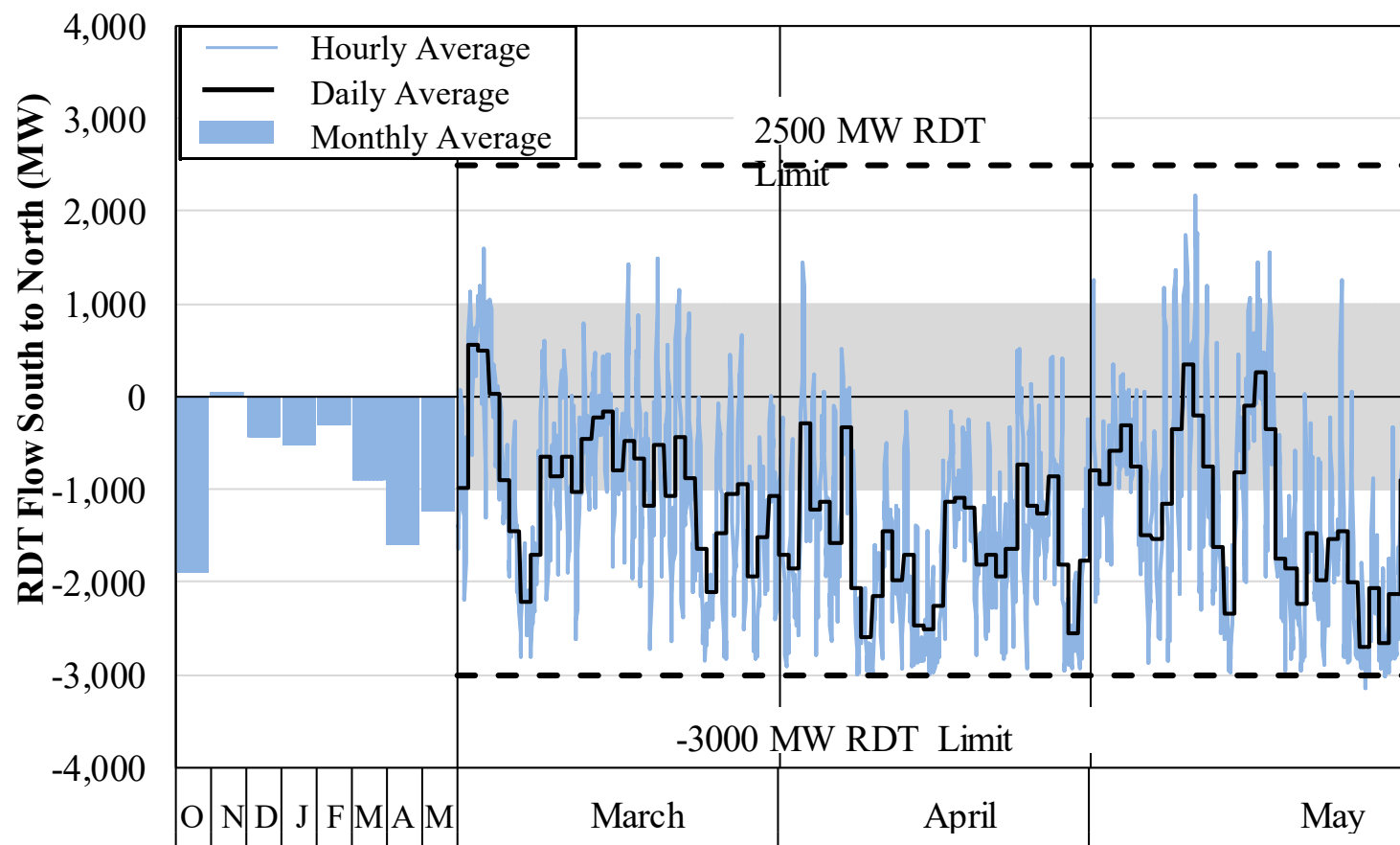


ELMP Phase II RSG Impacts May 2017



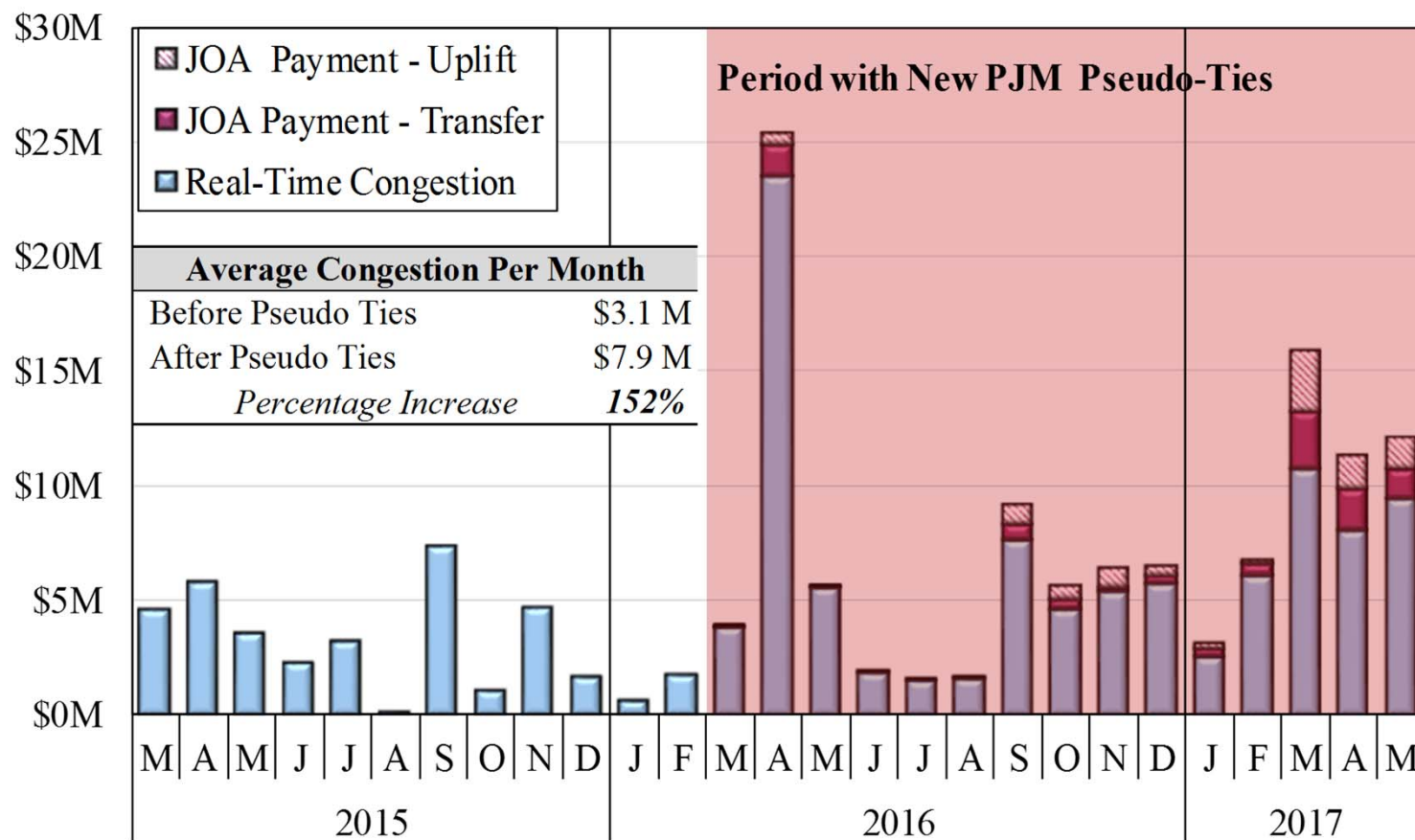


Real-Time Hourly Inter-Regional Flows 2016 - 2017



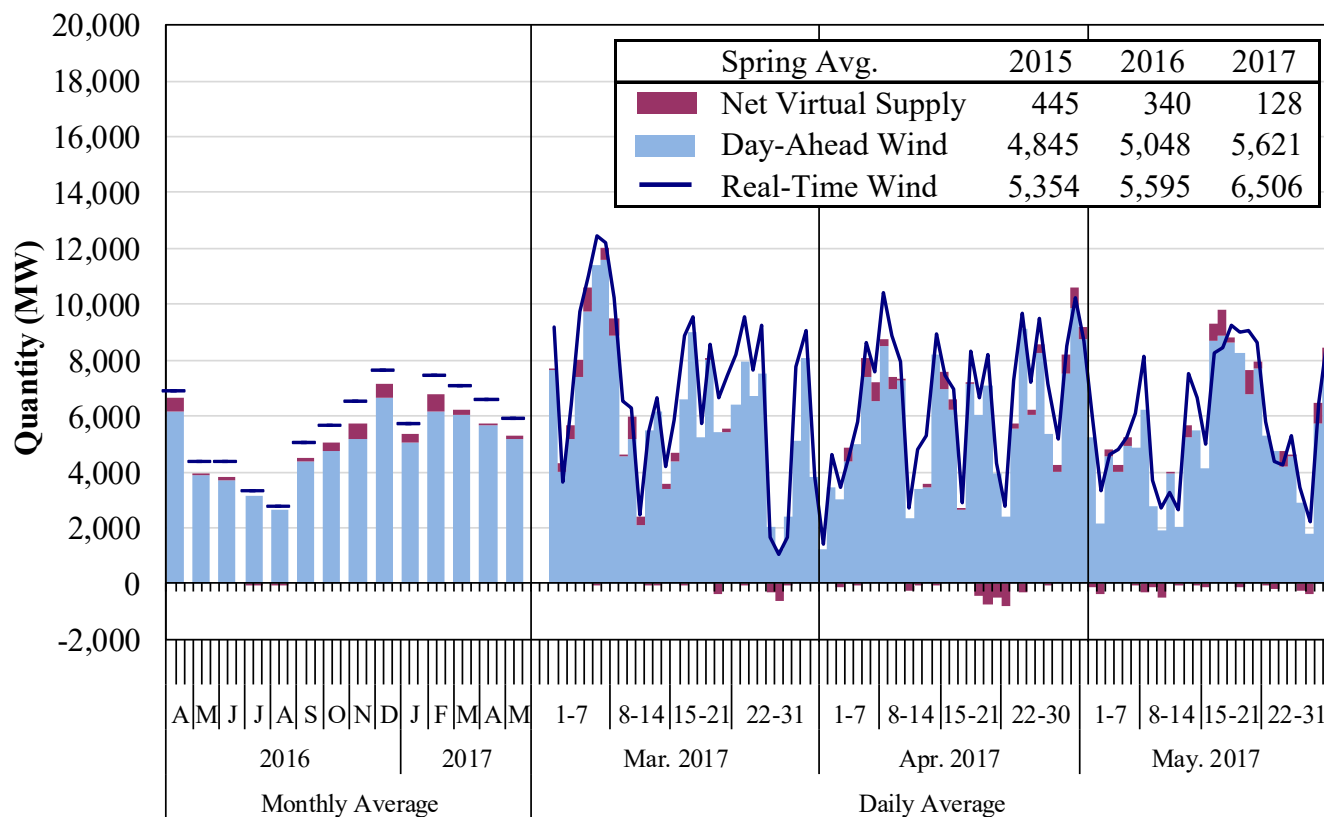


MISO Congestion Value and JOA Settlement Constraints Impacted by Pseudo-Ties



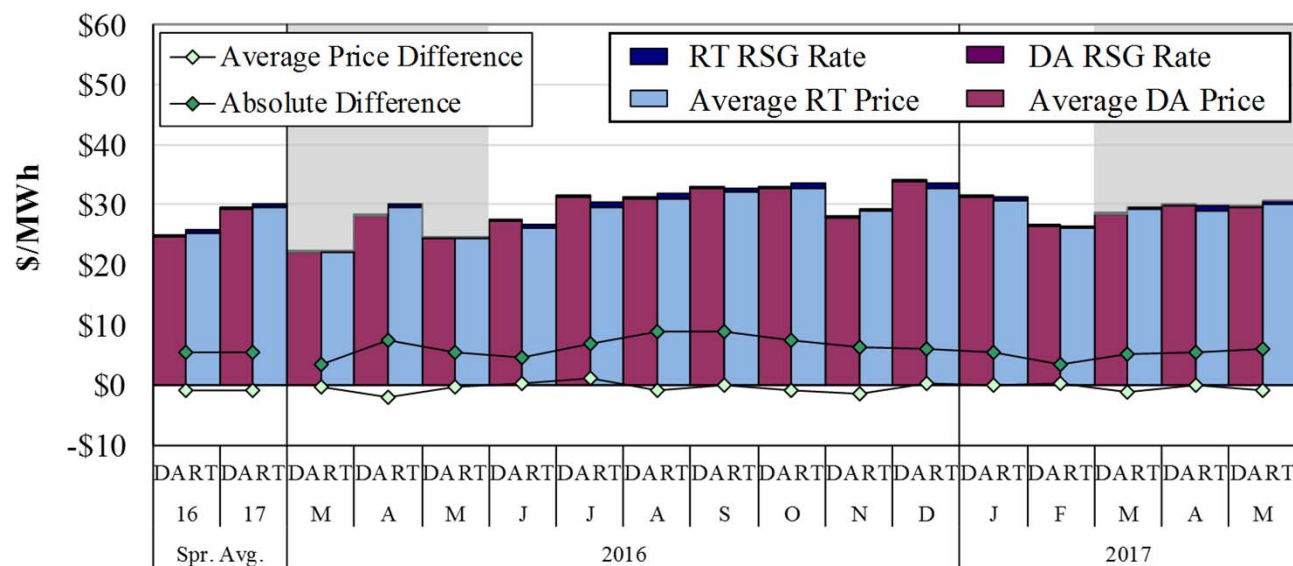


Wind Output in Real-Time and Day-Ahead Markets Monthly and Daily Average





Day-Ahead and Real-Time Price Convergence Spring 2016–2017



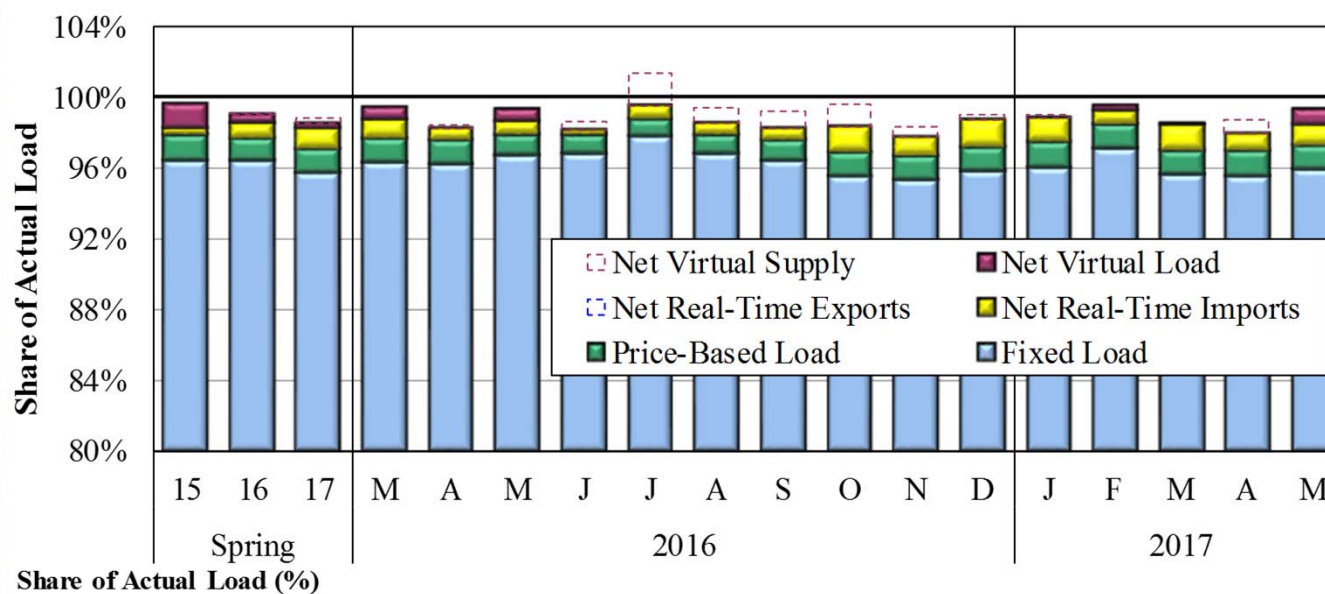
Average DA-RT Price Difference Including RSG (% of Real-Time Price)

Indiana Hub	-3	-2	-1	-7	-1	1	3	-2	0	-2	-5	1	0	1	-4	0	-3
Michigan Hub	-1	-3	-1	-6	4	0	5	-9	-2	4	-1	2	1	1	-6	-1	-1
Minnesota Hub	2	-2	-3	2	6	-5	0	-6	-2	-2	2	-6	3	3	-1	-5	1
WUMS Area	0	2	0	0	1	-3	-5	-7	1	4	1	-6	-1	-2	3	-1	3
Arkansas Hub	0	-1	-3	-3	7	4	-1	0	-3	-2	-6	0	1	3	-3	0	2
Texas Hub	-1	1	3	-18	13	2	-3	1	2	3	-1	2	-2	3	-2	3	4
Louisiana Hub	0	-9	-2	2	1	-14	-1	-4	-3	1	0	1	1	-2*	2	-4	3

* Excluding Feb 7, 2017.

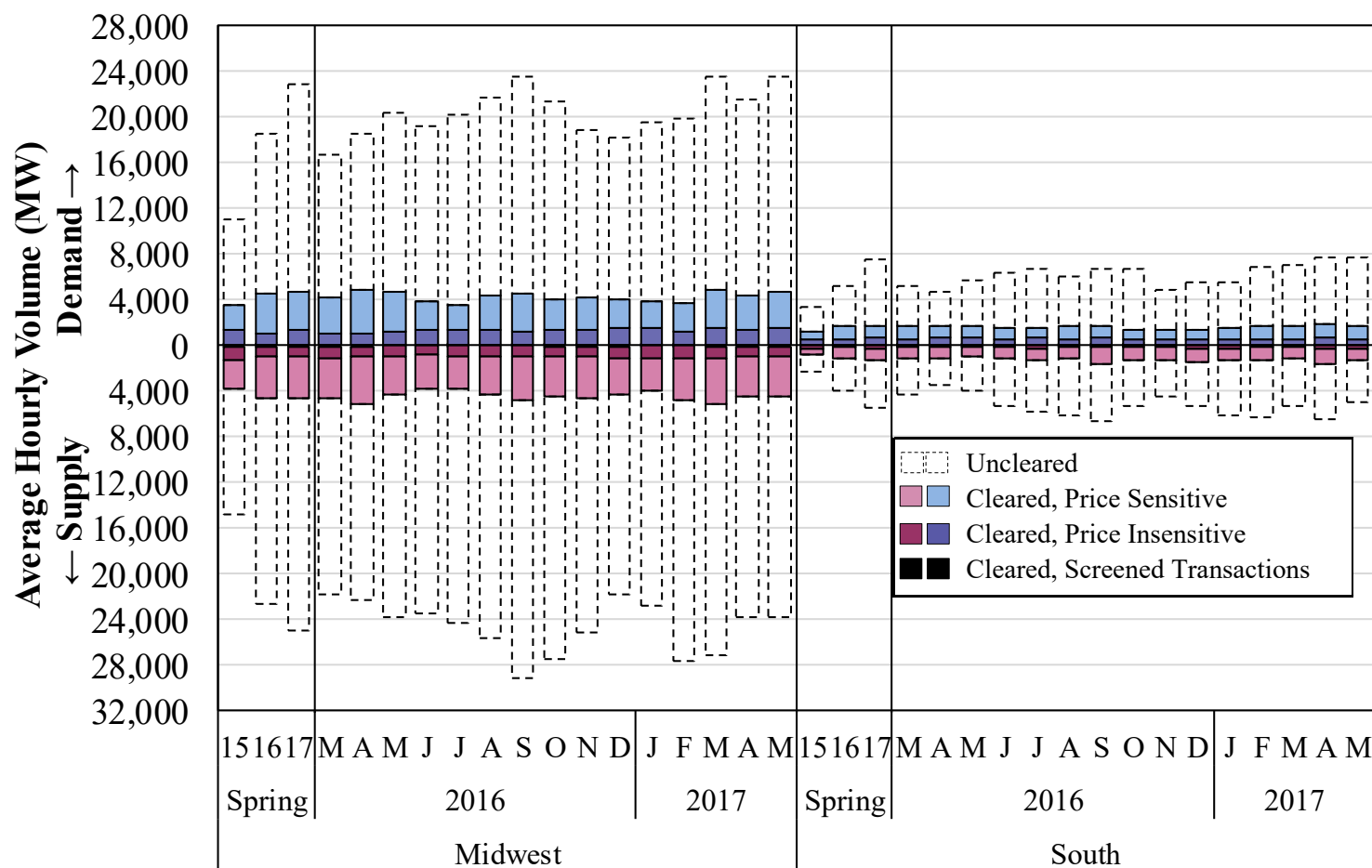


Day-Ahead Peak Hour Load Scheduling Spring 2016–2017



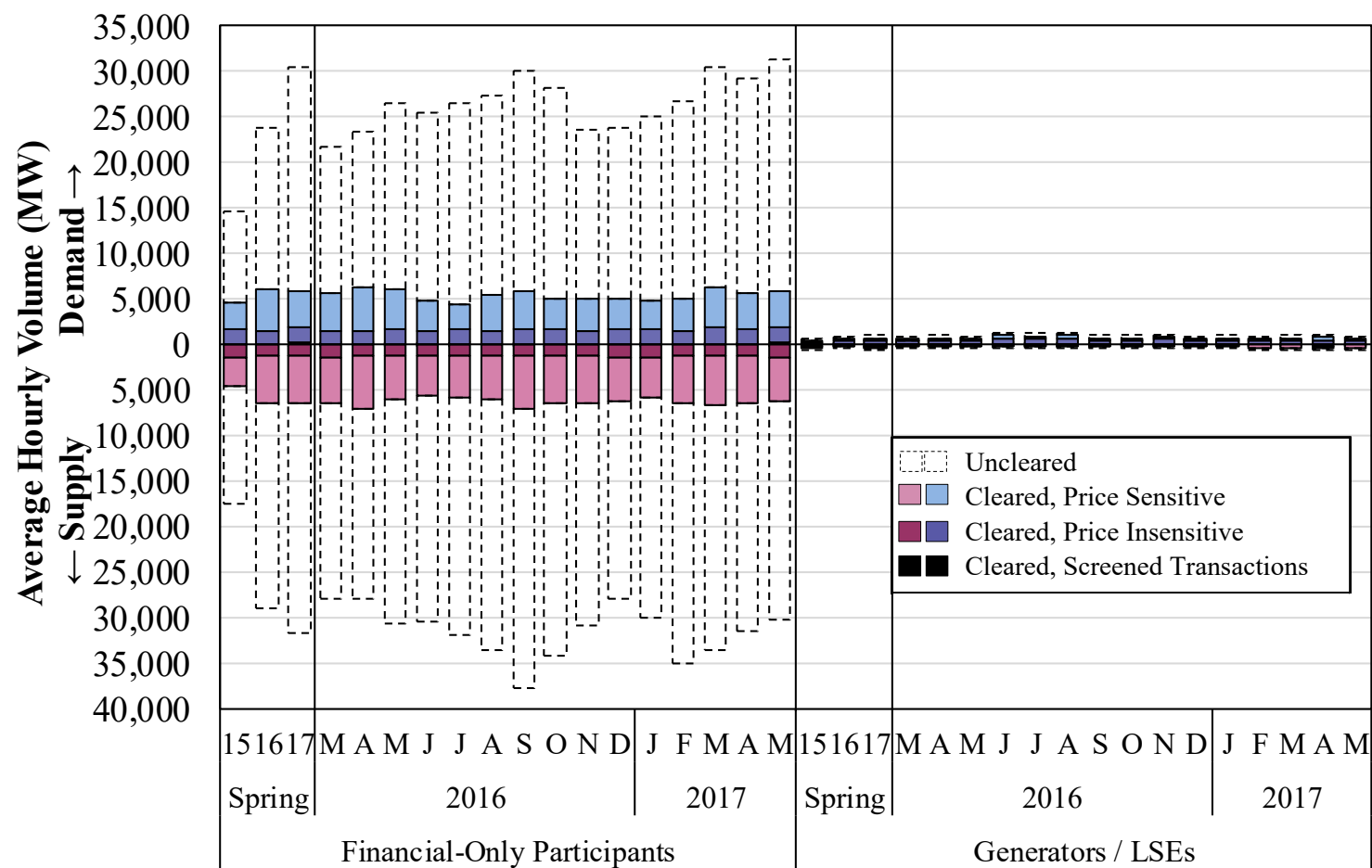
All Hours	99.1	98.9	99.0	98.3	98.7	99.6	98.6	100.1	99.4	98.3	98.5	97.8	98.9	99.2	98.7	99.1	98.5	99.5
Peak Hours Midwest	99.2	98.5	97.5	99.4	97.5	98.6	97.2	98.8	97.7	97.6	97.6	98.0	97.8	98.0	98.3	97.5	97.0	98.1
Peak Hours South	101.9	100.7	101.9	99.7	100.6	101.8	101.5	101.8	101.3	99.6	100.6	99.3	103.1	103.1	106.4	102.9	100.3	102.5

Virtual Load and Supply Spring 2016–2017



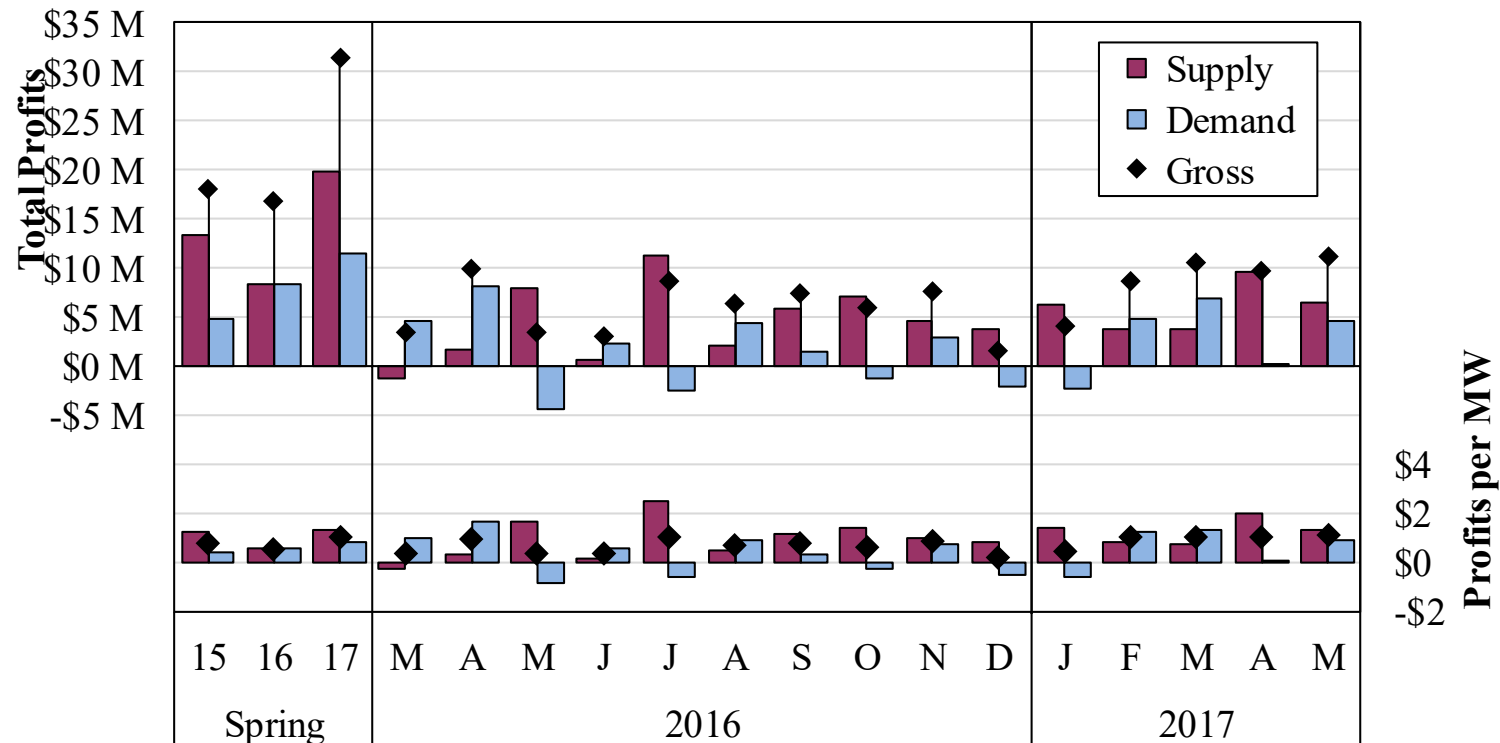


Virtual Load and Supply by Participant Type Spring 2016–2017





Virtual Profitability Spring 2016–2017

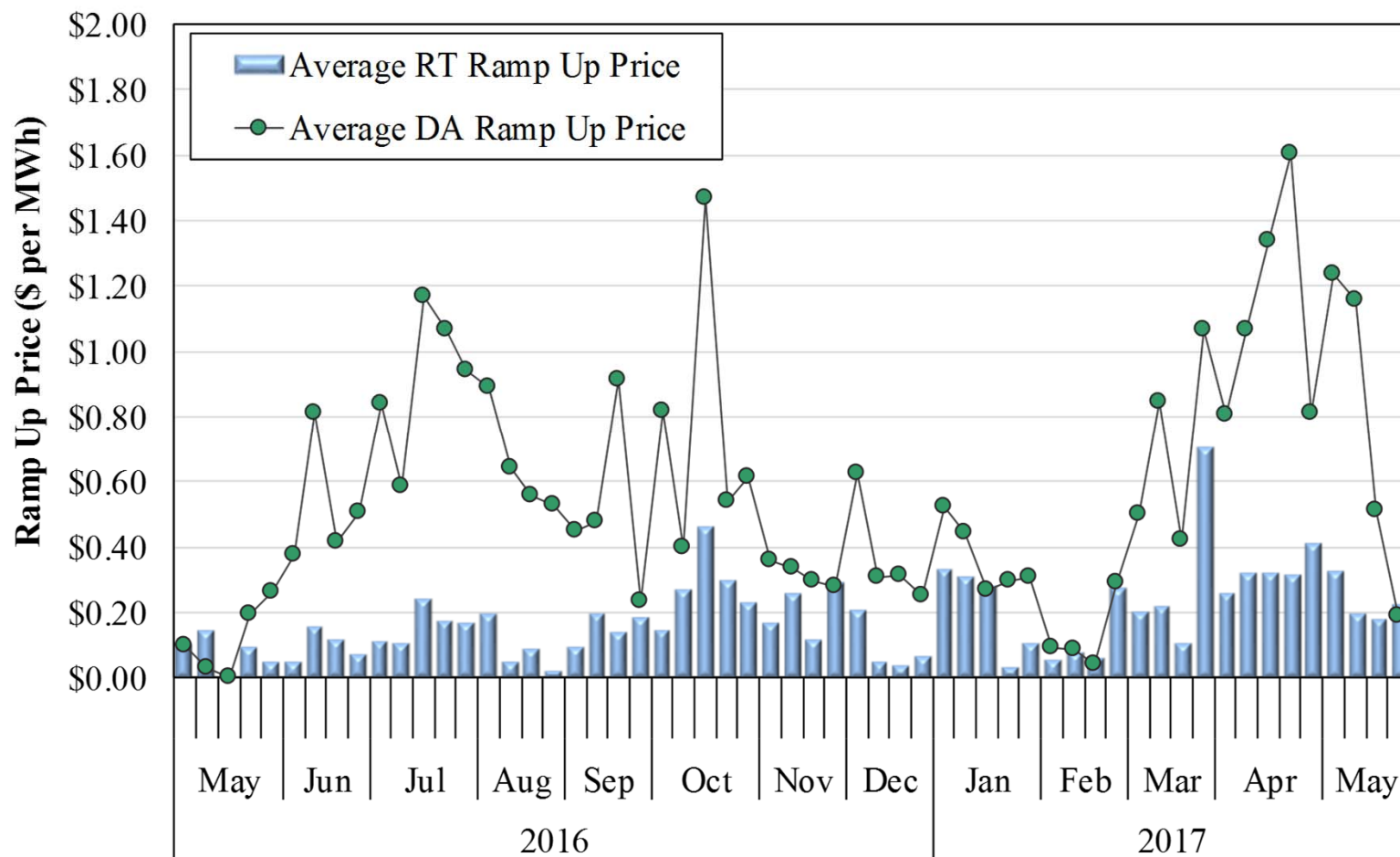


Percent Screened

Demand	1.5	1.2	2.1	1.0	1.2	1.6	1.5	1.2	1.3	1.2	2.1	0.4	1.1	0.9	1.3	1.4	2.1	2.8
Supply	1.0	0.5	0.4	0.8	0.4	0.3	0.2	0.3	0.3	0.3	0.6	0.4	0.6	0.3	0.2	0.4	0.4	0.5
Total	1.2	0.9	1.2	0.9	0.8	1.0	0.8	0.7	0.8	0.7	1.2	0.4	0.8	0.6	0.7	0.9	1.2	1.6

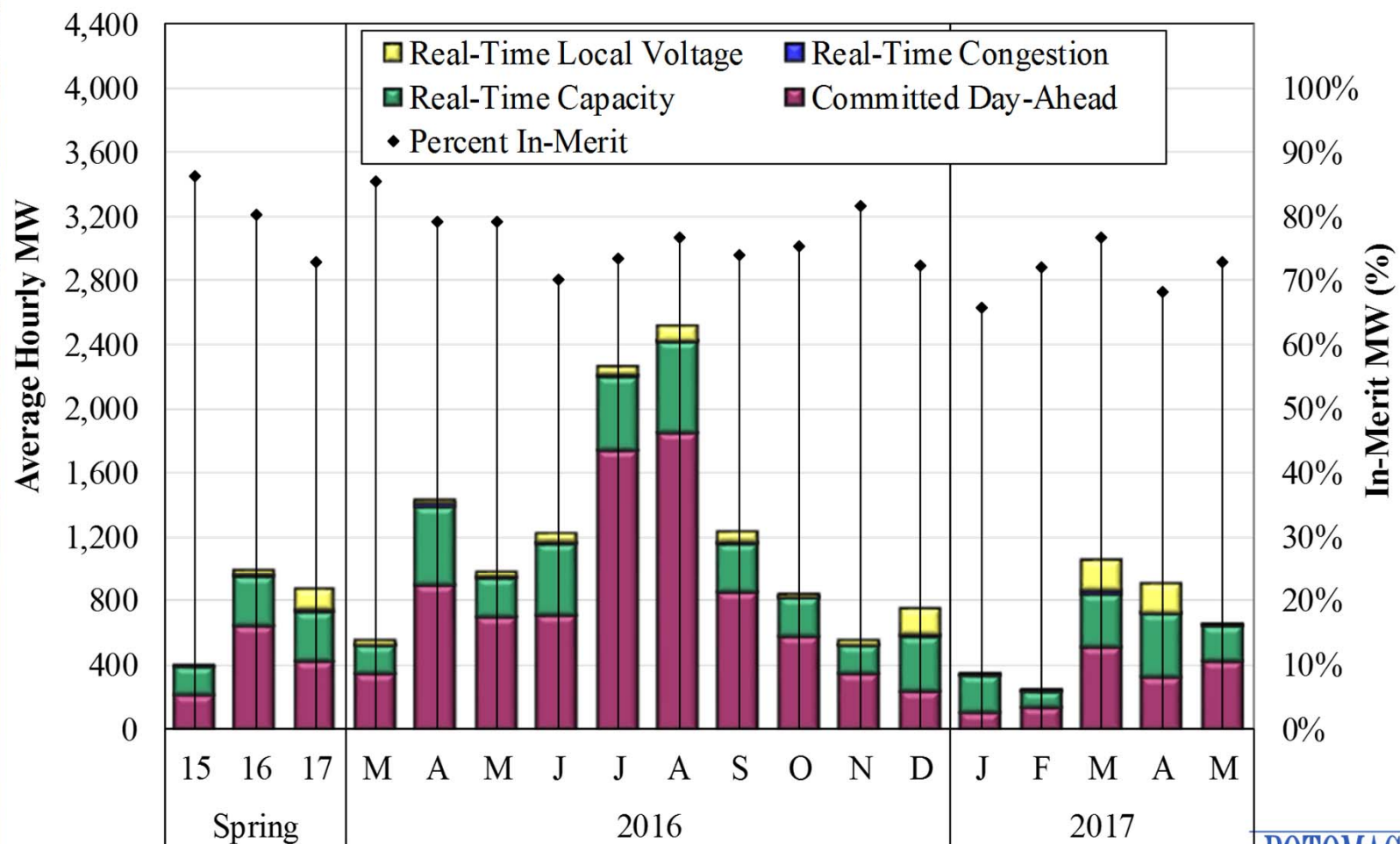


Day-Ahead and Real-Time Ramp Up Price 2016 – 2017



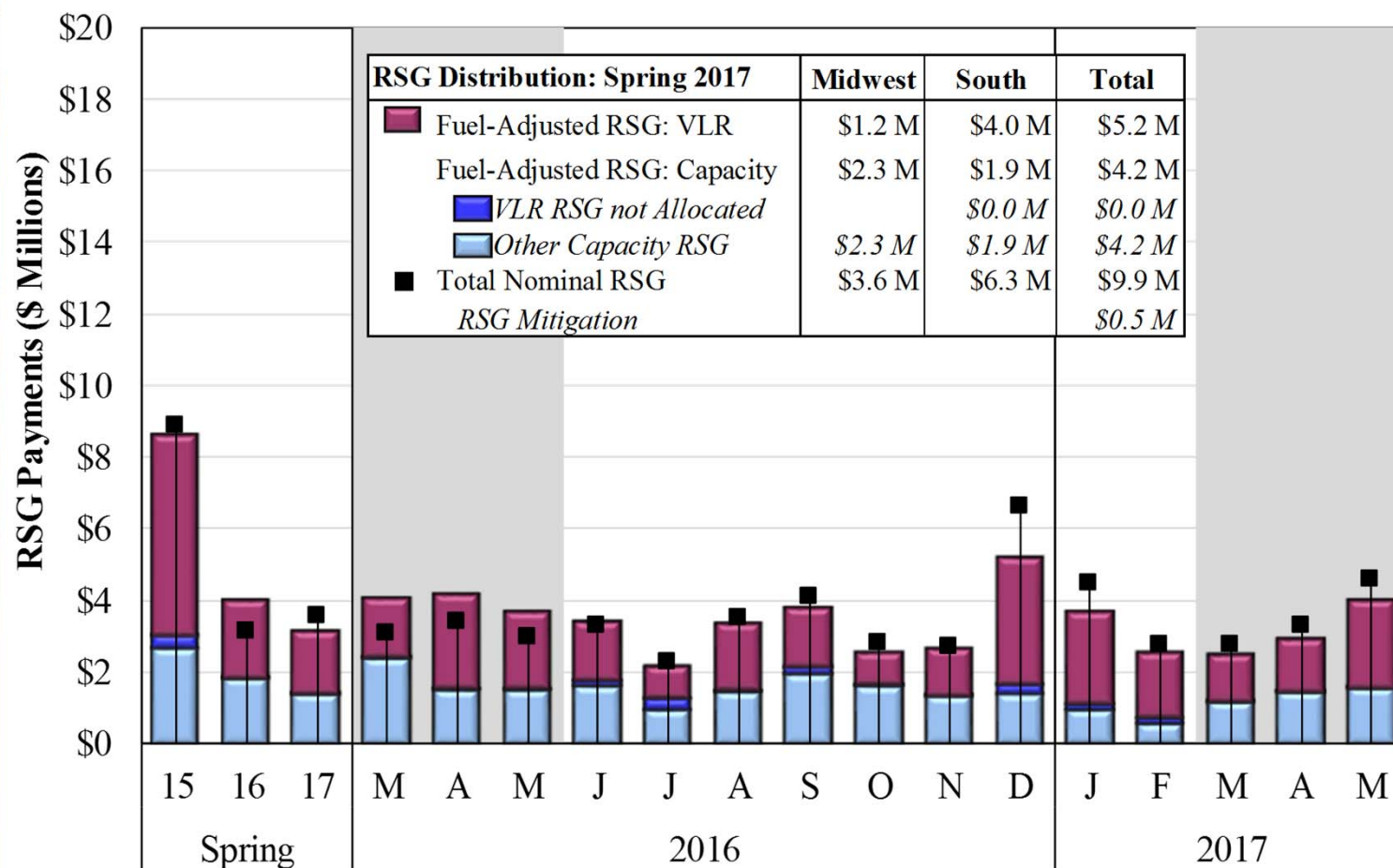


Peaking Resource Dispatch 2016–2017



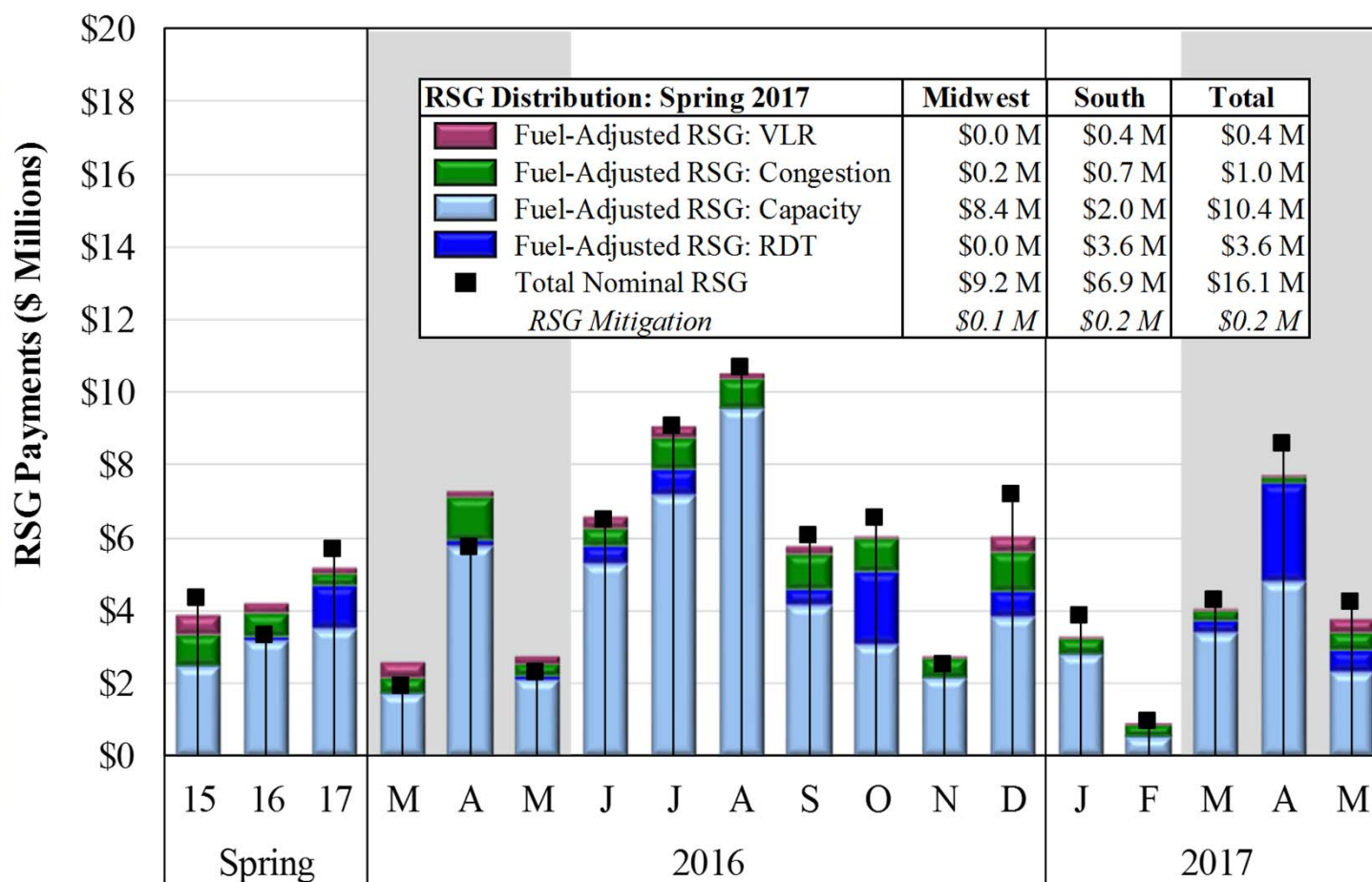


Day-Ahead RSG Payments 2016–2017



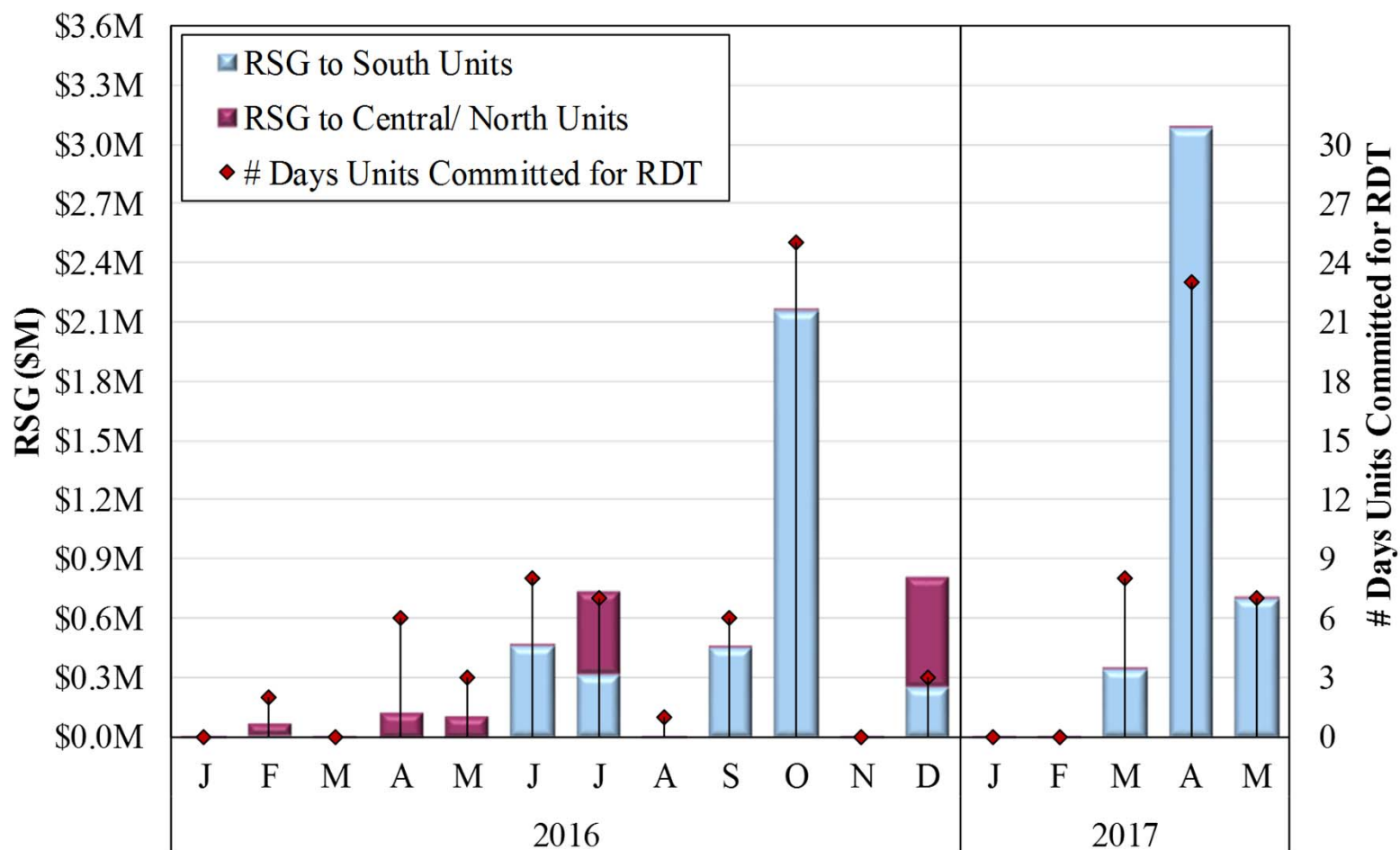


Real-Time RSG Payments 2016–2017



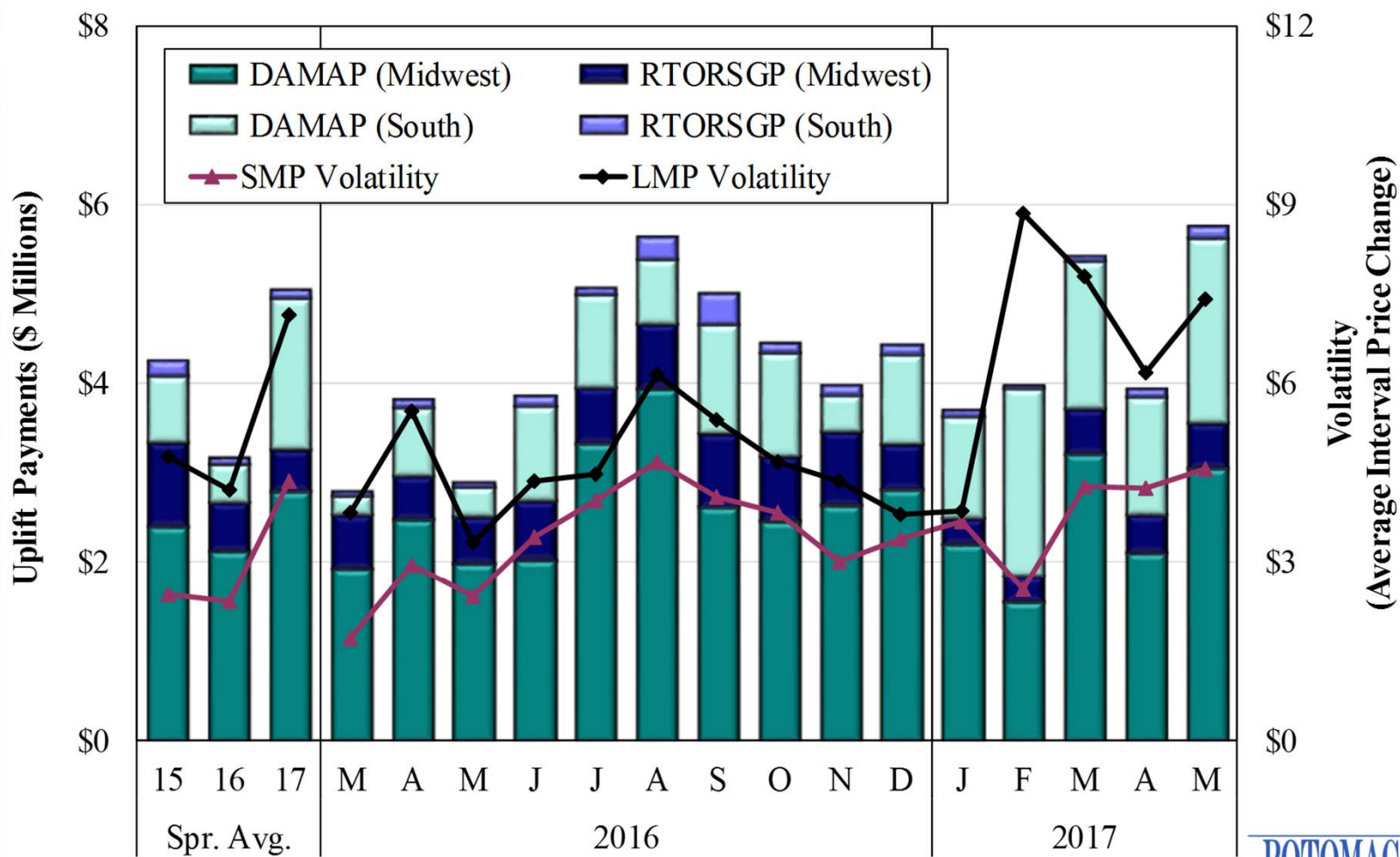


RDT Commitment RSG Payments 2016–2017



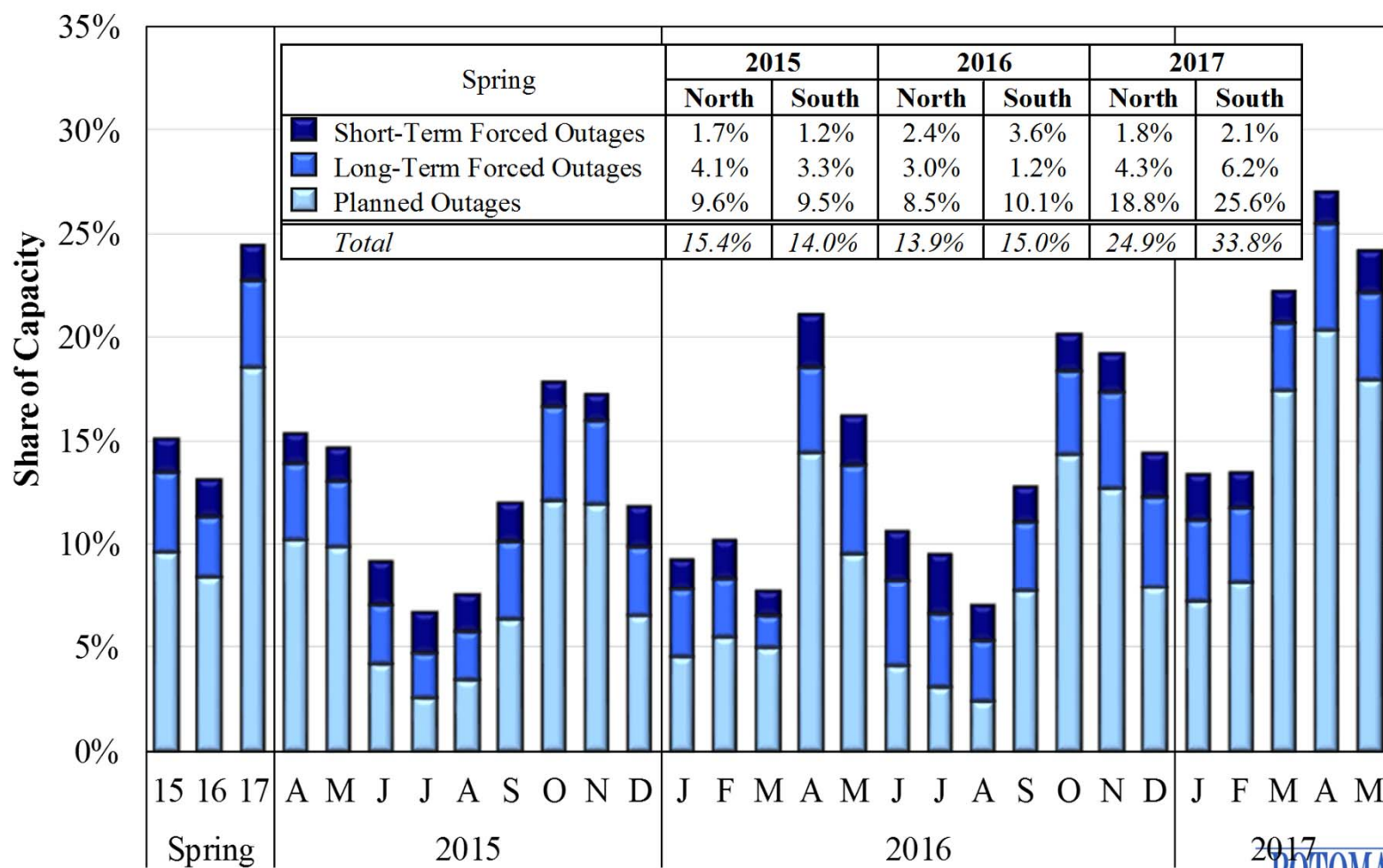


Price Volatility Make Whole Payments 2016–2017



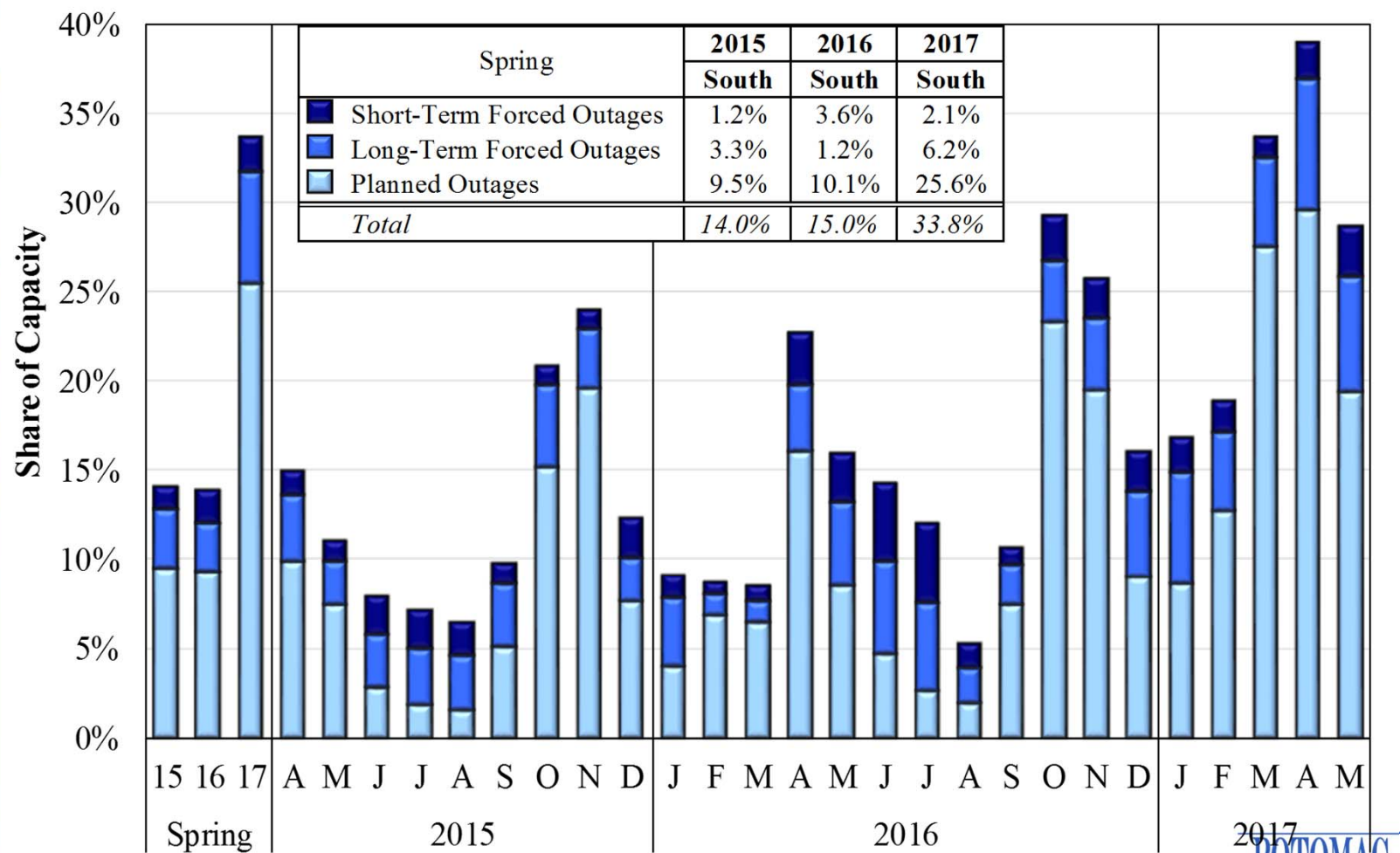


Generation Outage Rates 2016–2017



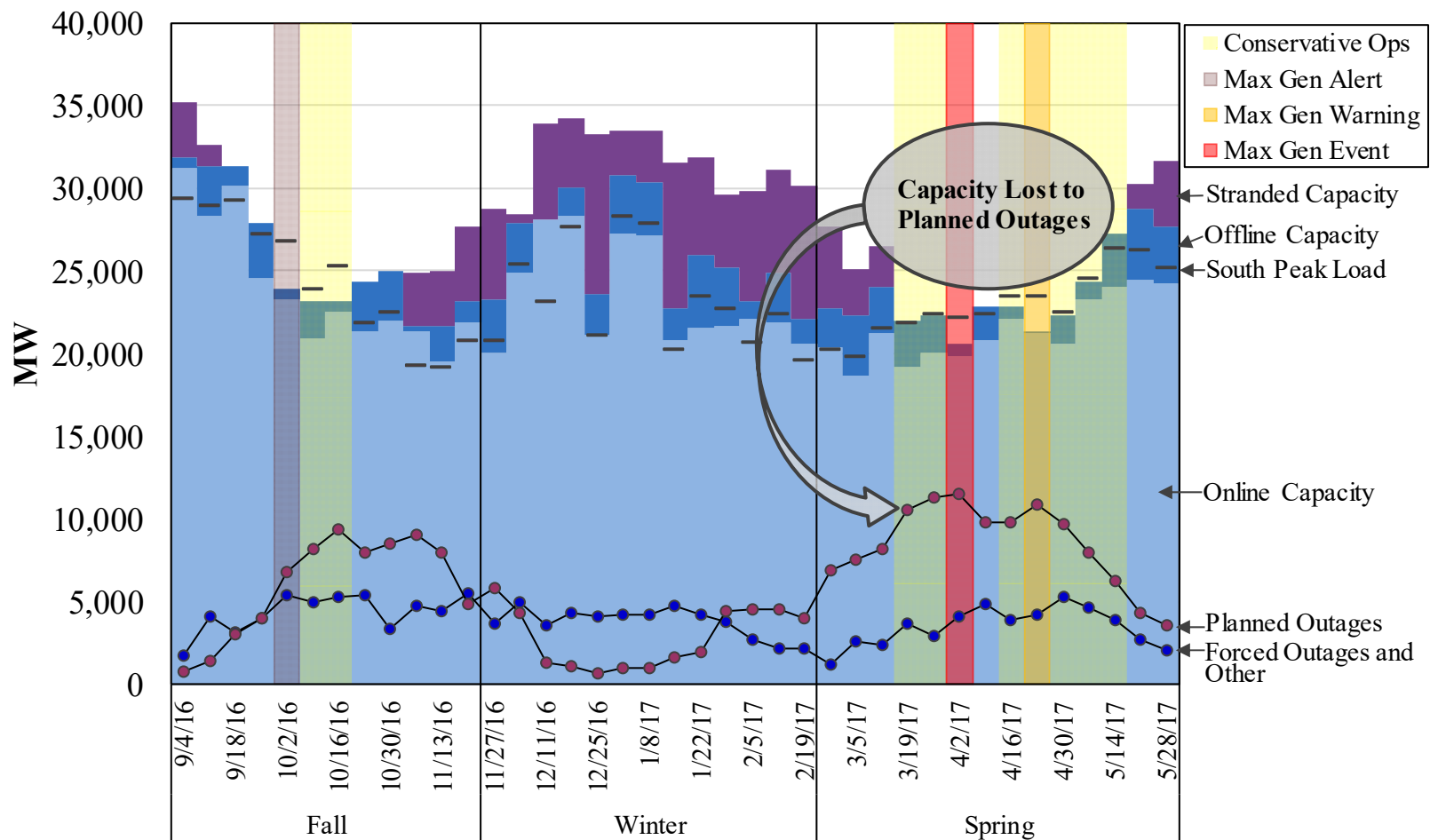


Generation Outage Rates South, 2016–2017

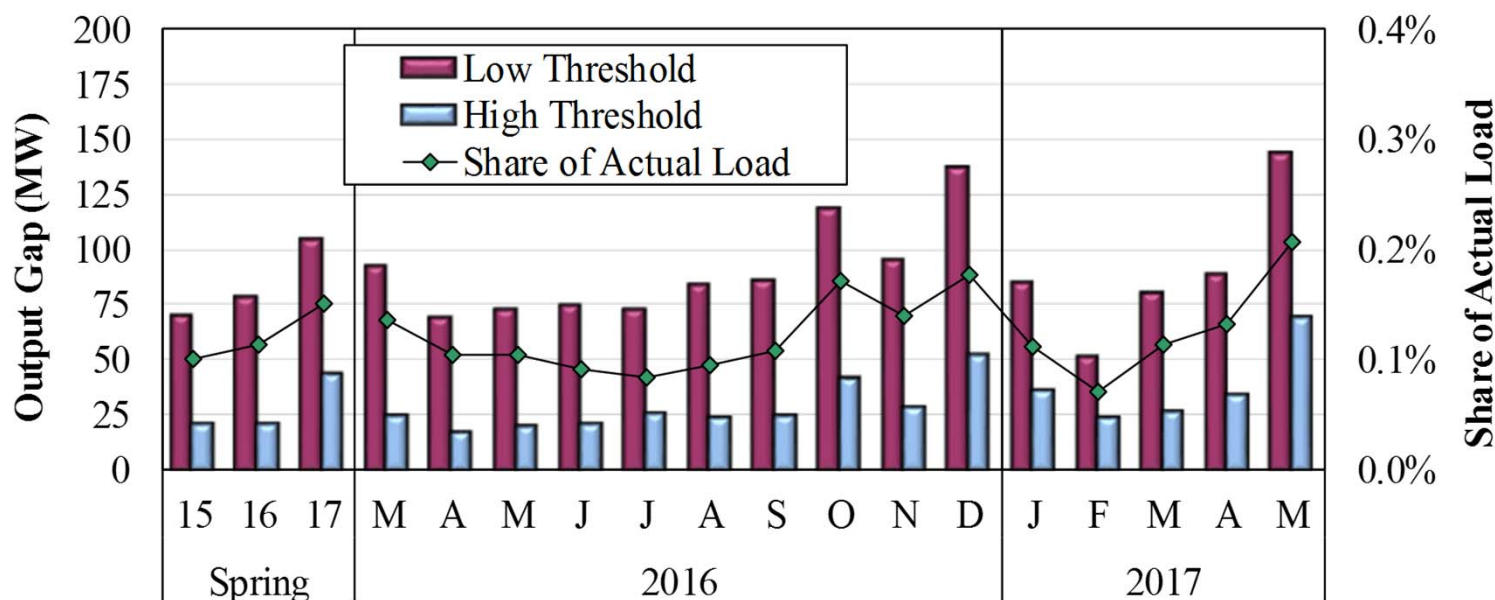




Generation Outage Rates South, 2016–2017



Monthly Output Gap 2016–2017



High Threshold Results by Unit Status (MW)

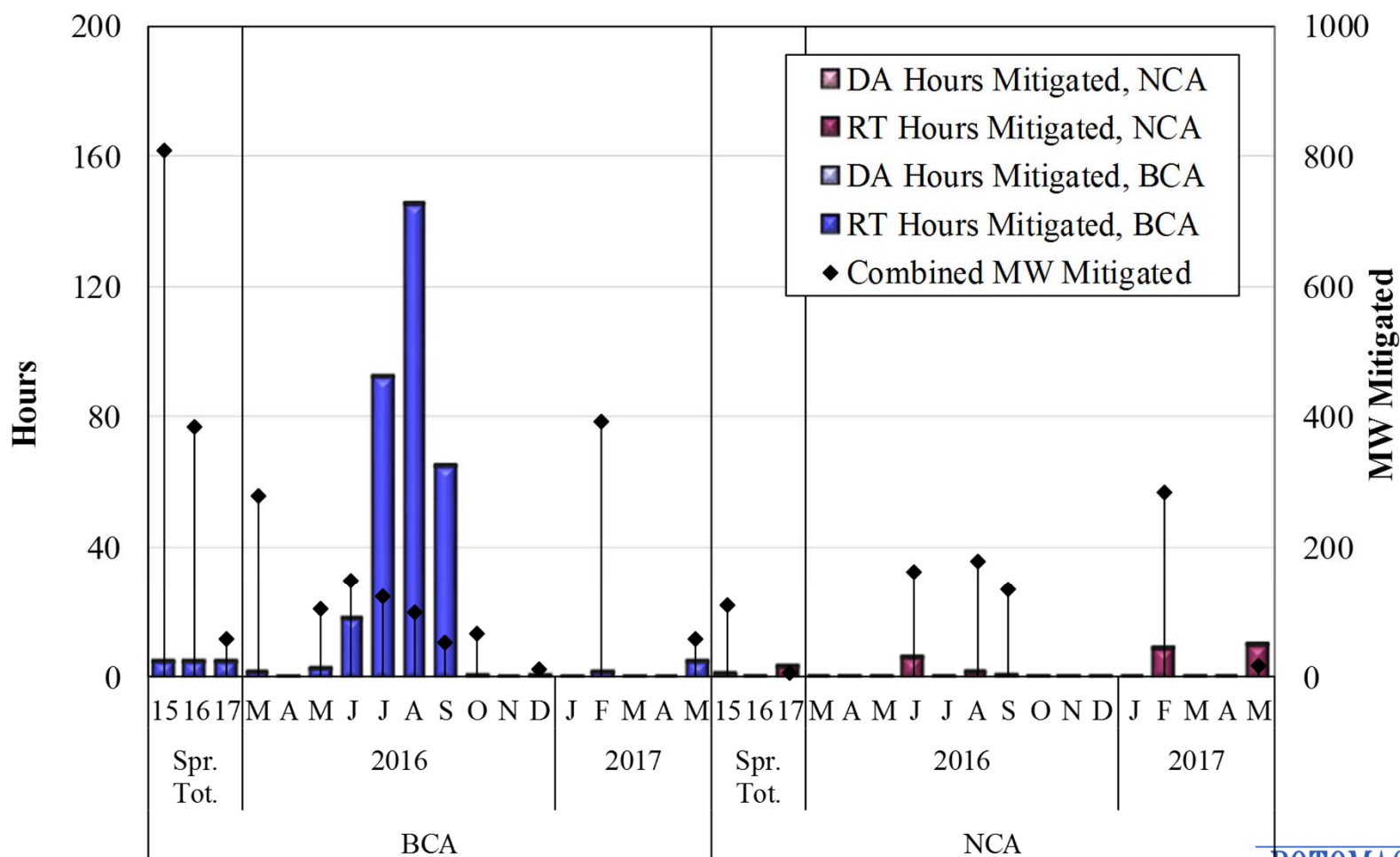
Offline	7	0	13	0	1	0	1	15	11	11	26	21	24	14	6	8	11	19
Online	15	21	37	25	16	20	20	11	14	14	16	8	29	23	19	19	24	67

Low Threshold Results by Unit Status (MW)

Offline	8	0	13	0	1	0	1	15	13	13	30	21	25	14	6	8	11	19
Online	63	78	102	94	69	73	74	58	72	73	89	75	113	72	46	73	79	154

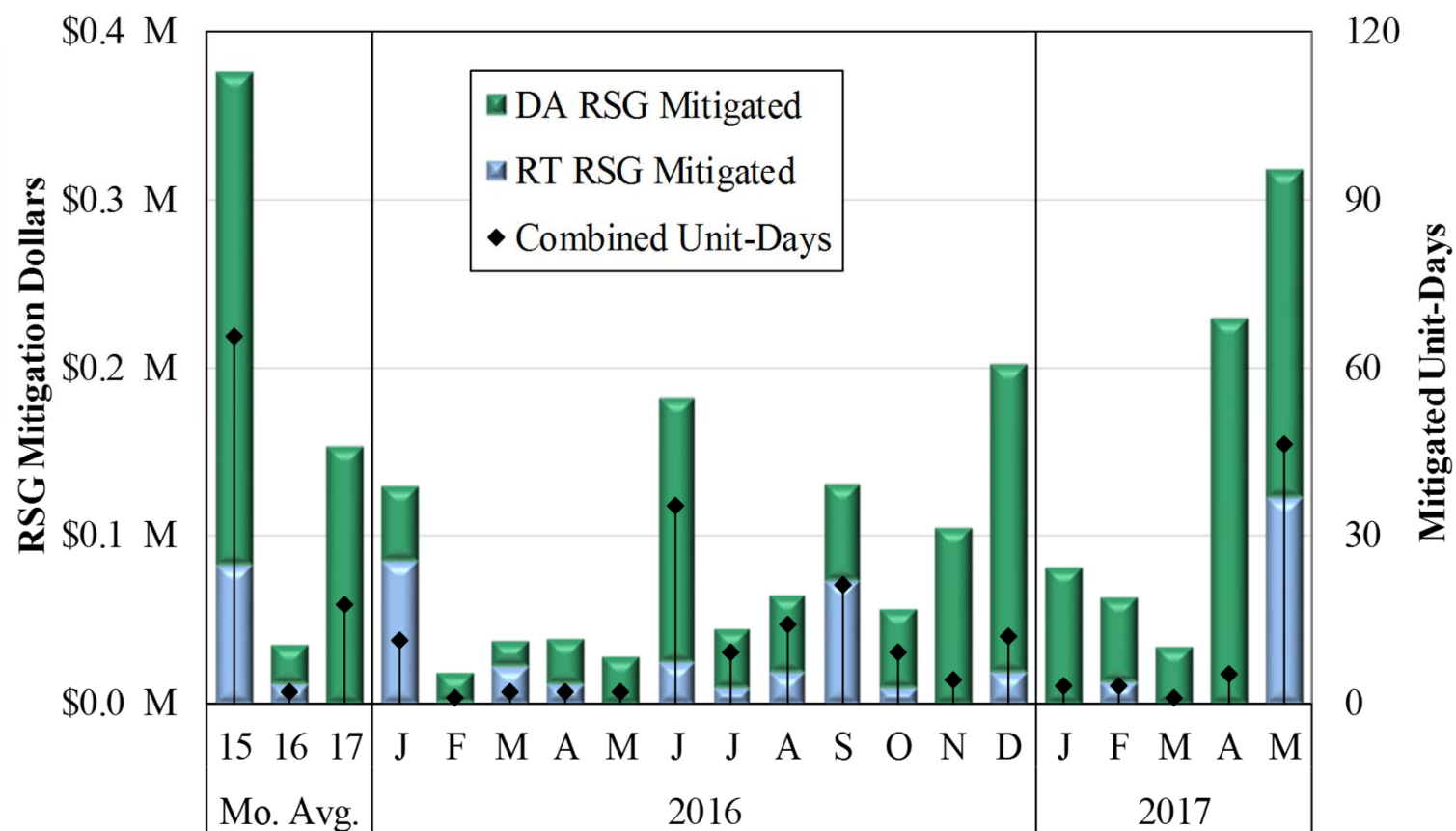


Day-Ahead And Real-Time Energy Mitigation 2016–2017





Day-Ahead and Real-Time RSG Mitigation 2016–2017





List of Acronyms

• AMP	Automated Mitigation Procedures	• PRA	Planning Resource Auction
• BCA	Broad Constrained Area	• PVMWP	Price Volatility Make Whole Payment
• CDD	Cooling Degree Days	• RAC	Resource Adequacy Construct
• CMC	Constraint Management Charge	• RDT	Regional Directional Transfer
• DAMAP	Day-Ahead Margin Assurance Payment	• RSG	Revenue Sufficiency Guarantee
• DDC	Day-Ahead Deviation & Headroom Charge	• RTORSGP	Real-Time Offer Revenue Sufficiency Guarantee Payment
• DIR	Dispatchable Intermittent Resource	• SMP	System Marginal Price
• HDD	Heating Degree Days	• SOM	State of the Market
• JCM	Joint and Common Market Initiative	• SRPBC	Sub-Regional Power Balance Constraint
• JOA	Joint Operating Agreement	• TLR	Transmission Line Loading Relief
• LAC	Look-Ahead Commitment	• TCDC	Transmission Constraint Demand Curve
• LSE	Load-Serving Entities	• VCA	Voluntary Capacity Auction
• M2M	Market-to-Market	• VLR	Voltage and Local Reliability
• MSC	MISO Market Subcommittee	• WPP	Weekly Procurement Process
• NCA	Narrow Constrained Area	• WUMS	Wisconsin Upper Michigan System
• ORCA	Operations Reliability Coordination Agreement		
• ORDC	Operating Reserve Demand Curve		
• PITT	Pseudo-Tie Issues Task Team		