Highlights from the Quarterly Report on the New York ISO Electricity Markets Second Quarter of 2017

Pallas LeeVanSchaick
Potomac Economics
Market Monitoring Unit

Market Issues Working Group
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Highlights and Market Summary:
Energy Market Outcomes and Congestion

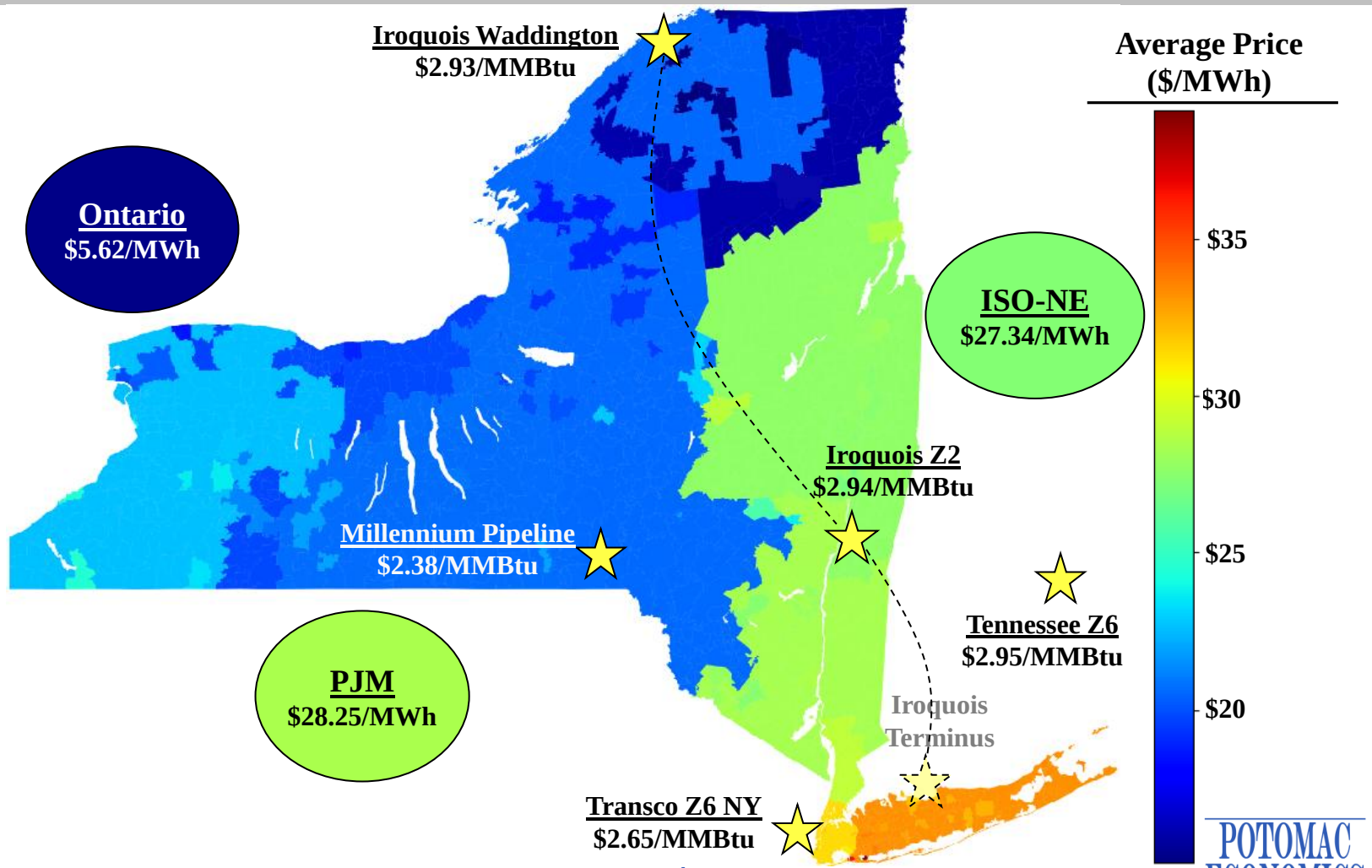
- This report summarizes market outcomes in the second quarter of 2017.
- The energy markets performed competitively and variations in wholesale prices were driven primarily by changes in fuel prices, demand, and supply availability.
- All-in prices averaged from $21/MWh in the North Zone to $57/MWh in NYC.
  - ✓ The range was primarily due to congestion on power flowing from the North Zone to central New York, Central East congestion, and capacity price differences.
  - ✓ Zone-level LBMPs rose in most regions by 7 to 25 percent because of:
    - – Higher gas prices, which rose 20 to 60 percent in East NY and 65 percent in Western NY. (see slide 12)
    - – However, higher output from nuclear, internal hydro, and Canadian imports (~950 MW total) offset much of the gas price impact on LBMPs. (see slides 16, 41)
  - ✓ Capacity costs were impacted by changes in Net CONE from the recent Demand Curve Reset process. (see slide 91)
- Congestion costs from priced and un-priced constraints rose from 2016.
  - ✓ DA congestion revenue was $117M, up 24 percent from 2016-Q2. (see slide 54)
  - ✓ Congestion increased into NYC, across the Central East interface, and along paths from western and northern NY.

Highlights and Market Summary:
Energy Market Outcomes and Congestion

- ✓ In western and northern NY, priced congestion declined, while un-priced congestion became more prevalent because of:
  - Improved hydro conditions in NY and low prices in the adjacent Canadian markets;
  - Transmission upgrades completed in May 2016, which reduced priced congestion on 230 kV facilities in the West, but shifted more flows onto parallel 115 kV circuits.
- ✓ We find that actions used to manage 115kV congestion in western and northern New York led to import limitations from Ontario and Quebec as well as congestion on the 200+kV system in other parts of the state. (see slides 64-67)
  - This congestion management could be performed more efficiently through the DA and RT market systems.

- RT congestion costs for the Valley Stream load pocket on Long Island fell from a year ago because of improved modeling of lines between NYC and Long Island.
- The M2M PAR coordination process expanded in May after the 1,000 MW ConEd-PSEG Wheel expired. (see slides 57-63)
  - ✓ Congestion increased through Millwood and into New York City.
  - ✓ The A/B/C and J/K lines were operated more efficiently. (see slides 52, 56)
  - ✓ However, we observe that these PARs were often not utilized to help manage congestion, being adjusted only 2 to 5 times per day on average.

Highlights and Market Summary:
Energy Market Outcomes and Congestion



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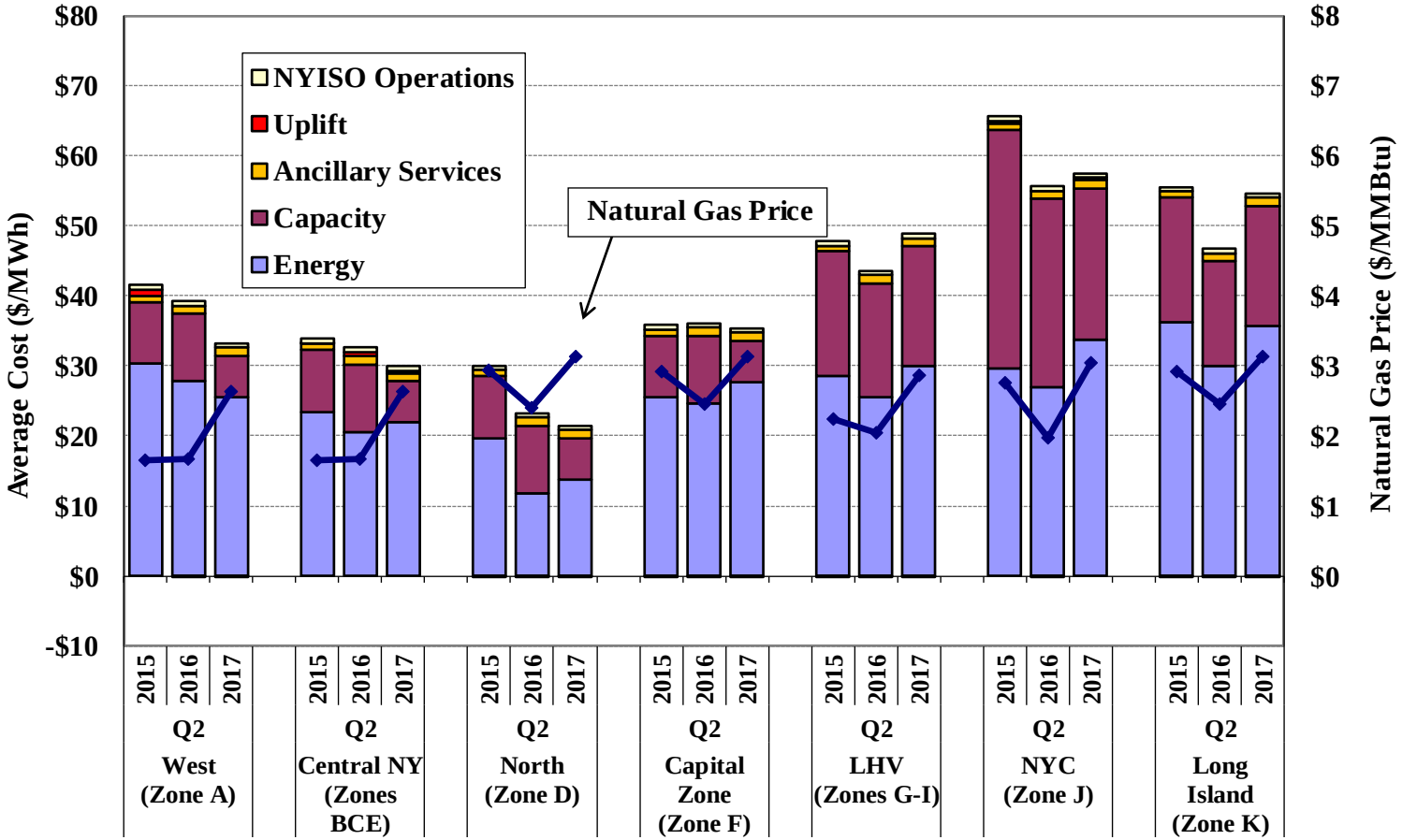
All-In Prices by Region



Note: Natural Gas Price is based on the following indices (plus a transportation charge of $0.20/MMbtu): the Dominion North index for West Zone and Central NY, the Iroquois Waddington index for North Zone, the Iroquois Zone 2 index for Capital Zone and LI, the average of Millennium East and Iroquois Zone 2 for LHV, the Transco Zone 6 (NY) index for NYC. A 6.9 percent tax rate is also included NYC.

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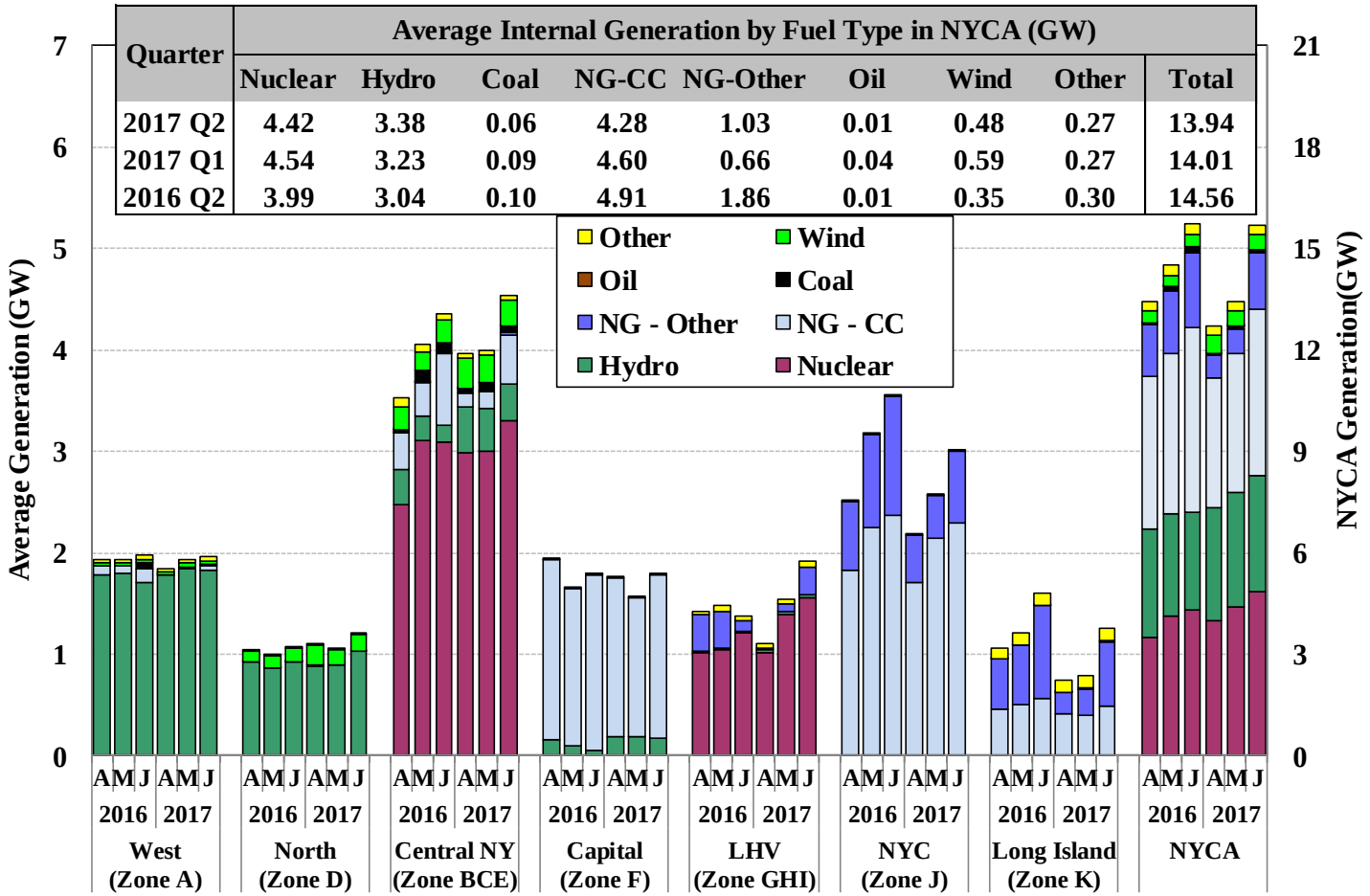
Real-Time Generation Output by Fuel Type

Quarter	Average Internal Generation by Fuel Type in NYCA (GW)								
	Nuclear	Hydro	Coal	NG-CC	NG-Other	Oil	Wind	Other	Total
2017 Q2	4.42	3.38	0.06	4.28	1.03	0.01	0.48	0.27	13.94
2017 Q1	4.54	3.23	0.09	4.60	0.66	0.04	0.59	0.27	14.01
2016 Q2	3.99	3.04	0.10	4.91	1.86	0.01	0.35	0.30	14.56



Notes: Pumped-storage resources in pumping mode are treated as negative generation.
"Other" includes Methane, Refuse, Solar & Wood.

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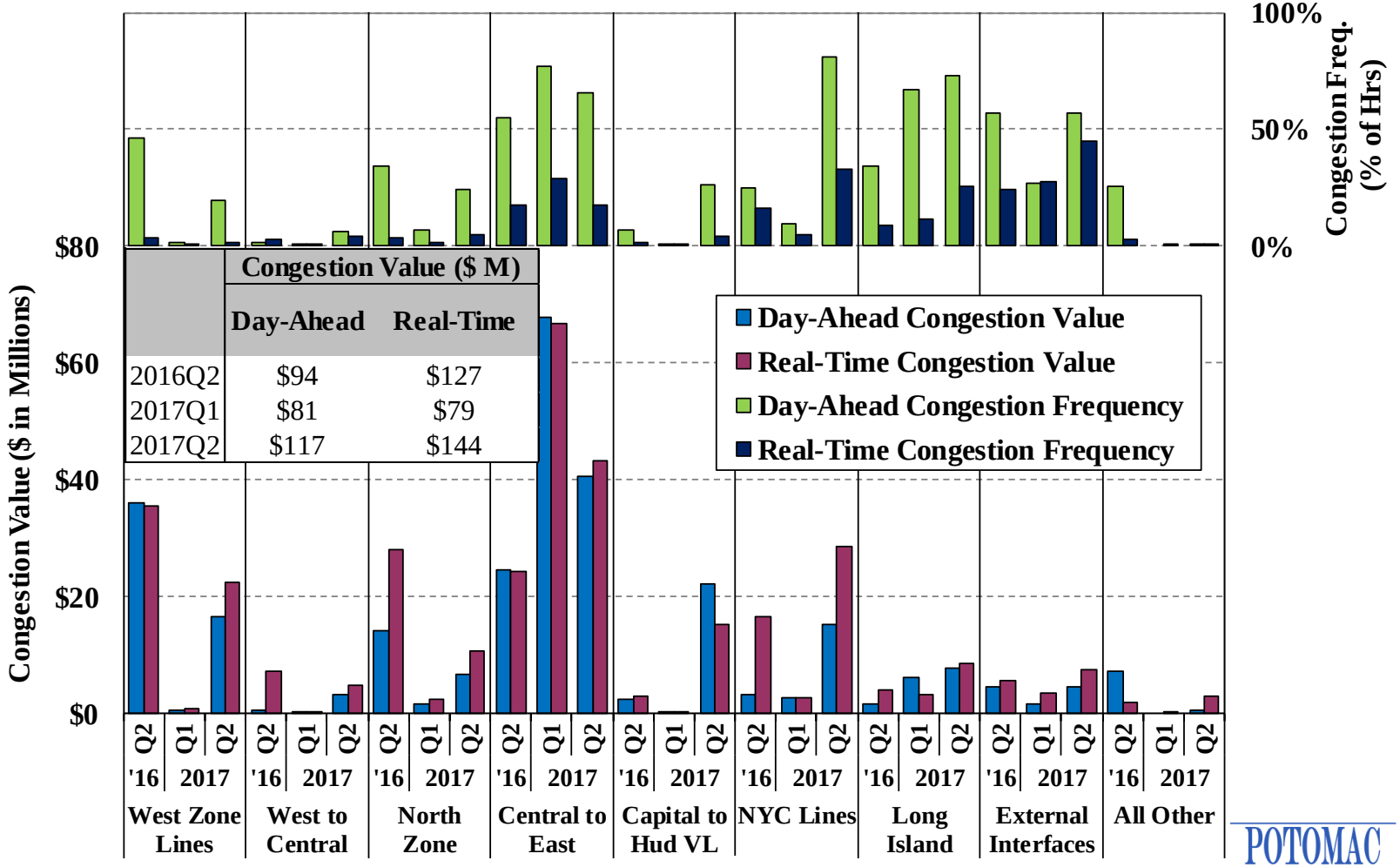
DA and RT Congestion Value and Frequency
by Transmission Path



	Congestion Value ($ M)	
	Day-Ahead	Real-Time
2016Q2	$94	$127
2017Q1	$81	$79
2017Q2	$117	$144

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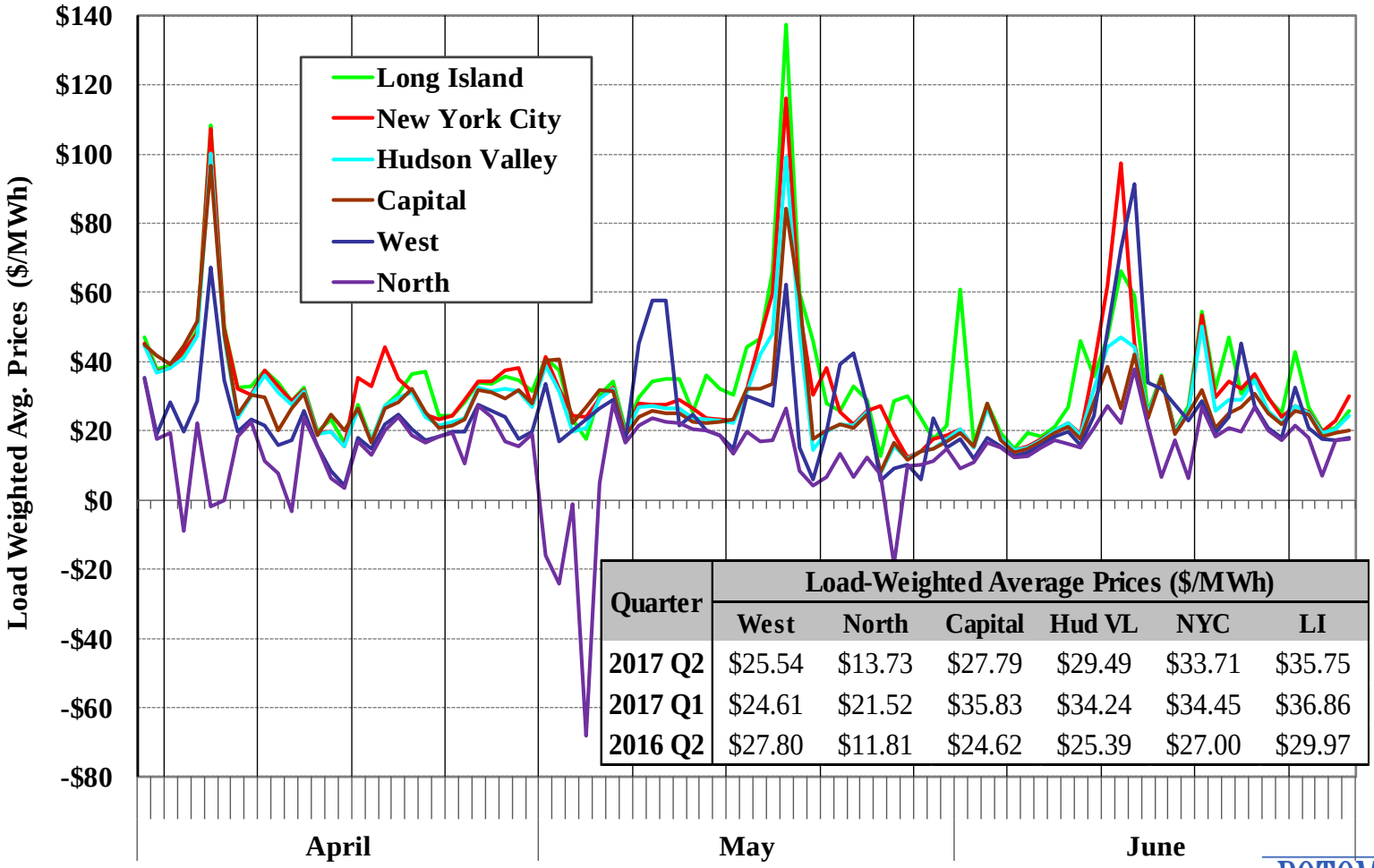
Real-Time Electricity Prices by Zone



Quarter	Load-Weighted Average Prices ($/MWh)					
	West	North	Capital	Hud VL	NYC	LI
2017 Q2	$25.54	$13.73	$27.79	$29.49	$33.71	$35.75
2017 Q1	$24.61	$21.52	$35.83	$34.24	$34.45	$36.86
2016 Q2	$27.80	$11.81	$24.62	$25.39	$27.00	$29.97

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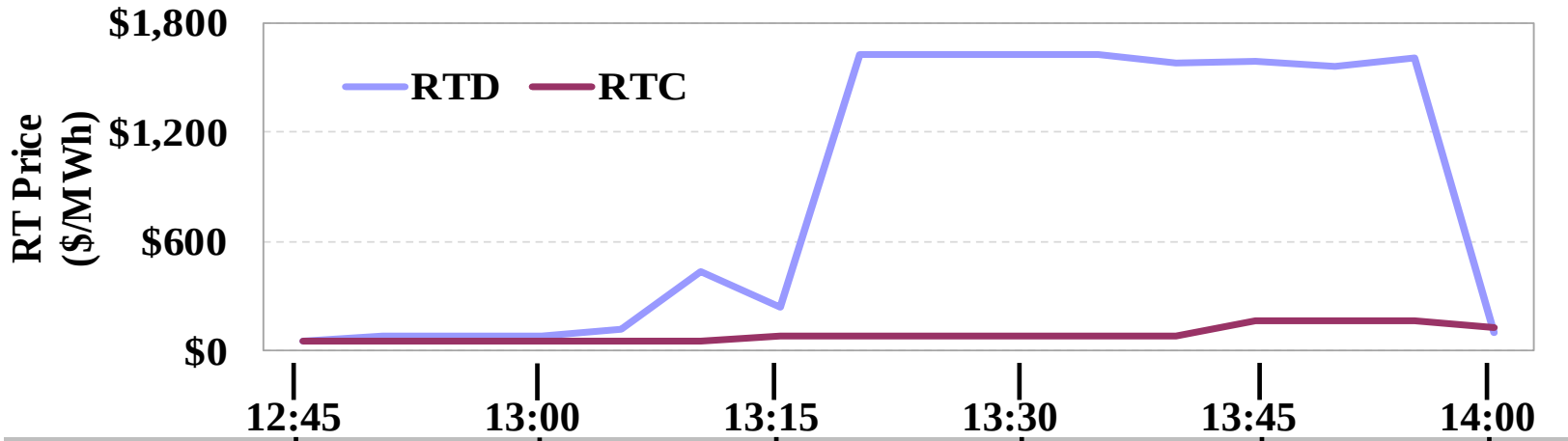
April 6 Real-Time Pricing Event

- Despite moderate demand conditions, unexpected reserve shortage conditions occurred in the afternoon on April 6, leading to high real-time shortage pricing.
  - ✓ While such events are infrequent, it is important to consider how efficiently the real-time market performed in bringing up imports and reserve capacity.
- The following slide outlines the sequence of events on this afternoon, including factors that led to large differences between RTC and RTD results.
  - ✓ The figure shows the RTC and the RTD price paths over a 75 minute period from 12:45 to 14:00 after the loss of 1,500 MW of imports from Quebec.
  - ✓ The event timeline lists a series of actions taken in response to the contingency.
    - Operators started a series of quick start units between 12:50 and 13:30.
    - The Moses South transmission constraint limit was reduced at following the contingency, leading significant amounts of hydro and wind to be scheduled down.
  - ✓ The RTC timeline illustrates why RTC did not schedule more imports from PJM and ISO-NE during the event.
    - RTC schedules resources based on information available ahead of real-time.
- RTD prices spiked during this event due to transmission outages at the HQ interface, while RTC prices were moderate.

April 6 Real-Time Pricing Event: RTC & RTD Modeling Results



Event Timeline→

- **1,500 MW Cable Trips** (12:45)
- **Operator updates Hr13 import schedule** (13:00)
- **Operator starts GTs and activates reserve pick-ups** (13:15)
- **Moses-South limit update reduces 800MW of Wind+HY** (13:45)

RTC Timeline→

RTC 13:15	RTC 13:30	RTC 13:45
Assumes incorrect HQ import MW	DNI ramp limited at +300MW	Assumes excess Wind+HY

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PAR Operations under M2M with PJM: Chart Descriptions

- The following figures evaluate the PAR operations under M2M with PJM for four PAR groups:
  - ✓ Goethals PAR (i.e., A PAR);
  - ✓ Farragut PARs (i.e., B & C PARs)
  - ✓ Waldwick PARs (i.e., E, F, and O PARs); and
  - ✓ Ramapo PARs.
- Each figure shows the following quantities on a daily basis:
  - ✓ The upper portion shows the total number of PAR tap movements (counted as total tap position changes. e.g., if one tap adjustment requires to move two taps, the figure shows two movements rather than one for that adjustment).
  - ✓ The middle portion shows two stacked bars, which indicate the number of 30-minute intervals when average: a) NY costs on relevant M2M constraints exceed PJM costs by $10, or b) PJM costs exceed NY costs by $10.
  - ✓ The bottom portion shows average actual PAR flows (blue bar), compared with their average M2M targets (red diamond).
  - ✓ The inset table shows daily average tap movements for each PAR in the group.

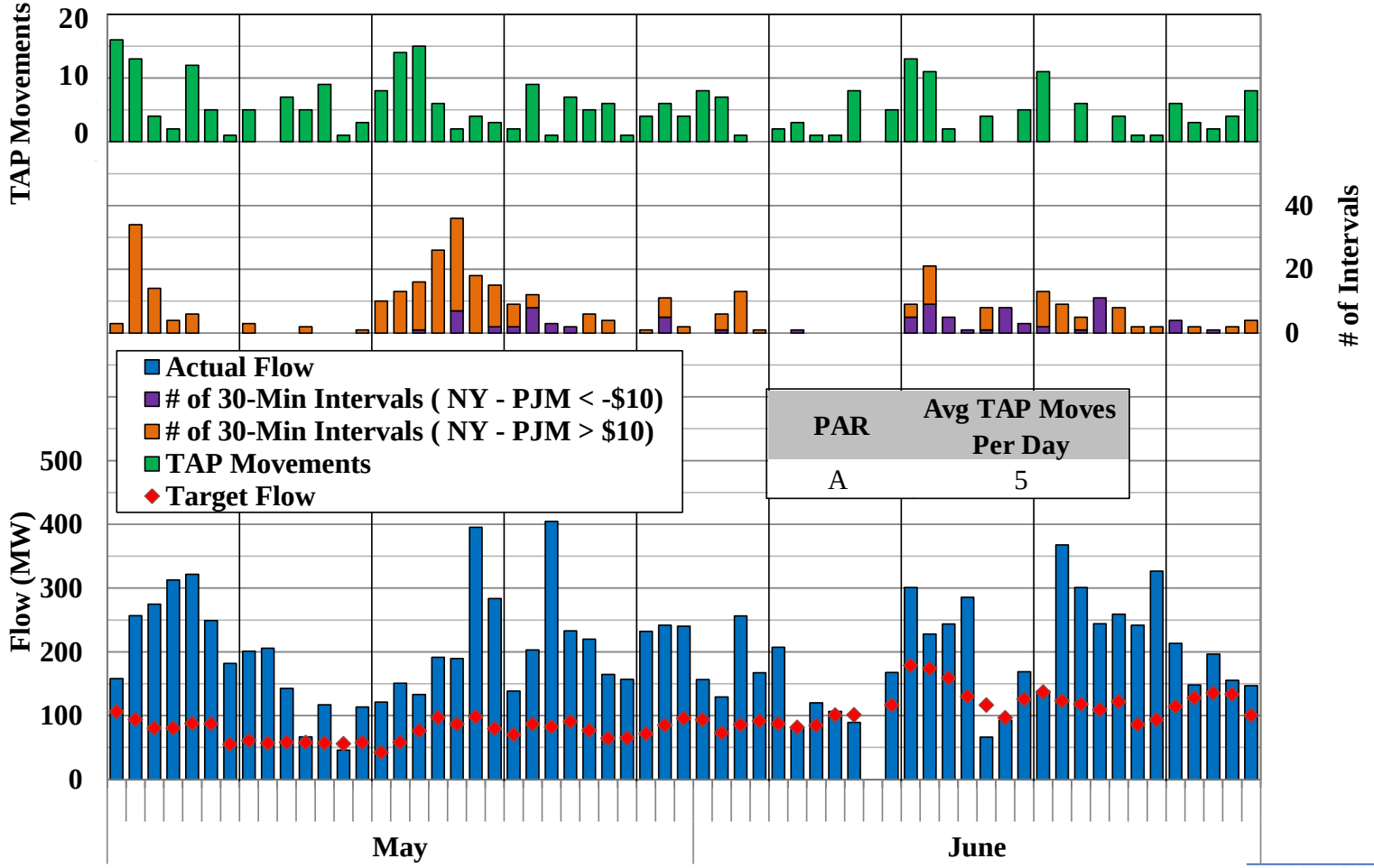
PAR Operations under M2M with PJM: Market Outcomes

- In May, the ABC and JK lines were incorporated into the M2M process following the expiration of the ConEd-PSEG wheel agreement.
  - ✓ New coordinated flow gates were added mostly in NYC and West Zone.
- For all PARs, actual flows typically exceeded their M2M targets towards NY, resulting in a small amount of M2M payments from PJM to NYISO in the second quarter.
- We have observed instances with efficient M2M coordination as PARs were moved in the correct direction to reduce overall congestion costs in a relatively timely manner.
  - ✓ However, there were many instances when PAR adjustments may have been available and would have reduced congestion but no adjustments were made.
  - ✓ PAR adjustments were not taken in some cases because of:
    - Difficulty predicting the effects of PAR movements under uncertain conditions;
    - The adjustment would have pushed actual flows or post-contingent flows close to the limit;
    - The transient nature of congestion; and
    - Mechanical failures (e.g., stuck PARs).

PAR Operations under M2M with PJM: Market Outcomes

- The Ramapo PARs have provided significant benefits to the NYISO in managing congestion on coordinated flow gates.
  - ✓ Balancing congestion surpluses have resulted from relief of transmission paths from Central to East and into SENY (see slide 56), indicating that it reduced production costs and congestion.
  - ✓ Nonetheless, comparable benefits have not been observed from the operation of ABC and JK PARs in the second quarter of 2017.
- We observed potential opportunities for increased utilization of M2M PARs.
  - ✓ The normal limit for each PAR-controlled line was over 500 MW, but flows were generally well below this level. However, these lines sometimes limited by their post-contingency limits versus flows, which are not shown.
  - ✓ On average, each PAR was adjusted 2 to 5 times per day.
    - This was well below the operational limits of 20 taps/day and 400 taps/month.
    - This was also below the average five to six 30-minute blocks of time per day when the congestion differential between PJM and NYISO exceeded $10/MWh across these PAR-controlled lines.
- We will continue to monitor the performance of the M2M process.

PAR Operation under M2M with PJM:
A PAR



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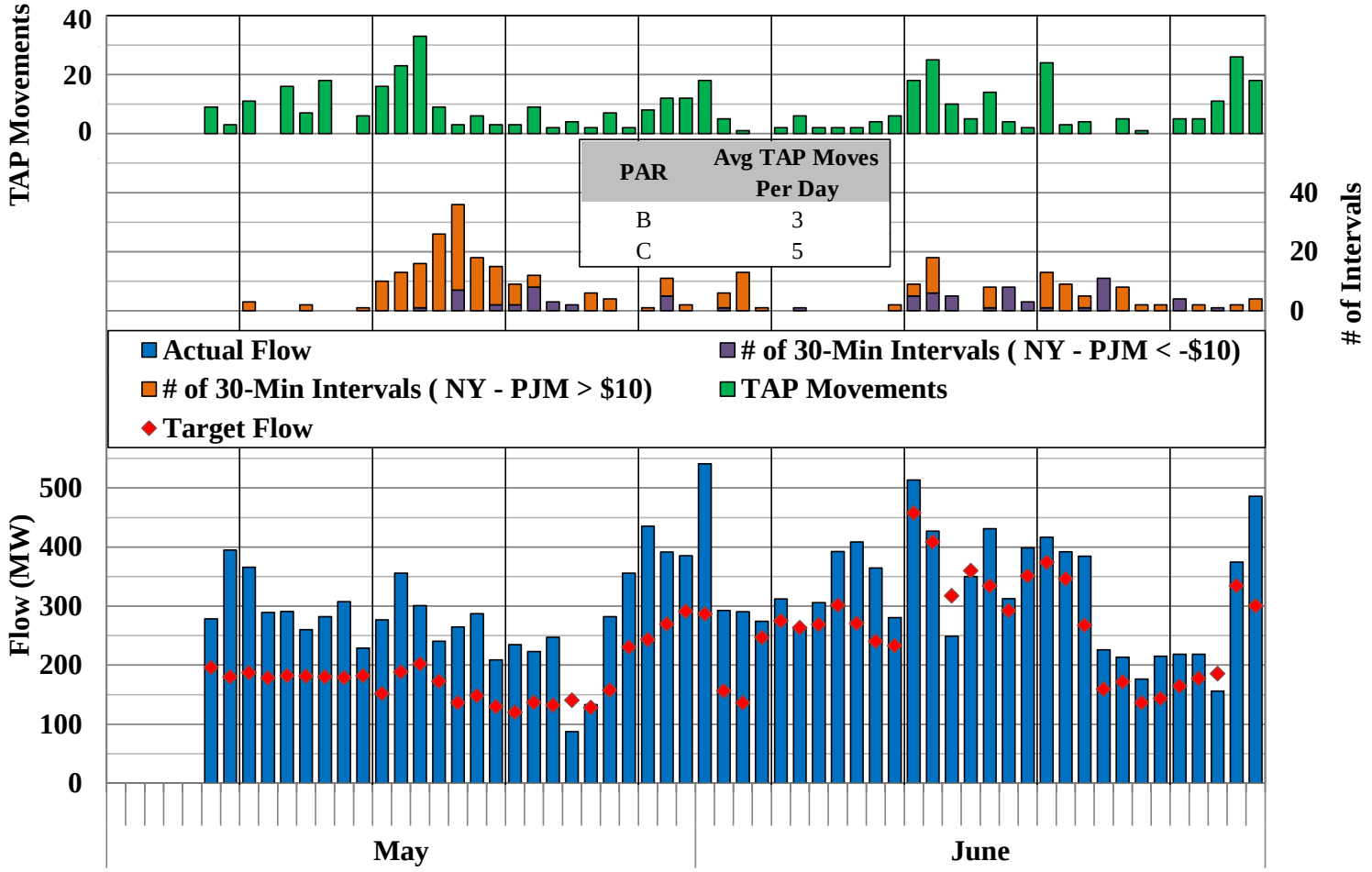
PAR Operation under M2M with PJM:
B & C PAR



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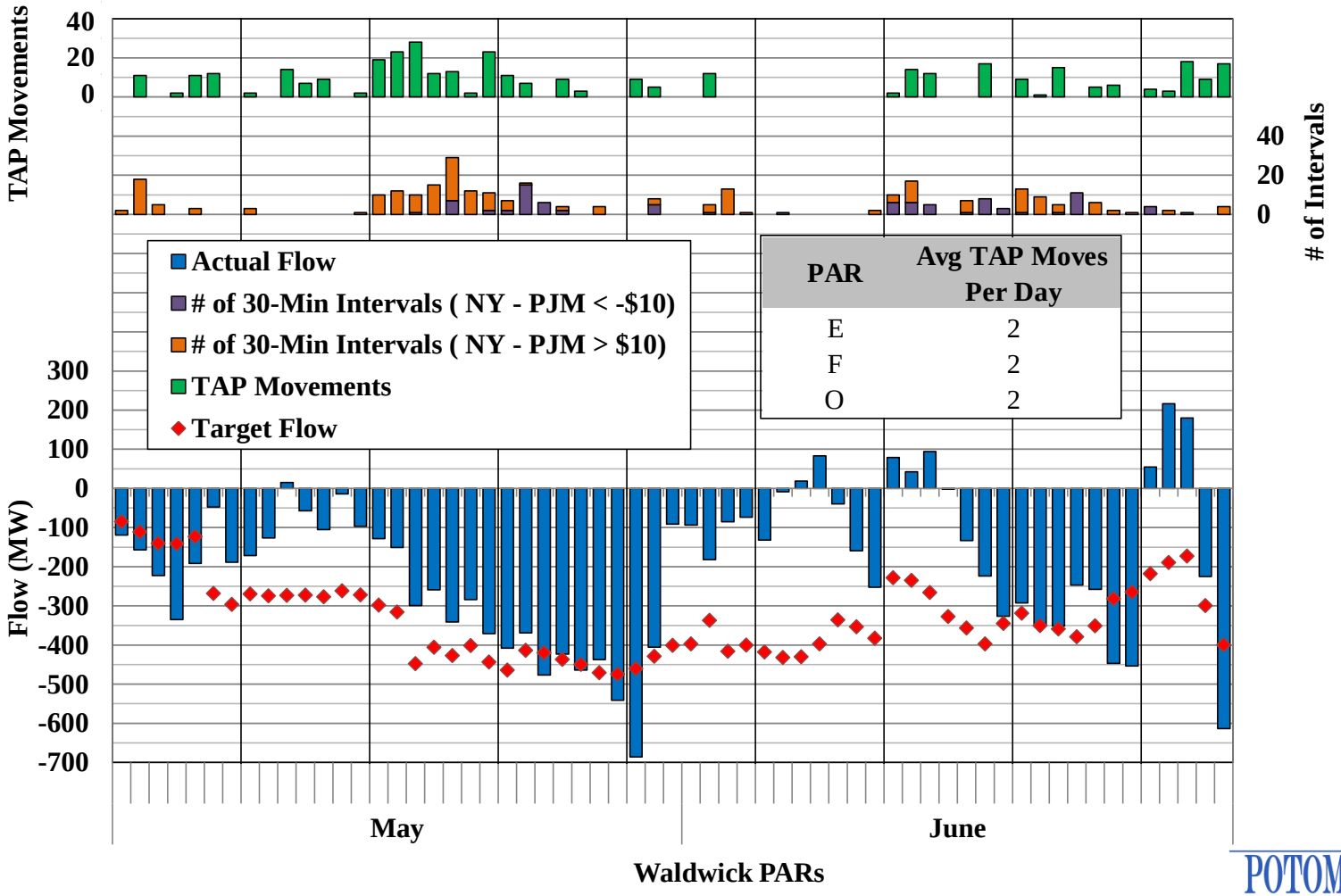
PAR Operation under M2M with PJM:
Waldwick PARs



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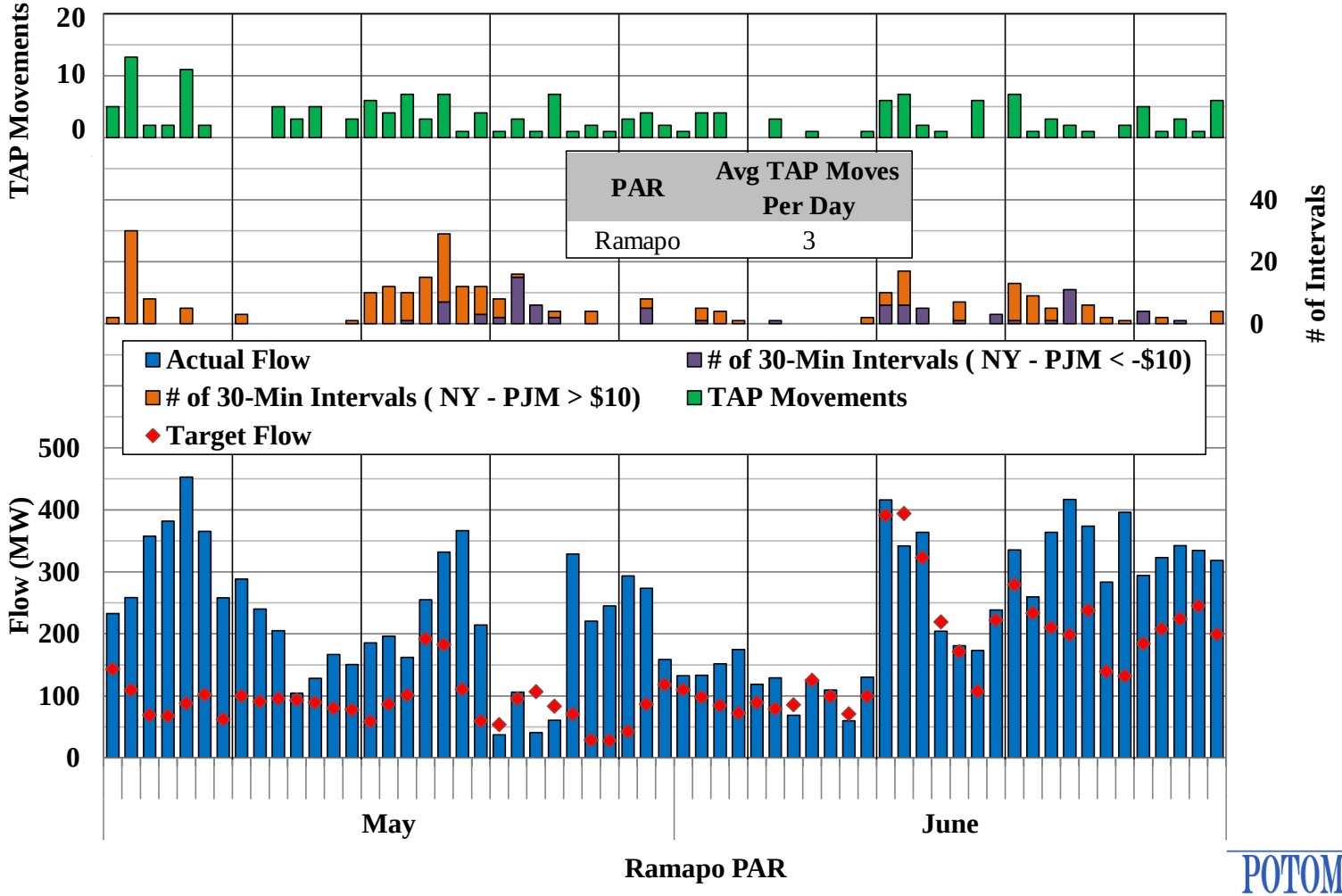
PAR Operation under M2M with PJM:
Ramapo PARs



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Constraints on the Low Voltage Network Upstate

- In upstate New York, constraints on 230 and 345 kV facilities is generally managed through the DA and RT market systems. This provides several benefits:
  - ✓ Efficient dispatch and scheduling decisions; and
  - ✓ Transparent prices that provide efficient signals for longer lead time decisions such as fuel procurement, external transaction scheduling, and investment.
- However, 69 and 115 kV constraints are resolved in other ways, including:
  - ✓ Out of merit dispatch and supplemental commitment;
  - ✓ External interface transfer limits;
  - ✓ Use of an internal interface limit as a proxy for the facility; and
  - ✓ Adjusting PAR-controlled lines.
- The first figure shows the number of days in the second quarter of 2017 when various resources were used to manage constraints in five areas of upstate NY.
  - ✓ West Zone: Mostly Niagara-to-Gardenville and Gardenville-to-Dunkirk circuits;
  - ✓ Central Zone: Mostly constraints around the State Street 115kV bus;
  - ✓ Cent-Hudson: Mostly constraints on the 69kV system in the Hudson Valley;
  - ✓ Capital Zone: Mostly Albany-to-Greenbush 115kV constraints; and

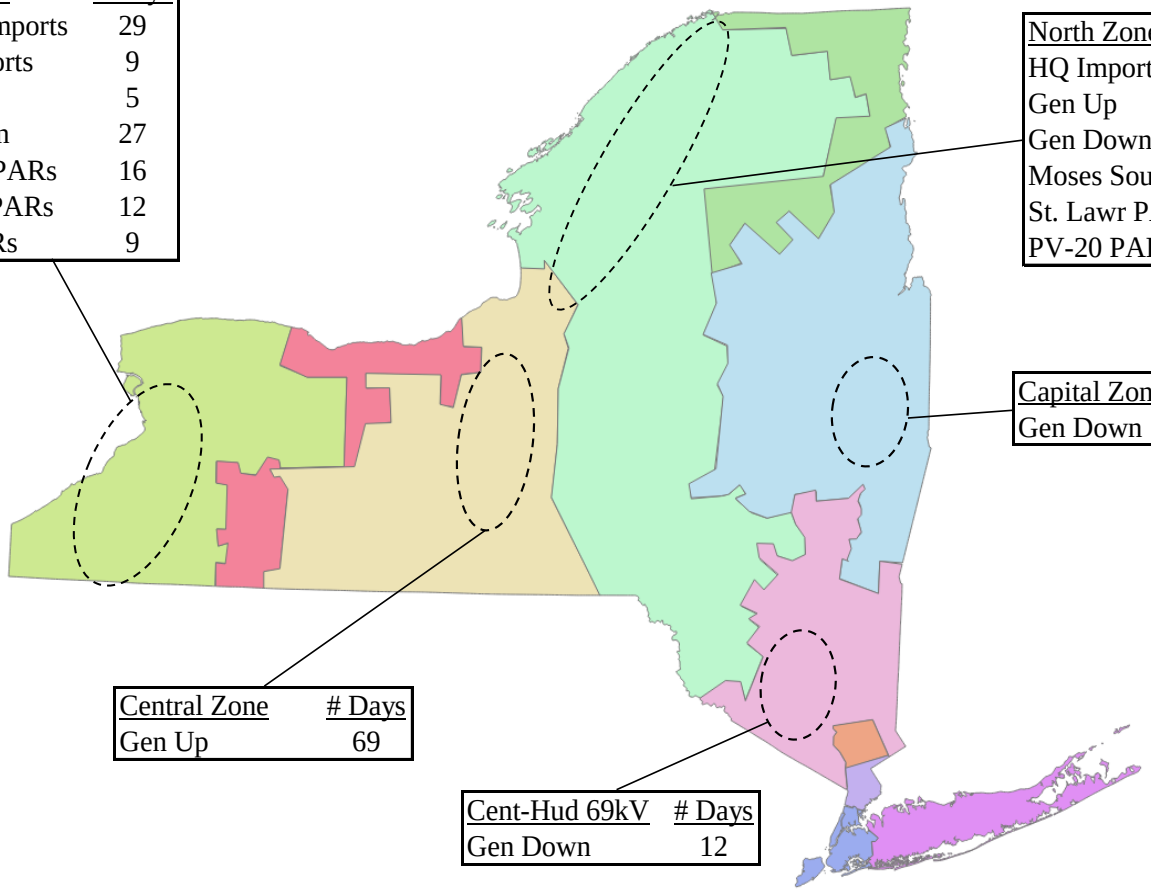
Congestion on the Low Voltage Network Upstate

- ✓ North Zone: Mostly 115kV constraints coming south from the North Zone between the Colton 115kV and Taylorville 115kV buses.

- The West Zone contains the most frequently constrained 115kV facilities.
  - ✓ Generation and Ontario imports were constrained on many days, while PARs in Northern NY and Southeast NY were also used on some days.
  - ✓ West Zone constraint management affected other areas of New York by:
    - Reducing low-cost imports from Ontario, which raised LBMPs in other areas; and
    - Using PARs to relieve West Zone constraints tends to exacerbate constraints going south from the North Zone, across the Central East interface, and into NYC.
    - Thus, the actions should be done in a manner that balances the benefits of relieving constraints in one area against the cost of exacerbating congestion in another.
      - This can be done more effectively if low-voltage constraints were managed using the DA and RT market systems.
    - The second figure illustrates these interactions for an example day (April 3).
  - ✓ Although the PJM export limit bound on just 9 days, PJM imports are generally helpful for managing 115kV congestion in the West Zone and Central Zone.
    - Modeling 115kV constraints in the market systems would provide incentives for PJM imports to relieve congestion in NY.

Constraints on the Low Voltage Network Upstate:
Summary of Resources Used to Manage Congestion

West Zone	# Days
Ontario Imports	29
PJM Exports	9
Gen Up	5
Gen Down	27
St. Lawr PARs	16
Ramapo PARs	12
ABC PARs	9



North Zone	# Days
HQ Imports	21
Gen Up	1
Gen Down	30
Moses South	3
St. Lawr PARs	20
PV-20 PAR	5

Capital Zone	# Days
Gen Down	24

Central Zone	# Days
Gen Up	69

Cent-Hud 69kV	# Days
Gen Down	12

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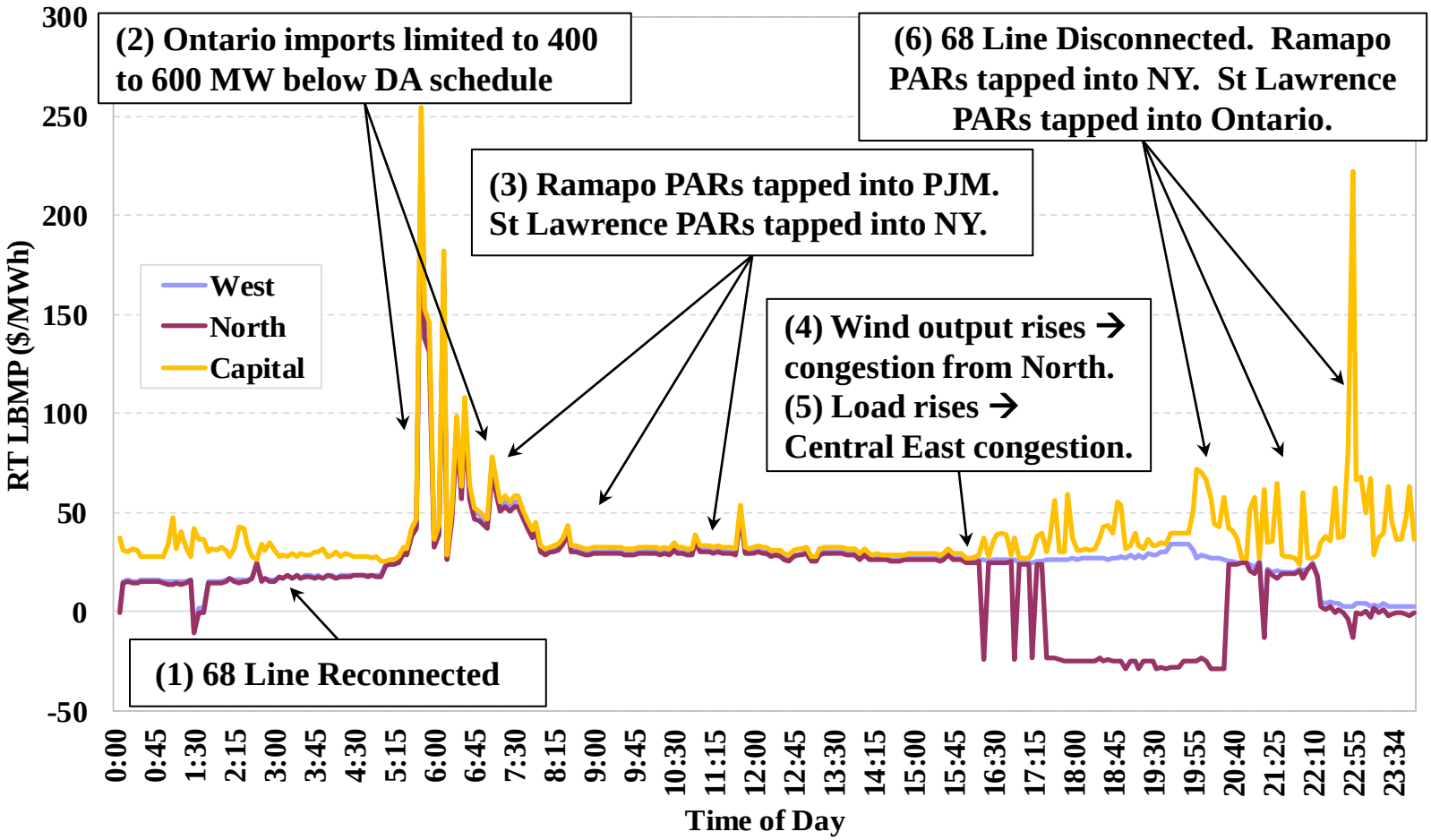
Congestion on the Low Voltage Network Upstate:
Management of 115kV Congestion on April 3



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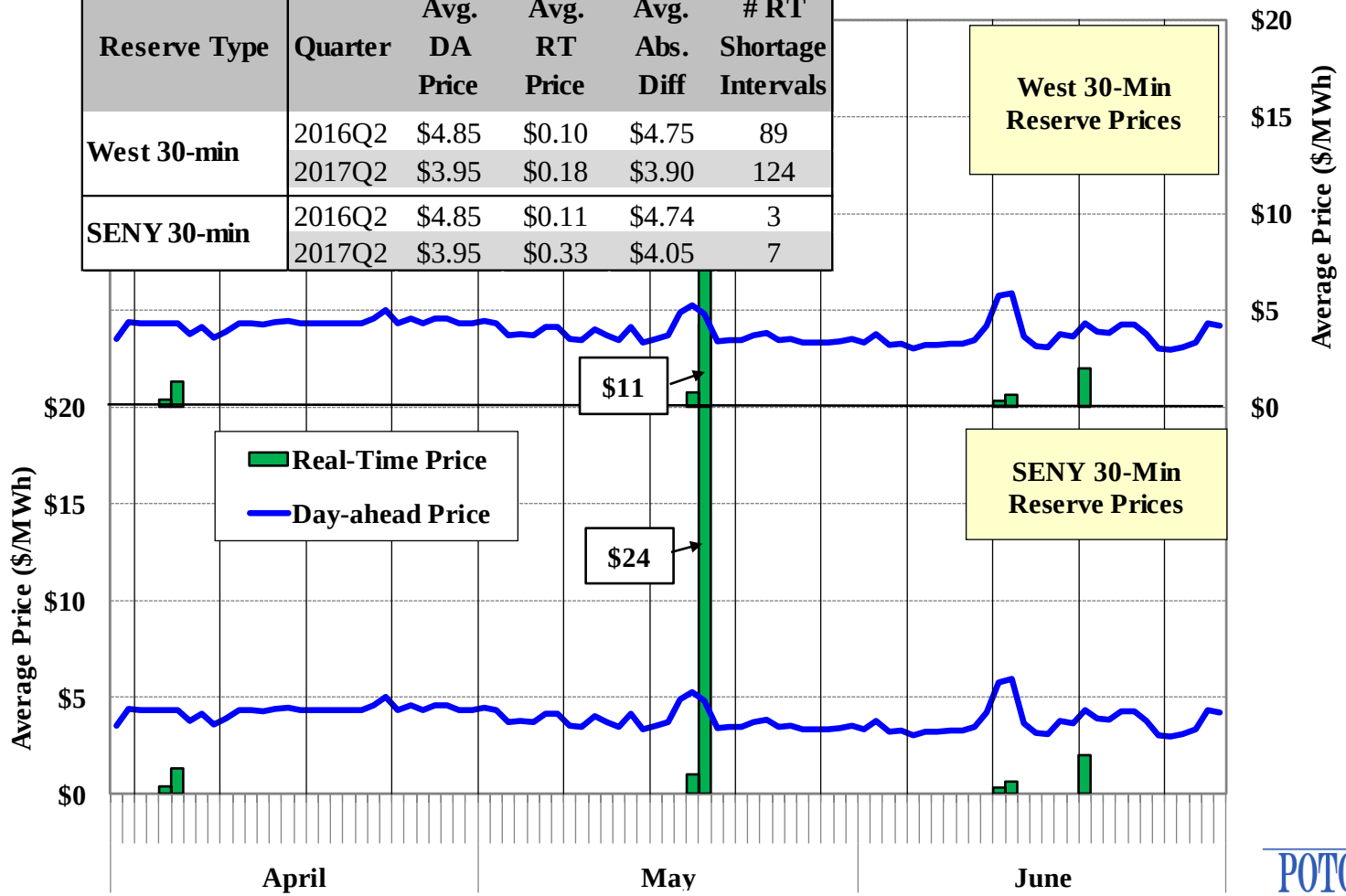
Highlights and Market Summary:
Reserve Market Performance

- DA 30-minute reserve prices have been substantially elevated since the market rule change in November 2015, driven primarily by:
  - ✓ The new limitation on scheduling reserves on Long Island (down 250-300 MW);
  - ✓ Increased 30-minute reserve requirement (up 655 MW); and
  - ✓ Higher reserve offer prices from some units (partly reflecting energy limitations).
- We have reviewed DA reserve offers and found many units that offer above the standard competitive benchmark (i.e., estimated marginal cost).
  - ✓ This is partly because it is difficult to accurately estimate the marginal cost of providing operating reserves.
  - ✓ DA offer prices may fall as suppliers gain more experience.
    - This was evident in 2017-Q2 as a large amount of reserve capacity reduced its offer prices from previous years. (see slides 31-33)
    - This has helped reduce average DA 30-minute reserve prices. (see slide 30)
- However, we will continue to monitor DA reserve offer patterns and consider potential rule changes including whether to modify the existing $5/MWh "safe harbor" for reserve offers in the market power mitigation measures.

DA and RT Ancillary Services Prices
Western and SENY 30-Minute Reserves

Reserve Type	Quarter	Avg. DA Price	Avg. RT Price	Avg. Abs. Diff	# RT Shortage Intervals
West 30-min	2016Q2	$4.85	$0.10	$4.75	89
	2017Q2	$3.95	$0.18	$3.90	124
SENY 30-min	2016Q2	$4.85	$0.11	$4.74	3
	2017Q2	$3.95	$0.33	$4.05	7



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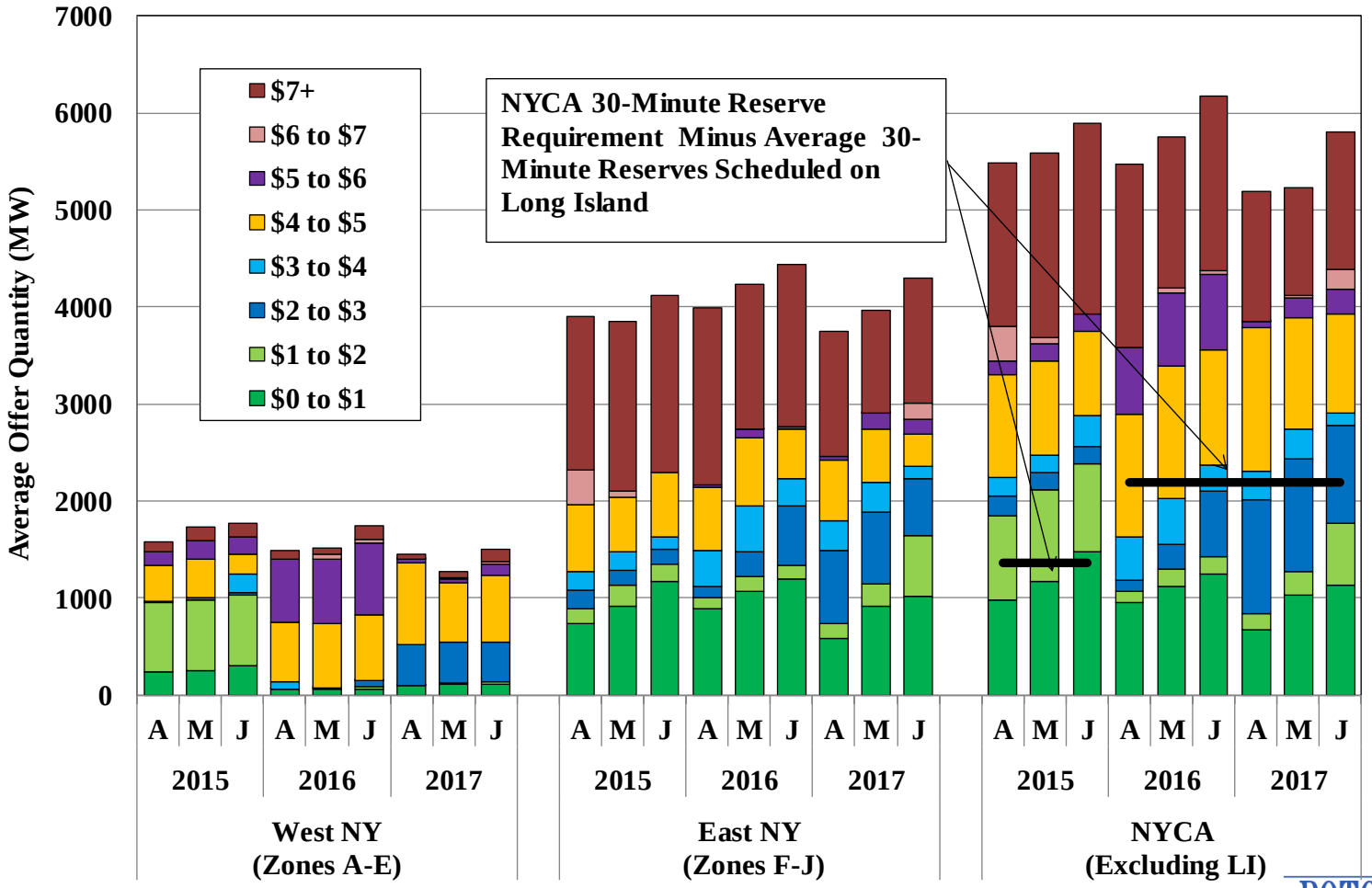
DAM NYCA 30-Minute Operating Reserve Offers
Committed and Available Offline Quick-Start Resources



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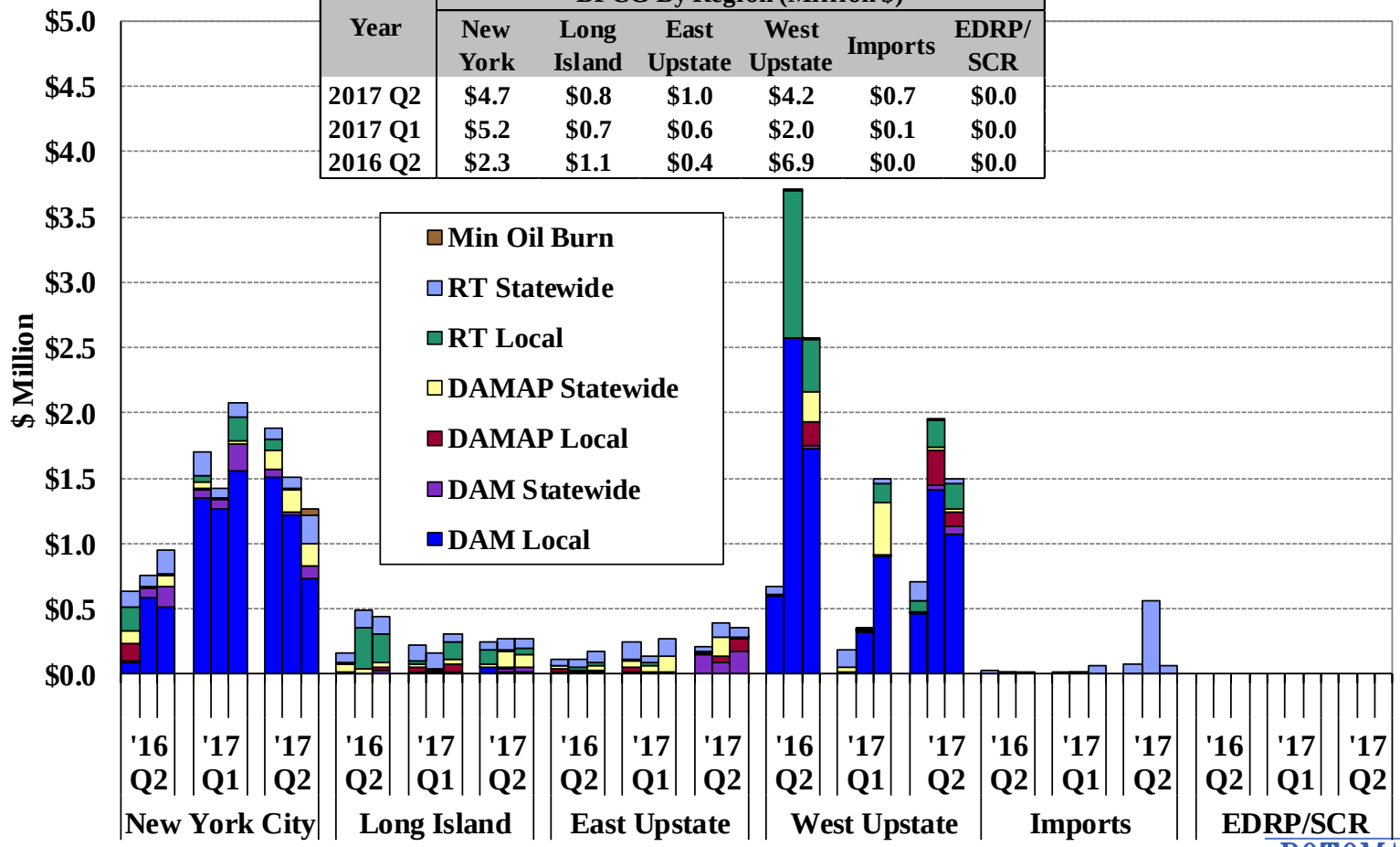
Highlights and Market Summary:
Uplift and Revenue Shortfalls

- Guarantee payments were $11.2M which was comparable to 2016-Q2. (see slides 76-79)
- Guarantee payments rose in New York City and fell in Western NY due to:
  - ✓ Higher gas prices that increased the commitment costs of gas-fired units in-city;
  - ✓ Increased supplemental commitment for reliability in New York City; and
  - ✓ Decreased OOM dispatch and commitment of the Milliken units. (see slides 73-75)
- Congestion shortfalls were $21M in the DAM and $11M in the RTM. DAM levels were higher and RTM levels lower than in 2016-Q2. (see slides 55-56)
  - ✓ Transmission outages accounted for the majority of DAM shortfalls (roughly 80 percent) in the second quarter of 2017.
    - – $17 million was allocated to the responsible TO.
  - ✓ Nearly all of RTM shortfalls were associated with the North Zone lines, the West Zone lines, and the Capital to Hudson Valley lines.
    - – North Zone RTM shortfalls were accrued almost in their entirety due to transmission outages on two days in early April (totaling $4.6 million in RTM shortfalls).

Uplift Costs from Guarantee Payments
By Category and Region

Year	BPCG By Region (Million $)					
	New York	Long Island	East Upstate	West Upstate	Imports	EDRP/ SCR
2017 Q2	$4.7	$0.8	$1.0	$4.2	$0.7	$0.0
2017 Q1	$5.2	$0.7	$0.6	$2.0	$0.1	$0.0
2016 Q2	$2.3	$1.1	$0.4	$6.9	$0.0	$0.0



Note: BPCG data are based on information available at the reporting time that can be different from final settlements.

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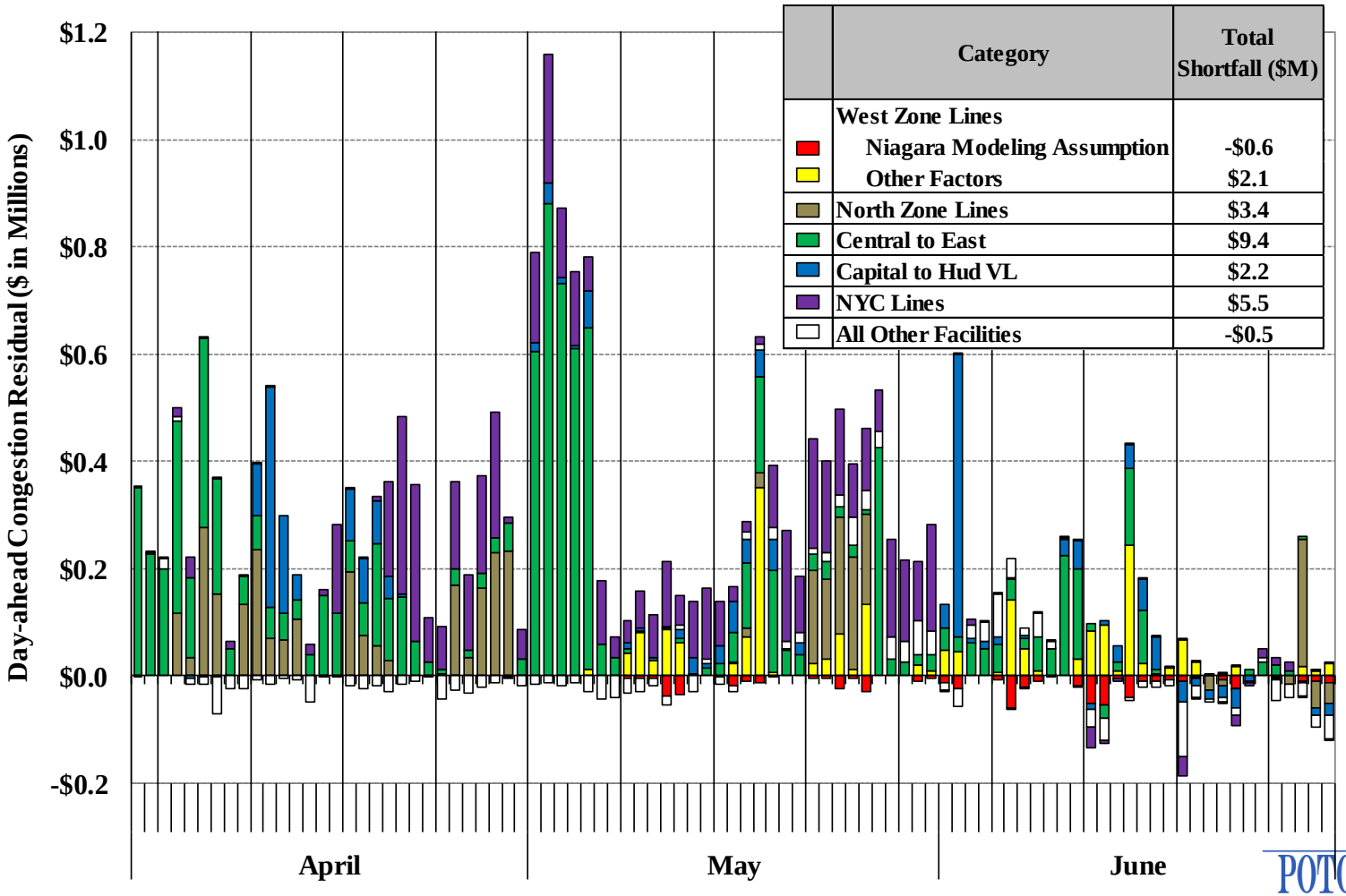
Day-Ahead Congestion Revenue Shortfalls
by Transmission Facility



	Category	Total Shortfall ($M)
	West Zone Lines	
	Niagara Modeling Assumption	-$0.6
	Other Factors	$2.1
	North Zone Lines	$3.4
	Central to East	$9.4
	Capital to Hud VL	$2.2
	NYC Lines	$5.5
	All Other Facilities	-$0.5

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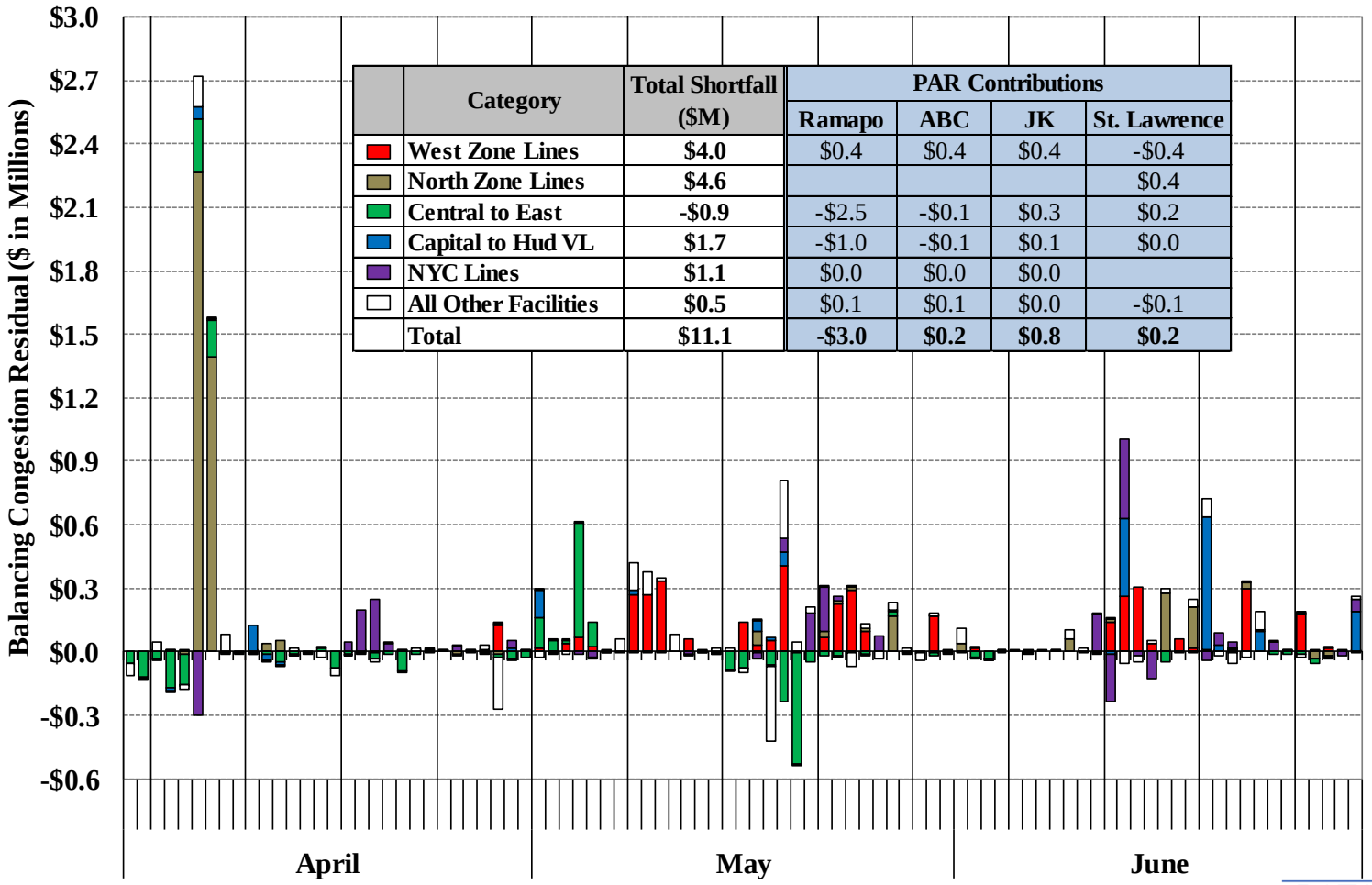
Balancing Congestion Shortfalls
by Transmission Facility



	Category	Total Shortfall ($M)	PAR Contributions			
			Ramapo	ABC	JK	St. Lawrence
	West Zone Lines	$4.0	$0.4	$0.4	$0.4	-$0.4
	North Zone Lines	$4.6				$0.4
	Central to East	-$0.9	-$2.5	-$0.1	$0.3	$0.2
	Capital to Hud VL	$1.7	-$1.0	-$0.1	$0.1	$0.0
	NYC Lines	$1.1	$0.0	$0.0	$0.0	
	All Other Facilities	$0.5	$0.1	$0.1	$0.0	-$0.1
	Total	$11.1	-$3.0	$0.2	$0.8	$0.2

Note: The BMCR estimated above may differ from actual BMCR because the figure is partly based on real-time schedules rather than metered values.

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Highlights and Market Summary:
Capacity Market

- In 2017-Q2, spot prices ranged from $1.99/kW-month in ROS $8.02/kW-month in NYC. (see slides 88-91)
  - ✓ Average spot price for the second quarter include one month of winter pricing (April) and two months of summer pricing (May and June).
- Compared to 2016-Q2, average spot prices fell 21 to 45 percent in NYC and NYCA and rose 9 to 17 percent in the G-J Locality and Long Island.
  - ✓ Price changes in all regions were driven largely by changes to the IRM and Net CONE of the proxy unit from the Demand Curve Reset process.
    - Net CONE values rose substantially in both G-J Locality and in Long Island while falling in NYC and NYCA which impact capacity prices in directionally the same way. (see slide 91)
  - ✓ Internal supply fell predominantly due to DMNC testing and increased exports, but this was partly offset by the return of Greenidge 4.
    - Additionally, import levels averaged 430 MW higher this quarter compared to 2016-Q2 with noticeably more imports from PJM more than offsetting reduced imports from ISO-NE.