Second Year Evaluation of CTS between New England and New York

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Introduction and Summary

- CTS has improved from $2.0M of production cost savings (compared to hourly scheduling) in 2016 to $4.8M in 2017.
- This presentation summarizes our study comparing:
  - ✓ CTS, which uses (i) forecasted price differences and (ii) MP offers; and
  - ✓ Tie Optimization ("TO"), which uses forecasted price differences only.
- A tariff-defined trigger would lead to the adoption of TO if a study of Year 2 indicated it would lead to significant savings.
- We find Year 2 results are similar to Year 1 results:
  - ✓ TO would have *increased* production costs (compared to CTS) by $0.4 million in Year 2 largely because of forecast errors.
  - ✓ The trigger for moving to TO has not been satisfied.
  - ✓ We discuss the forecast errors and potential improvements the ISOs could explore to reduce them.

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Overview of Presentation

- Background
- Description of Model
- Summary of Results
- Discussion of Forecasting Issues
- Conclusions
- Appendix

Background

Background

- In 2011, Stakeholders in the ISO-NE and NYISO markets considered options for improving interchange between markets
- Two options emerged:
  - ✓ Tie Optimization
  - ✓ Coordinated Transaction Scheduling
- Simulations performed at the time found that TO would perform better than CTS.
  - ✓ TO simulations provided $3.4M/year (35 percent) of additional production cost savings over CTS.
  - ✓ However, it is difficult to simulate trading behavior under CTS.
- Ultimately, stakeholders adopted CTS, but the filing included a process for switching to TO, if warranted.

Background

- CTS implemented on December 15, 2015
- NYISO tariff requires:
  - ✓ MMU perform evaluation after first year & after second year.
  - ✓ MMU shall estimate:
    - 31.2(i) - *actual bid production cost savings…that would have occurred had the ISOs had an infinite number of zero bids in the CTS process… (“**Tie Optimization Interchange**”);* and
    - 31.2(ii) - *actual bid production cost savings…that would have occurred had the ISOs had an infinite number of zero bids in the CTS process, but utilizing actual real-time prices from each market rather than the forecasted prices that were used in the CTS process (“**Optimal Interchange**”).*
  - ✓ Second year evaluation triggers potential market design change.

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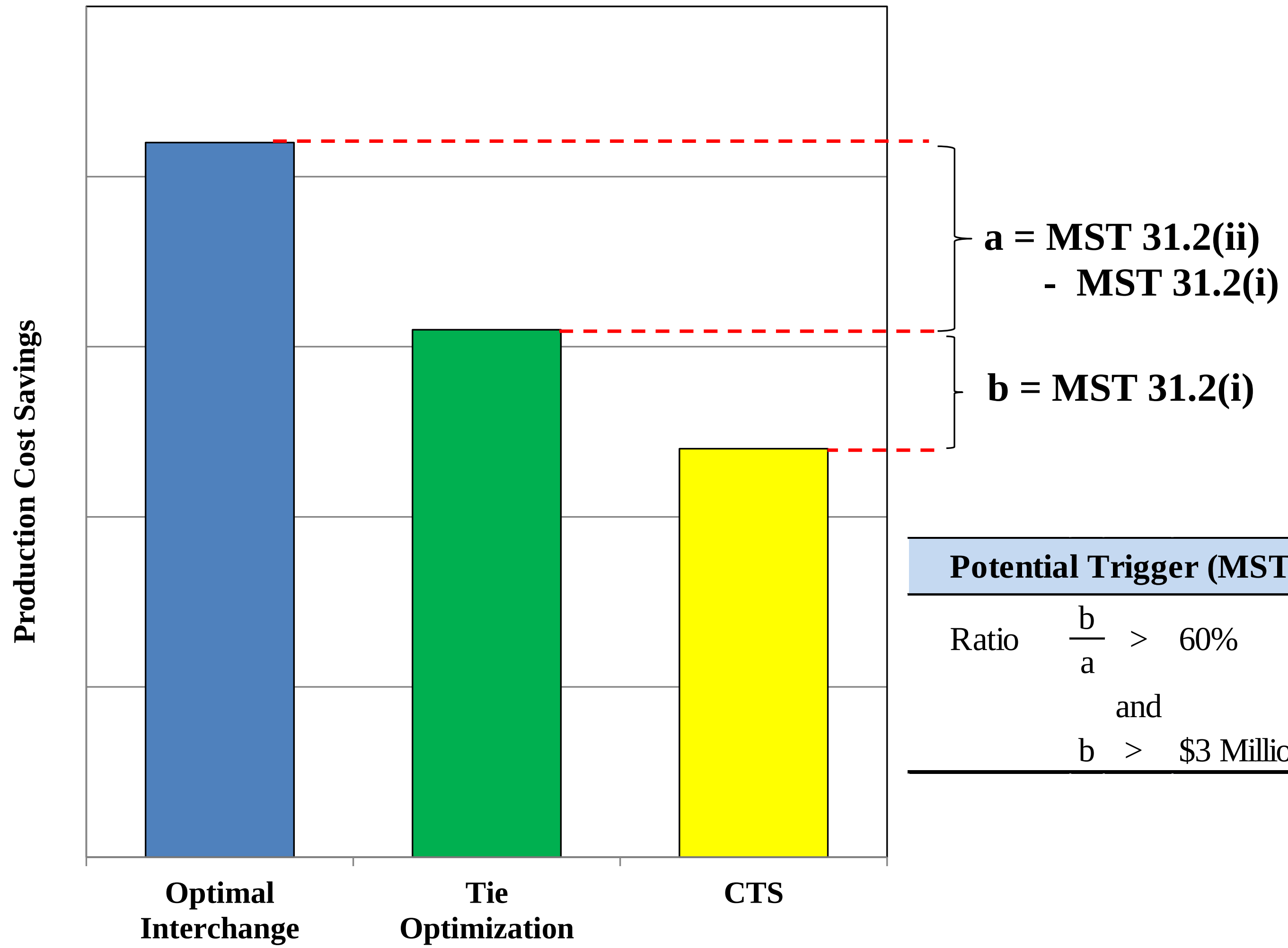
Background
Illustration of Potential Triggers



Potential Trigger (MST 31.2.1)			
Ratio	$\frac{b}{a}$	>	60%
	and		
	b	>	$3 Million/Year

Description of Simulation Model

Description of the Simulation Model

- Adjusts interchange toward higher-priced market until:
  - ✓ Interface is fully loaded;
  - ✓ Internal constraints prevent additional re-dispatch;
  - ✓ Adjustment reaches 200 MW from interchange that actually occurred; or
  - ✓ Prices at the border equalize.
- Supply curves constructed for each market:
  - ✓ Based on Inc Energy offers from online and offline 10-minute resources;
  - ✓ Respects active transmission constraints:
    - – Units with lower congestion component (than at the border) are eligible to go down only; and
    - – Units with higher congestion component (than at the border) are eligible to go up only.
  - ✓ Ignores ancillary services requirements and ramp limits.

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Description of the Simulation Model
Optimal Interchange Case

- The interchange is adjusted every 5 minutes toward the optimal level (based on actual RTD prices and LMP-c prices).
- Up/down supply curves are constructed from eligible resources based on NYISO RTD and ISO-NE LMPc results.
- Bid production cost savings are estimated based on these curves and resulting optimal interchange adjustments.
  - ✓ **Production cost savings are always non-negative.**
- The following figure illustrates this for a particular interval (August 1, 2016 at 9:05 am).

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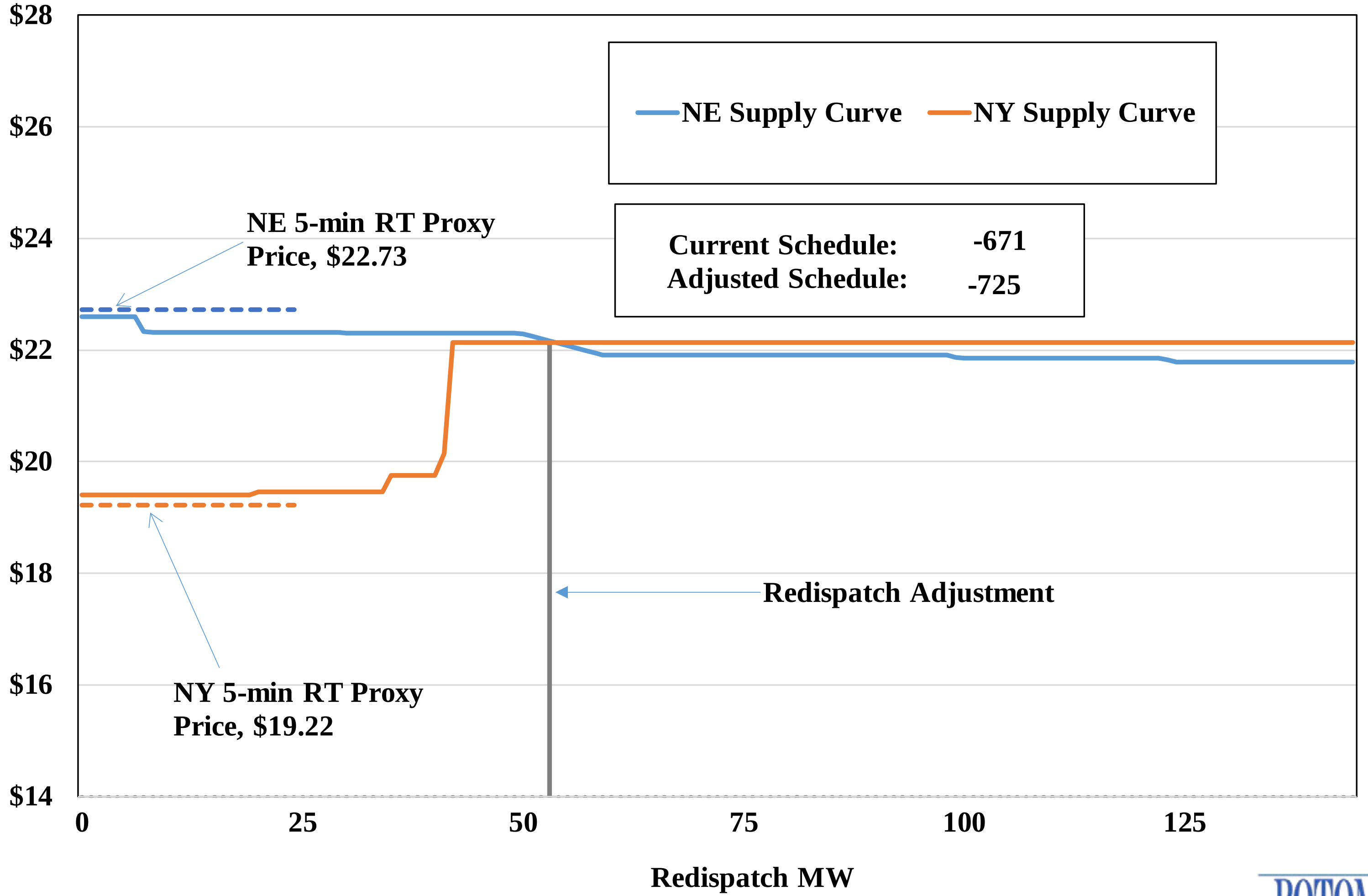
Description of the Simulation Model
Illustration of Optimal Interchange Case



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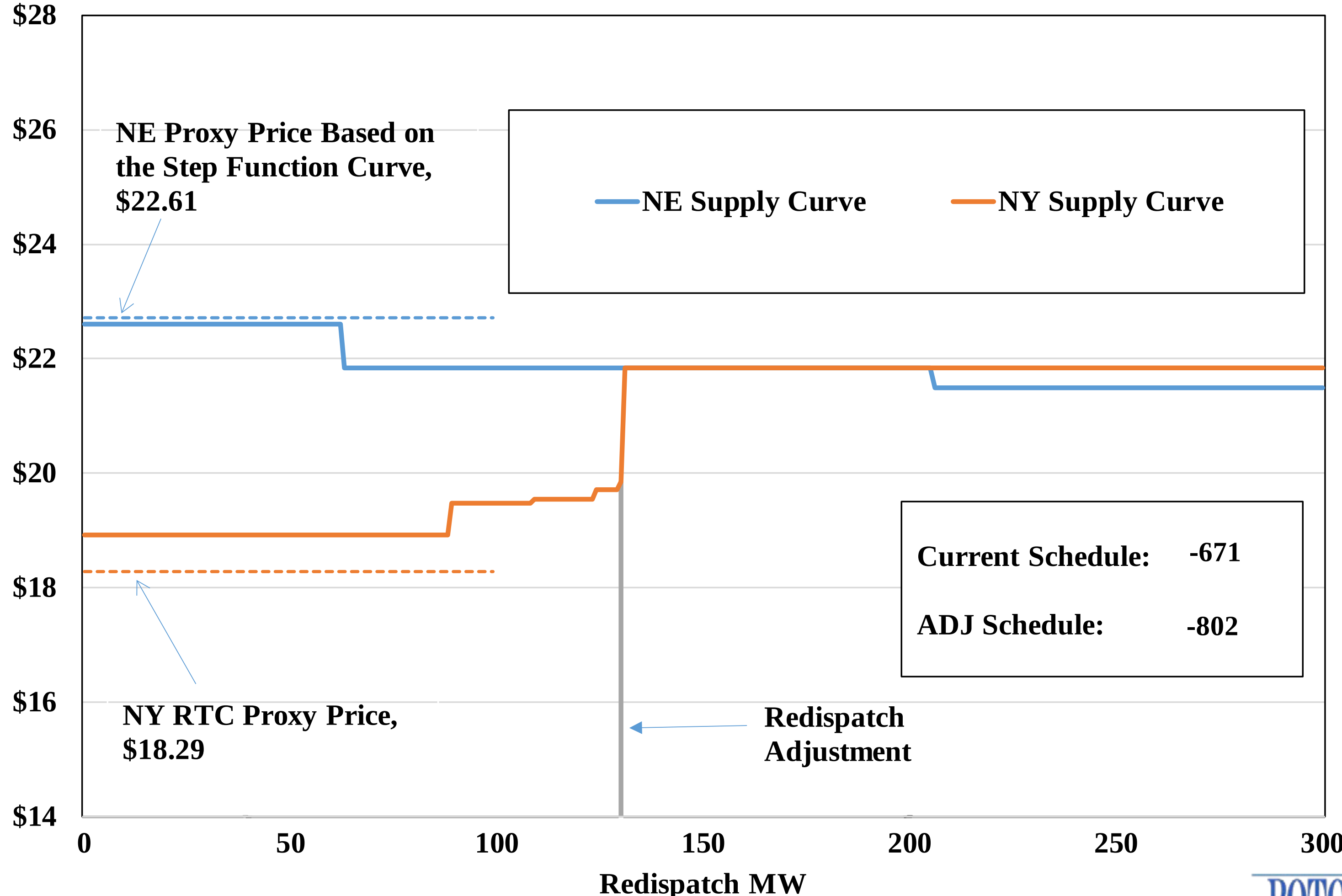
Description of the Simulation Model
Tie Optimization Case

- Step 1: Sets interchange every 15 minutes to forecast optimum.
  - ✓ NYISO supply curves based on RTC "binding" intervals
  - ✓ ISO-NE supply curves based on step-function evaluated by RTC:
    - – ISO-NE creates a 7-point piecewise linear supply curve; and
    - – NYISO converts this to a 7-step function for the RTC evaluation.
- Step 2: Calculates bid production cost savings resulting from interchange that is set in Step 1.
  - ✓ Reflects interchange ramp profile (e.g., if Step 1 is +200 MW at :30, Step 2 assumes +100 MW at :30 and +200 MW at :35 and :40)
  - ✓ NYISO and ISO-NE supply curves based on 5-minute RTD and LMPc results.
  - ✓ **Production cost savings are not necessarily positive.**
- This is illustrated in the following two slides.

Description of Simulation Model

Illustration of Tie Optimization Step 1



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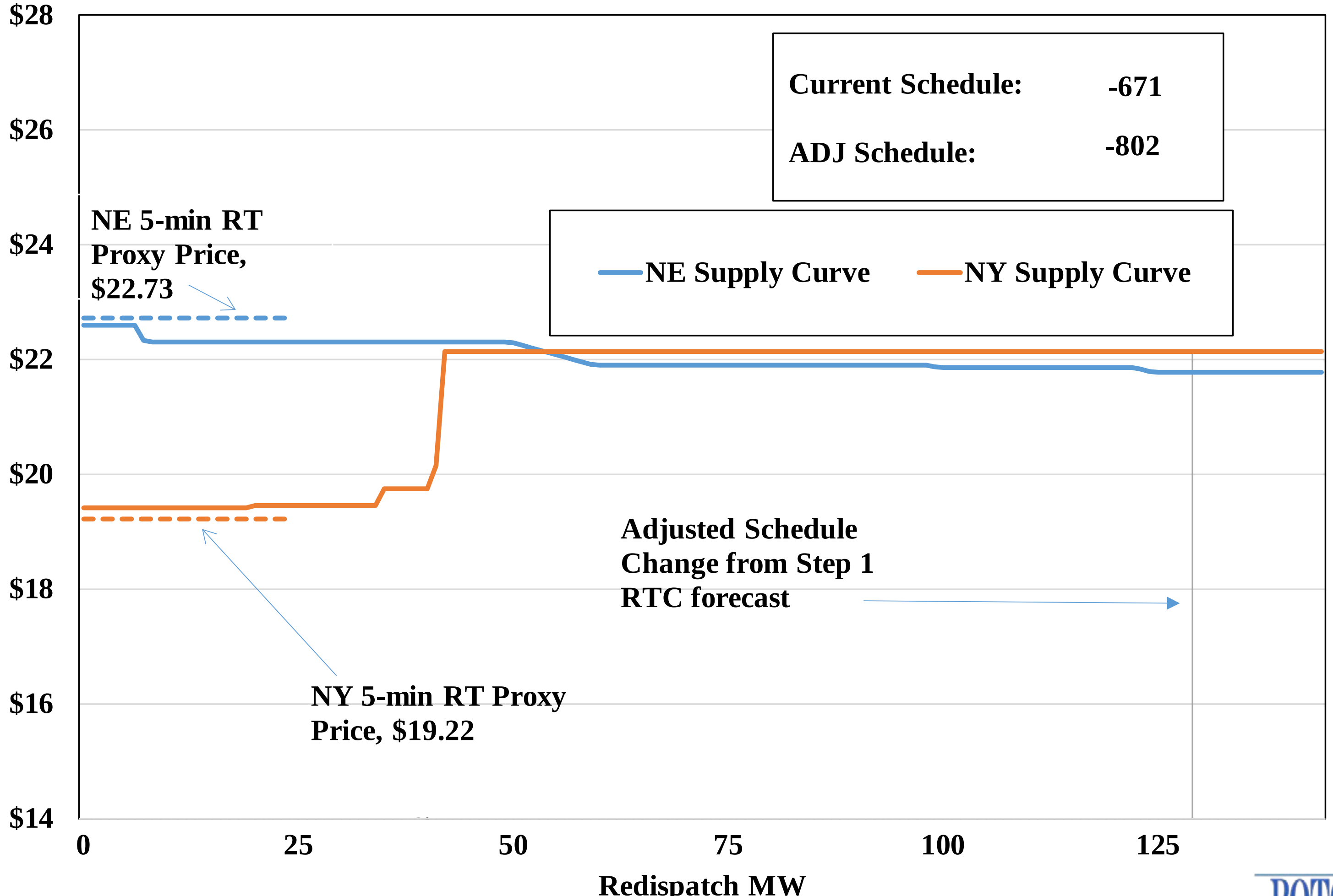
Description of Simulation Model

Illustration of Tie Optimization Step 2



Summary of Results

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Summary of Simulation Results

- The figure shows monthly production cost savings for Optimal Interchange (“OI”) and Tie Optimization (“TO”) cases.
  - ✓ For Year 2 of CTS, we estimate OI would reduce regional bid production costs by $5.3 million, while TO would ***increase*** them by $0.4 million.
  - ✓ This is very similar to the Year 1 results.

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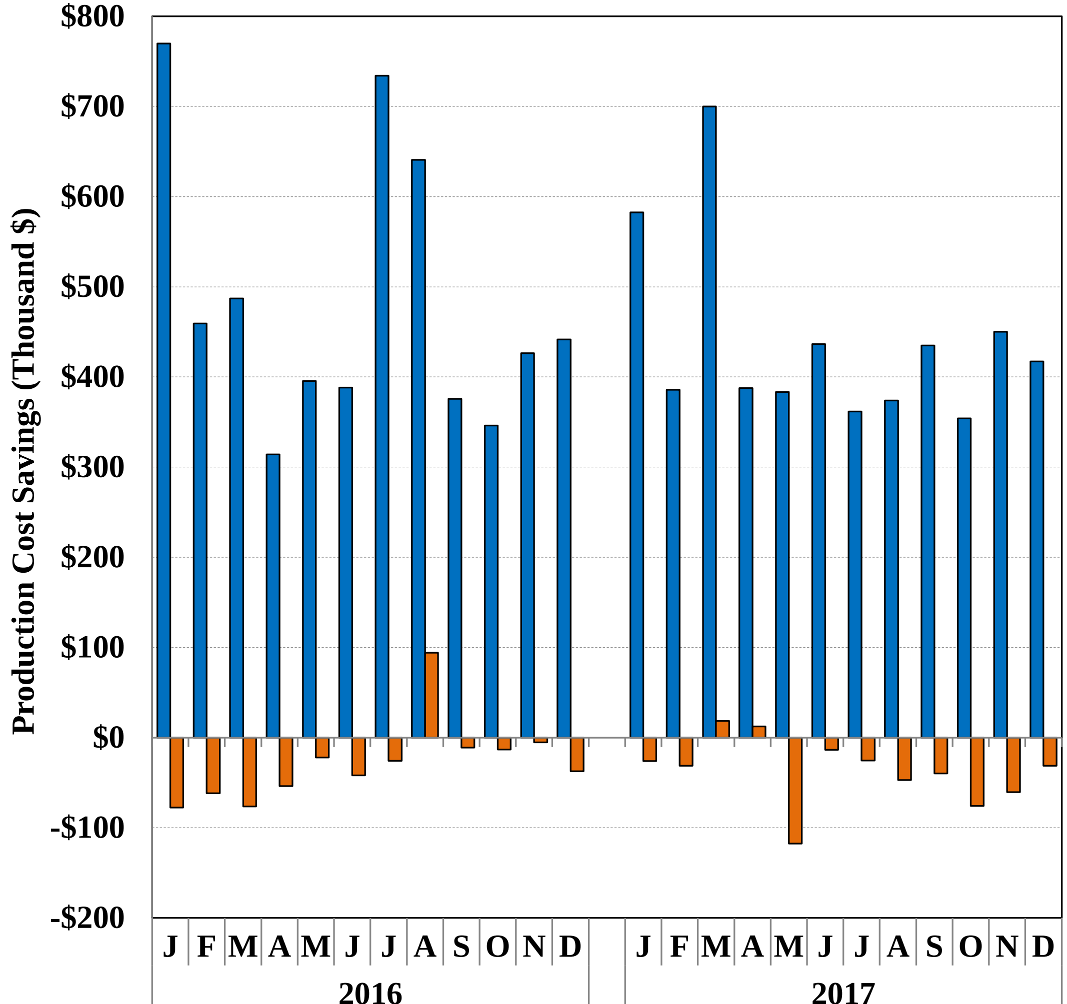
Estimated Production Cost Savings
By Month



Production Cost Savings ($M)	2016	2017
Optimal Interchange	$5.8	$5.3
Tie Optimization	-$0.3	-$0.4

Trigger Value for 2017	
b =	-$0.4M
a =	$5.7M
b / a =	-8%

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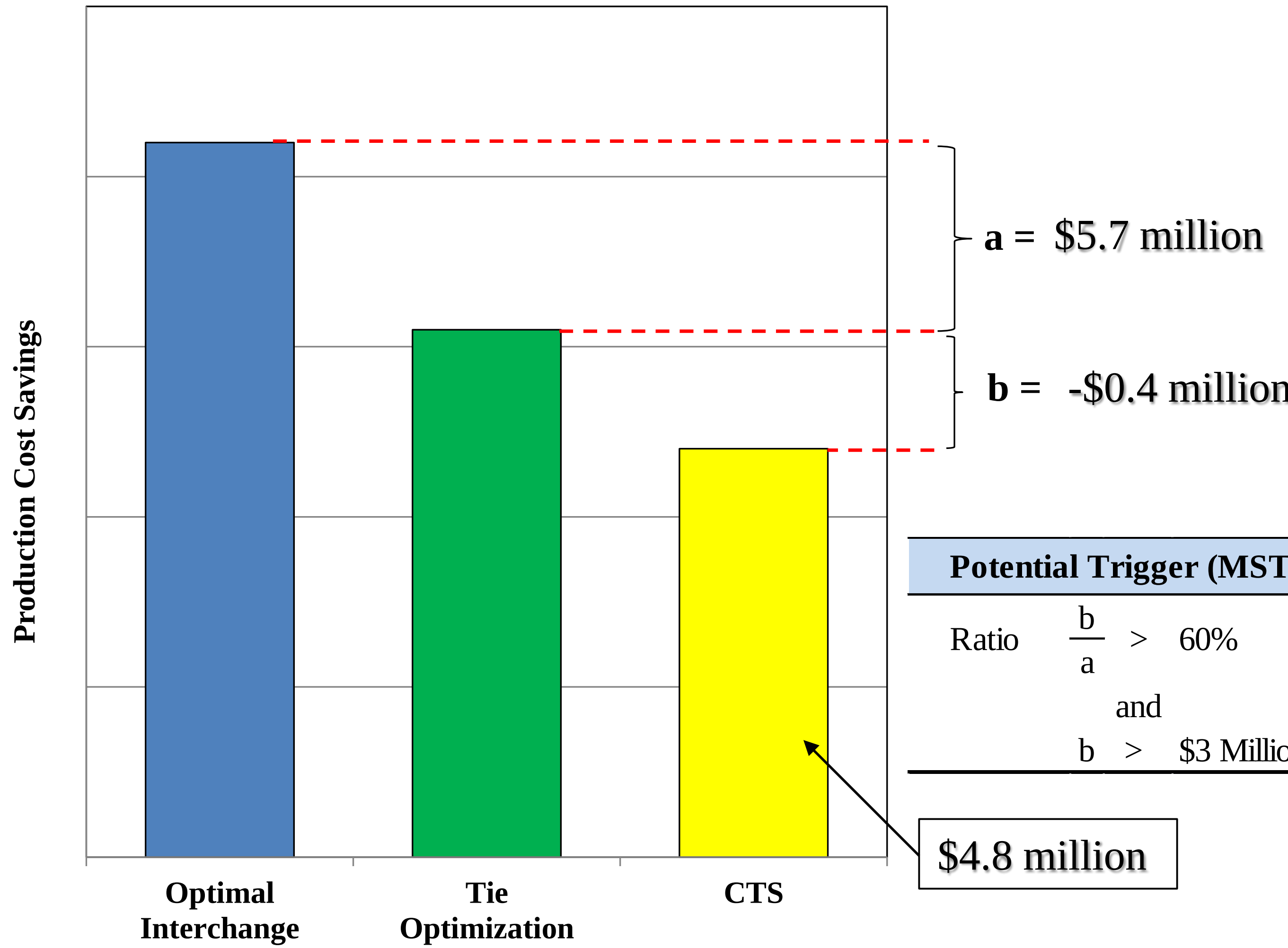
Results versus Potential Triggers



Potential Trigger (MST 31.2.1)

Ratio $\frac{b}{a} > 60\%$

and

$b >$ \$3 Million/Year

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Summary of Simulation Results

- The table summarizes the results comparing the interchange adjustments in the two cases:
  - ✓ No Adjustment: No interchange adjustments for both TO and OI.
  - ✓ Same Adjustment: Same interchange adjustments for TO and OI.
  - ✓ Over-Adjustment: TO over-adjusts the interchange in the same direction as OI (including TO adjusts but OI does not).
  - ✓ Under-Adjustment: TO under-adjusts the interchange in the same direction as OI (including OI adjusts but TO does not).
  - ✓ Adjustment in Wrong Direction: TO adjusts in the opposite direction as OI.

Estimated Production Cost Savings
By Category of Adjustment, 2017

Category of Adjustment		Production Cost Savings: Tie Optimization (TO)	Production Cost Savings: Optimal Interchange (OI)	% of 5-Minute Intervals
No Adjustment				22%
Same Adjustment		$0.6	$0.6	5%
Over Adjustment	Same Direction as OI	-$0.03	$0.1	9%
	No OI Adjustment	-$0.5		9%
Under Adjustment	Same Direction as OI	$0.7	$1.5	17%
	NO TO Adjustment		$2.0	24%
Adjustment in Wrong Direction		-$1.3	$1.1	14%
Total		**-$0.4**	**$5.3**	**100%**

Discussion of Forecasting Issues

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Discussion of Forecasting Issues

- The next figure summarizes the distribution of forecast errors.
  - ✓ Green: Distribution of NE-side forecast error

    = (a) Forecast using 7-step supply curve – (b) LMPc price
  - ✓ Blue: Distribution of NY-side forecast error

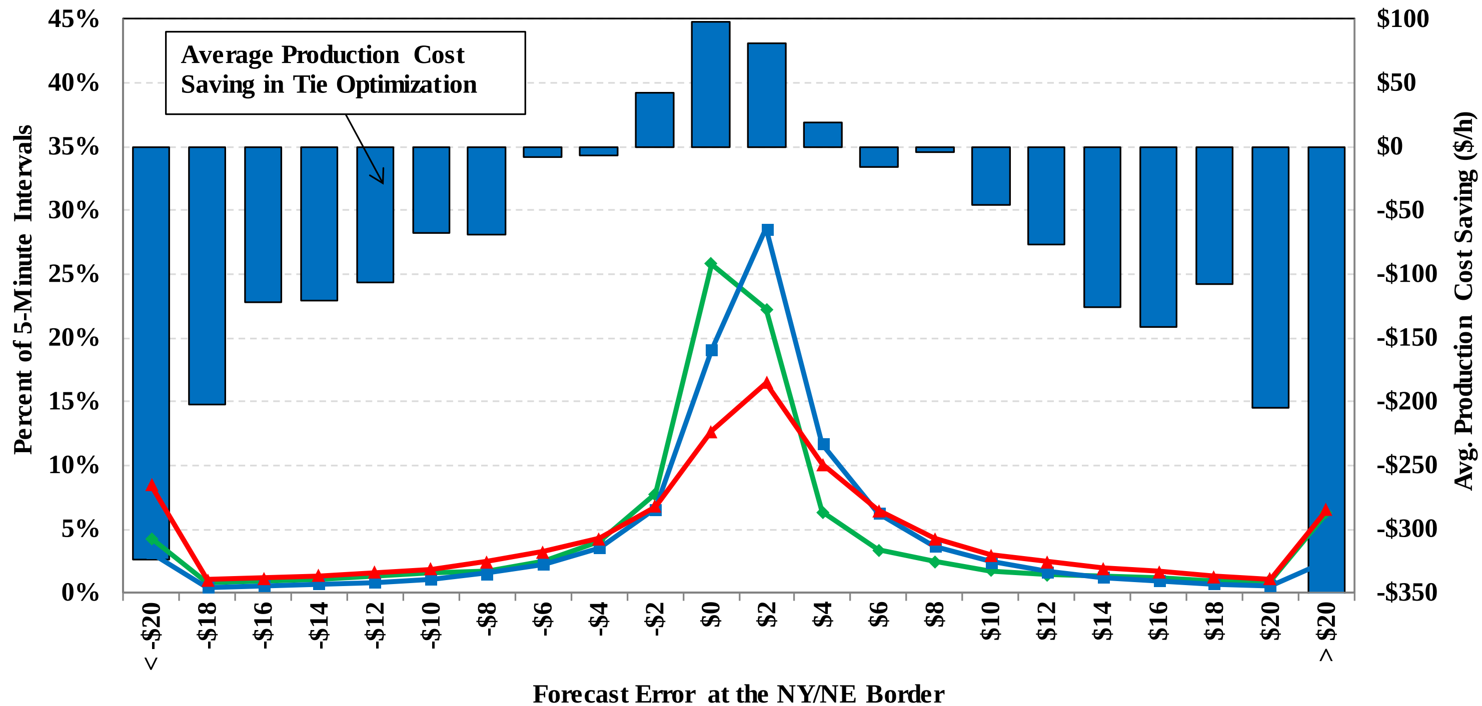
    = (c) RTC price – (d) RTD price
  - ✓ Red: Distribution of forecast error differential

    = [(c) – (a)] – [(d) – (b)]. When this is positive, the values is shown with the "Over-Forecast Amount" group. When this is negative, the values are shown with the "Under-Forecast Amount" group.
  - ✓ The bars show the average production cost savings in our TO simulations for each category.

Discussion of Forecasting Issues

- ISO-NE forecast of the border price was $1.26/MWh *higher* on average than the actual price in 2017 during CTS-enabled intervals,
  - ✓ NYISO forecast was $0.98/MWh *lower* than the actual price.
  - ✓ The forecasts would have led TO to systematically over-schedule toward ISO-NE.
- Forecast errors by each ISO were widely distributed, exceeding $10/MWh in 14 to 22 percent of intervals in 2017.
- The forecast error of the border price differential (the red line) exceeded $10/MWh in 30 percent of intervals in 2017, leading to larger inefficiency of interchange scheduling.
  - ✓ The production cost savings from TO were generally negative when forecast errors were greater than $6/MWh.

Forecast Errors and Production Cost Savings Shortfalls, 2017



	Forecast Error ($/MWh)				% of Intervals When Forecast Errors	
	MEAN	MIN	MAX	STD	Within $10/MWh	Beyond $20/MWh
NE Forecast	$1.26	-$994	$2,763	$29	78%	11%
NY Forecast	-$0.98	-$1,923	$1,933	$31	86%	6%
Border Differential	-$2.24	-$2,759	$2,004	$42	70%	15%

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Factors Contributing to Forecast Error

Factors Contributing to NYISO Forecast Error

- We evaluated factors that contribute to price forecast errors by the NYISO model that schedules CTS transactions (i.e., RTC).
- We found the largest contributing factors were:
  - ✓ *Congestion management issues* (39 percent) – Includes effects of changes in: (a) loop flows, (b) inaccurate modeling of PARs, (c) transmission outages, (d) transfer limits, and (e) intrazonal load distribution.
  - ✓ *Load and wind forecasting* (22 percent) – Includes changes in forecast
  - ✓ *Ramp profile and timing* (18 percent) – Includes price differences resulting from differences between RTC and RTD in the assumed ramp profile or the time being evaluated.
- In the coming months, we plan to provide:
  - ✓ More detailed results from this analysis of NYISO forecast error, and
  - ✓ A similar assessment of factors contributing to forecast error in the models that ISO-NE uses to provide its forecast to the NYISO.

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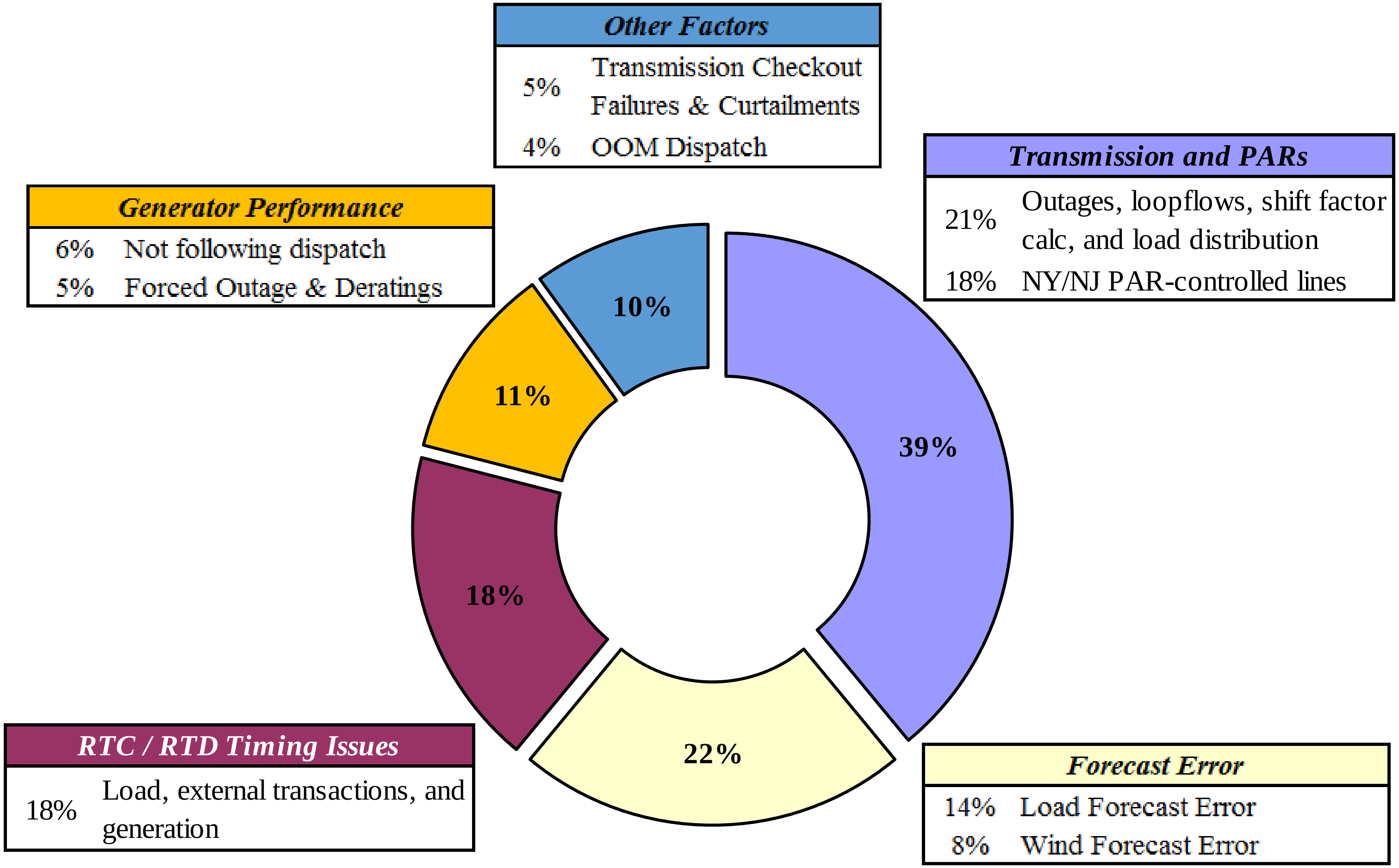
Factors Contributing to NYISO Forecast Error



Conclusions

Conclusions

- Based on our simulations for Year 2:
  - ✓ CTS has reduced production costs by an estimated $4.8 million.
  - ✓ Optimal Interchange would have reduced production costs by an additional $5.3 million.
  - ✓ However, Tie Optimization would have increased production costs by $0.4 million.
  - ✓ These results are well below the tariff thresholds that would trigger an assessment by the ISOs.
- Forecast errors would likely have led Tie Optimization to adjust the interchange to a suboptimal level or even in the wrong direction relatively frequently.
  - ✓ Regardless of whether the ISOs use Tie Optimization or CTS, these results highlight the need to enhance forecasting tools.
  - ✓ Accurate forecasting is also important for efficient commitment of fast start units and external transactions at other interfaces.

Conclusions

- We have previously identified factors that contribute to forecast error in the ISO-NE and NYISO markets, including:
  - ✓ Inconsistency between the scheduling models and dispatch models related to the timing of external interchange ramp
  - ✓ NYISO uses a 7-step approximation of ISO-NE’s supply function
  - ✓ Load forecast and wind forecast errors in both markets
  - ✓ Other factors that lead to transient real-time price volatility in the NYISO market (e.g., loop flows).
- See 2016 NYISO SOM Report at pages 49-52, 82-84 and 2016 ISO-NE Annual Report at pages 46-56.
- We plan to publish additional information this year regarding factors that contribute to forecast error by NYISO and by ISO-NE.

Appendix

Simulation Examples

- This appendix provides two additional illustrative examples from our simulations:
  - ✓ Example 1: Both TO and OI adjust the interchange in the same direction, but TO under-adjusts (below the optimal level in OI).
    - Production cost savings are positive for TO but lower than for OI.
  - ✓ Example 2: TO and OI adjust the interchange in the opposite direction because of TO forecast in the opposite direction.
    - Production cost savings are negative for TO.

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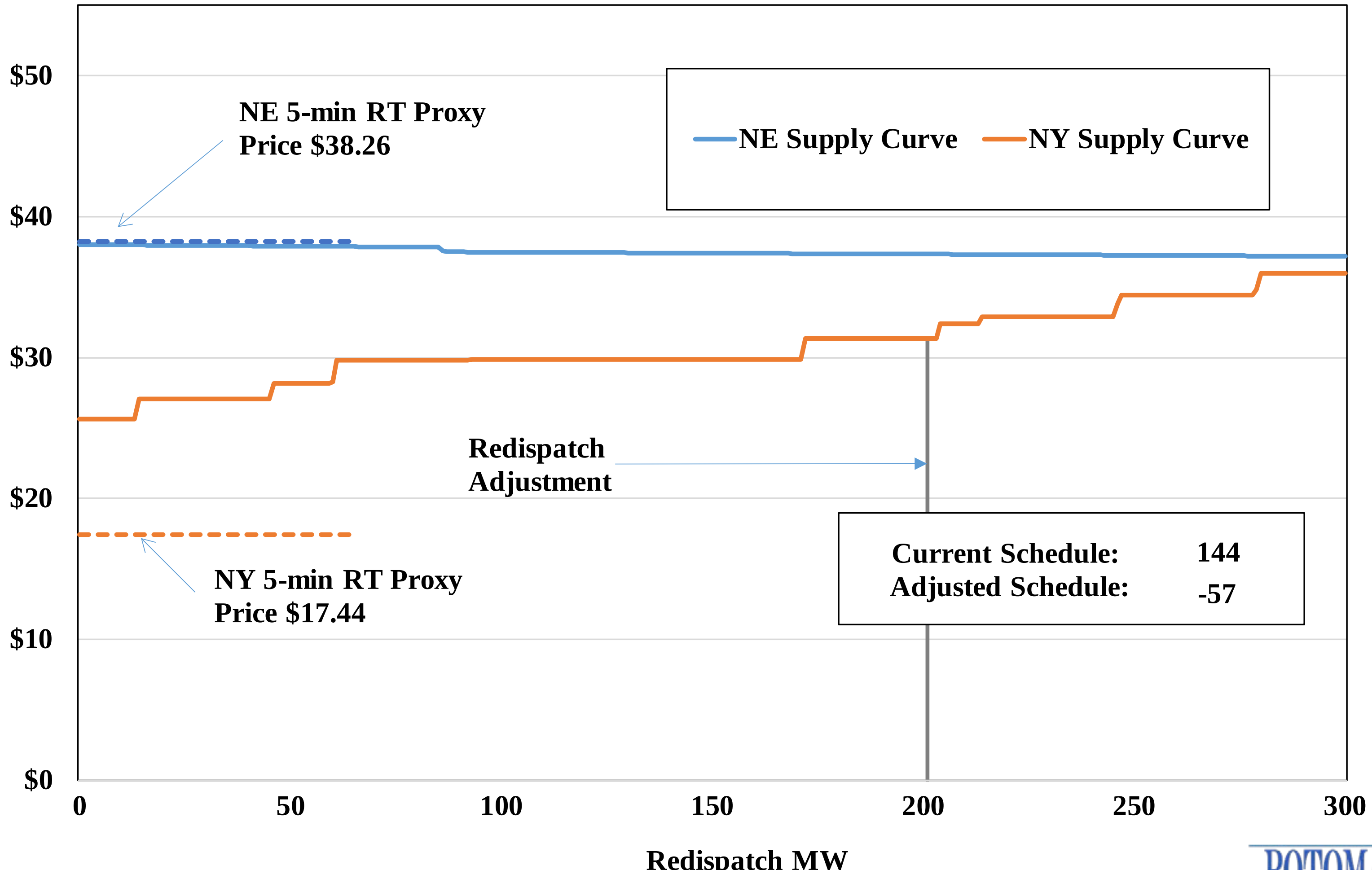
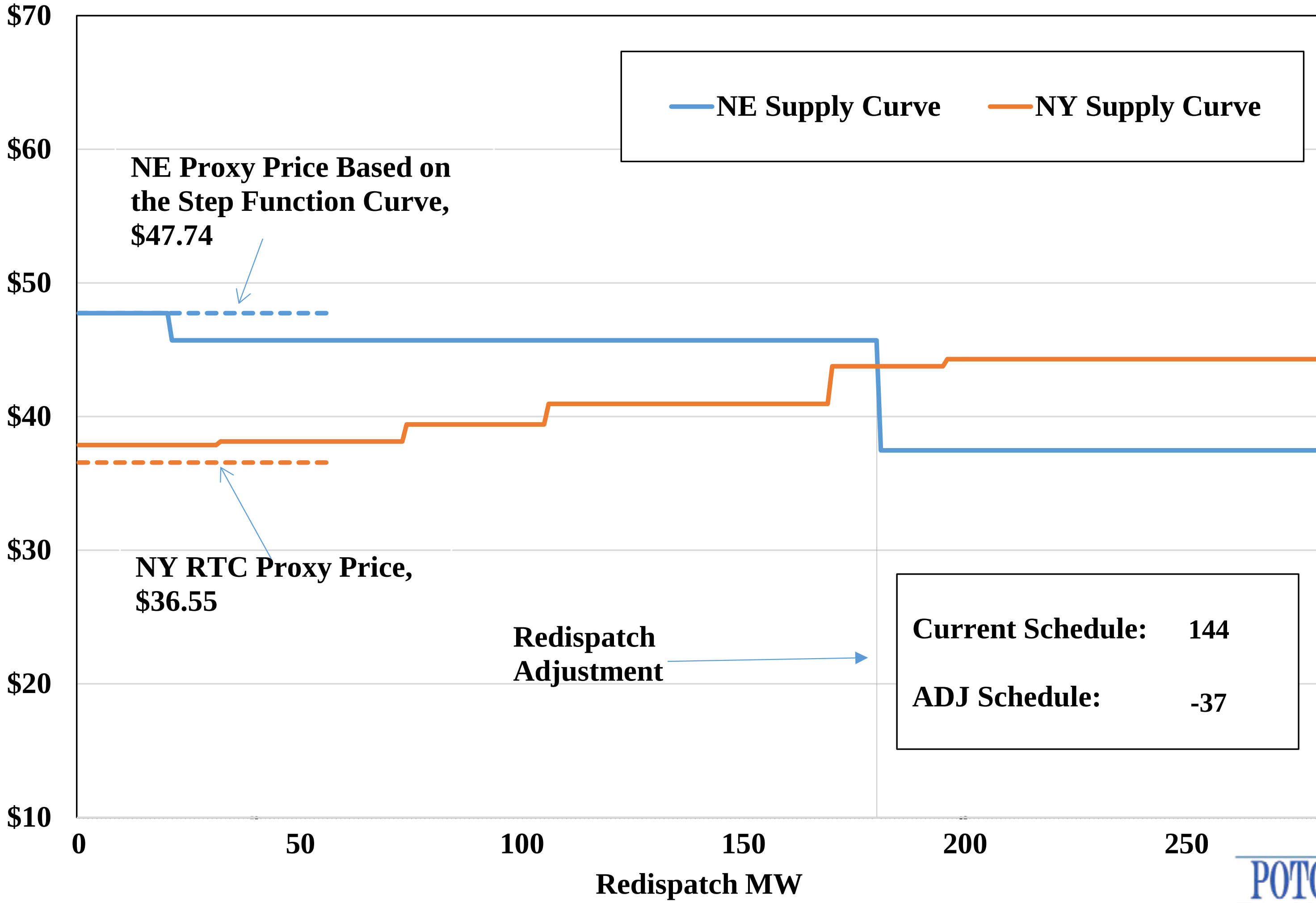
Example 1: Optimal Interchange Case June 1 at 15:20



Example 1: Tie Optimization Step 1
June 1 at 15:20



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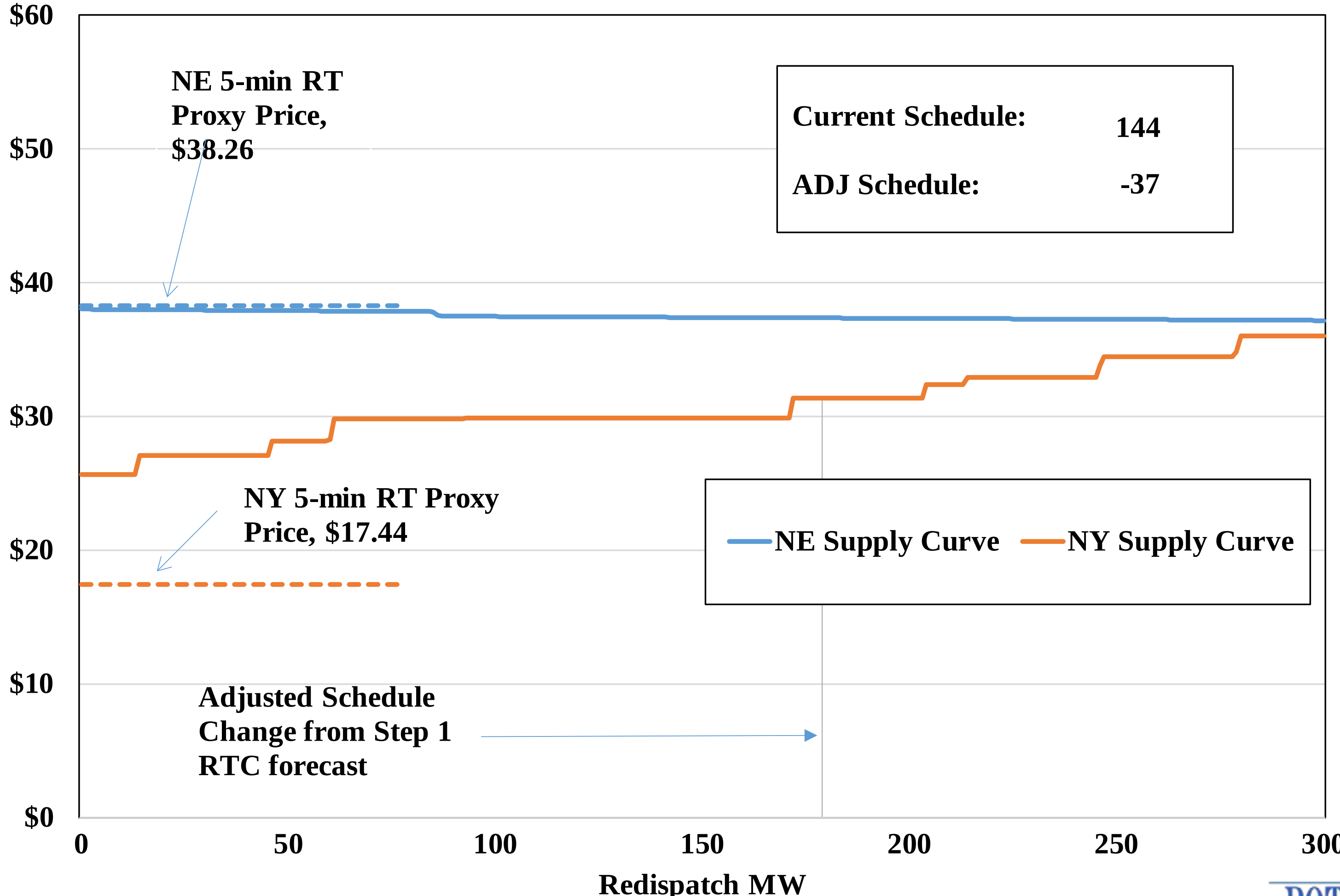
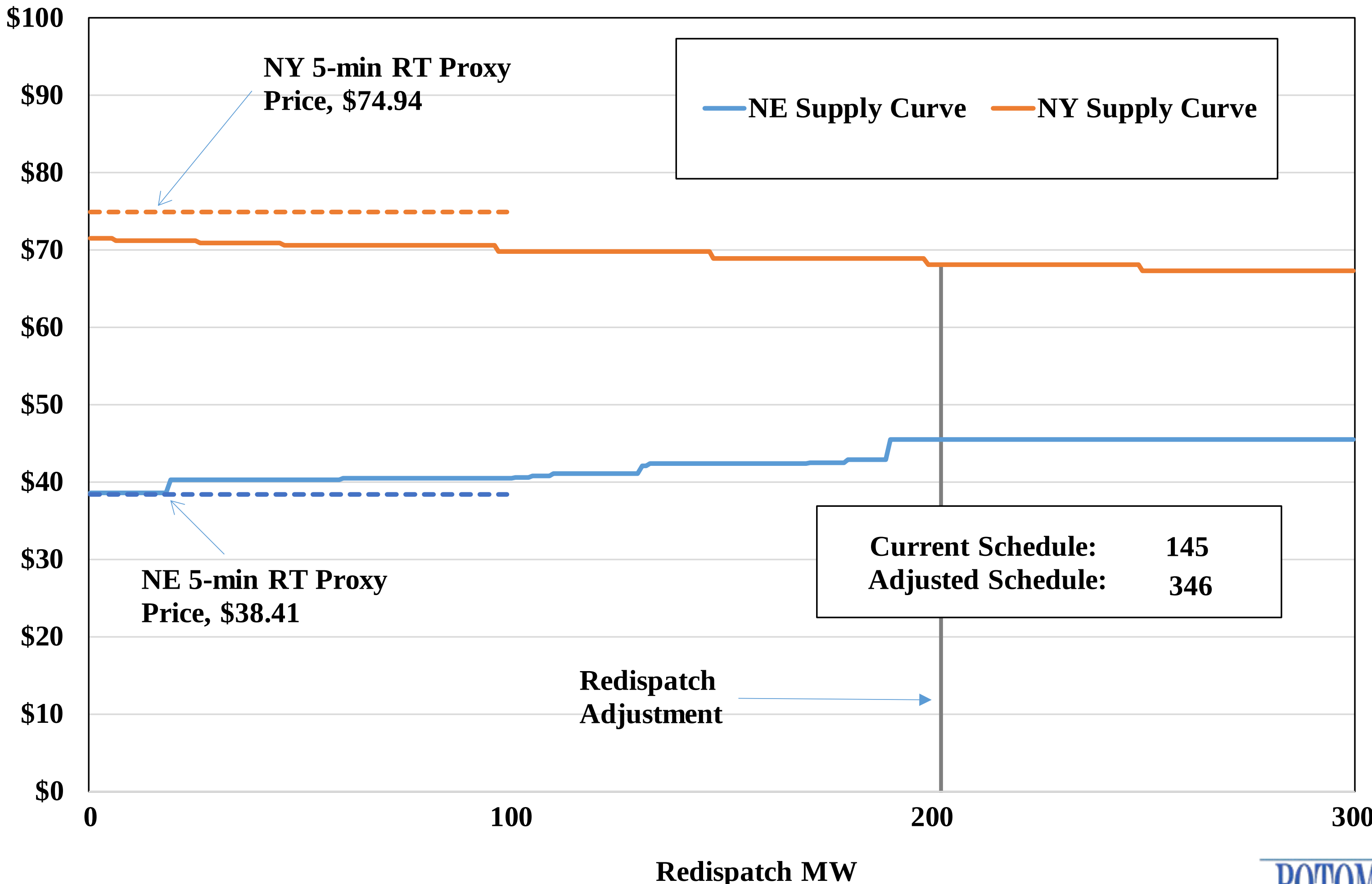
Example 1: Tie Optimization Step 2 June 1 at 15:20



Example 2: Optimal Interchange Case June 1 at 16:10



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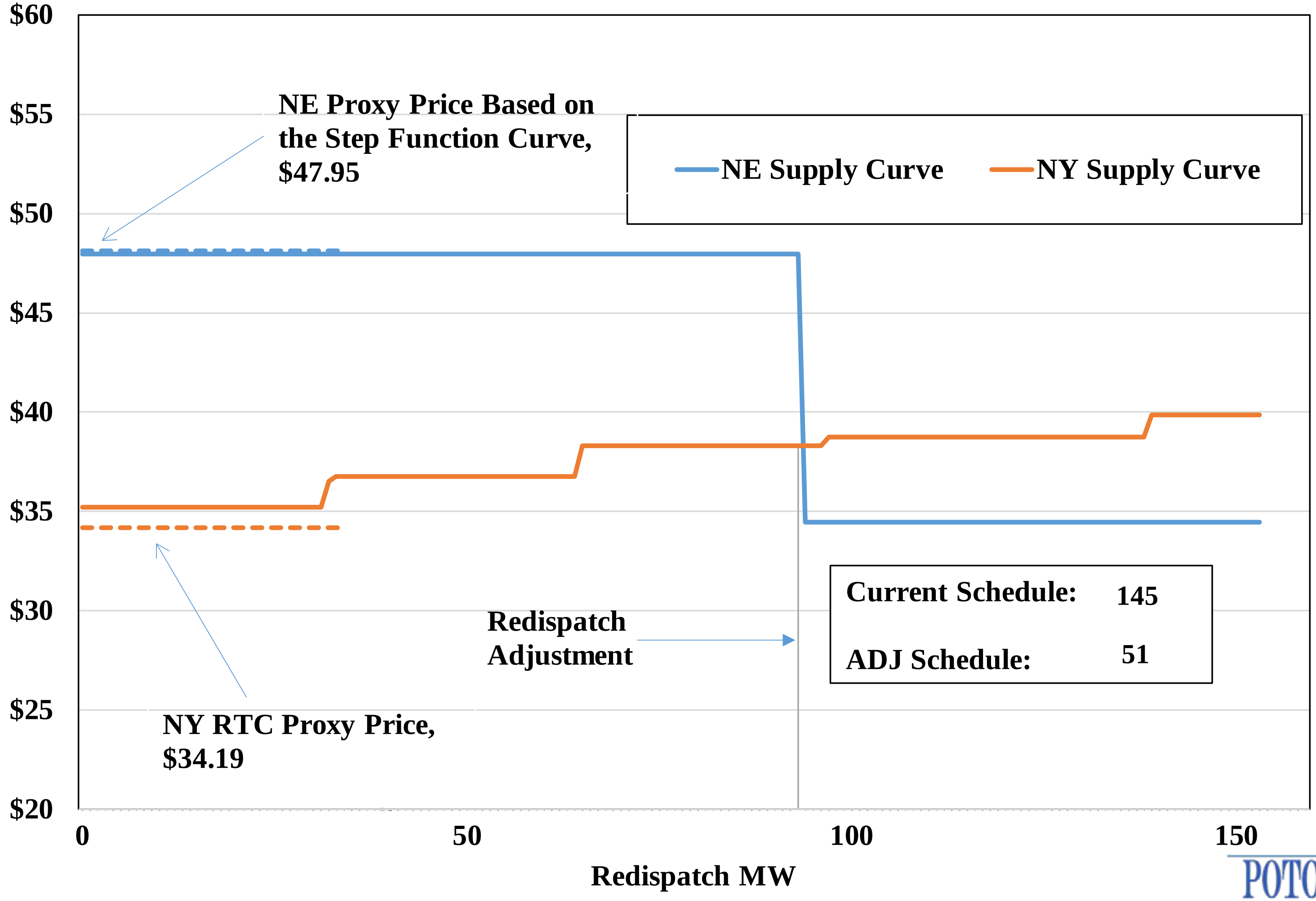
Example 2: Tie Optimization Step 1
June 1 at 16:10



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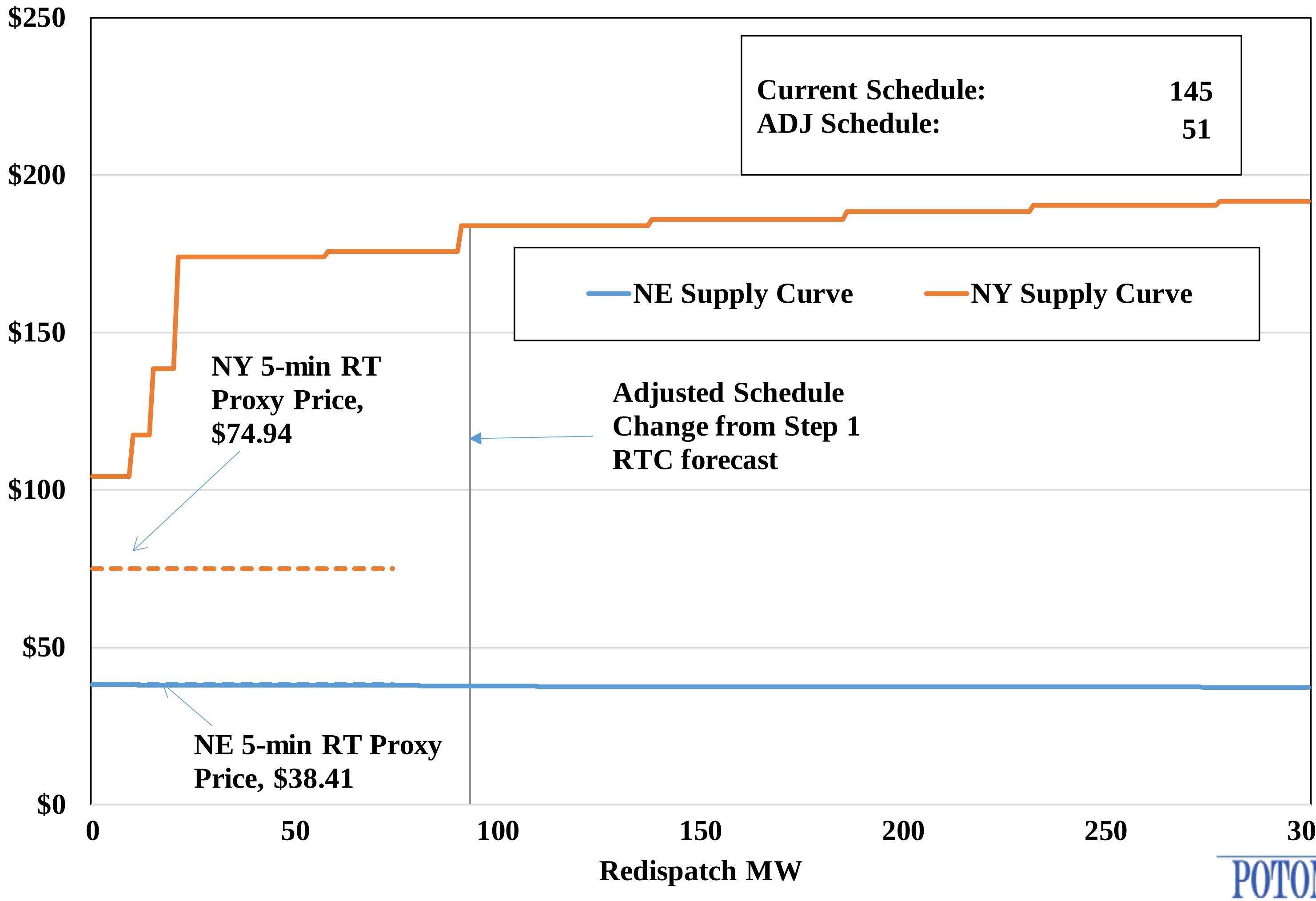
Example 2: Tie Optimization Step 2
June 1 at 16:10



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