Review of Coordinated Transaction Scheduling (CTS) Performance

December 15, 2015 – June 15, 2016

Shannon L. Carey

DIRECTOR, MARKET ANALYSIS & SETTLEMENT

ISO-NE PUBLIC

Summary

- CTS operations are working smoothly

- CTS would be more effective with greater market participation

- Additional experience and data are needed to draw firm conclusions about overall efficiency improvements

Objective: Increase Efficiency at the Interface

- Increase economic utilization of interface capacity

- Reduce latency between scheduling and actual flow

- Reduce "counterintuitive flow," where higher-priced power flows to the lower-priced region

- Use of "spread bids" for economic clearing of external transactions

CTS To-Date: Presentation Roadmap

- Operational observations

- Keys to success
  - ISO price forecasting
  - Spread bidding participation

- Summary and next steps

OPERATIONAL OBSERVATIONS

Constrained operations events are down significantly

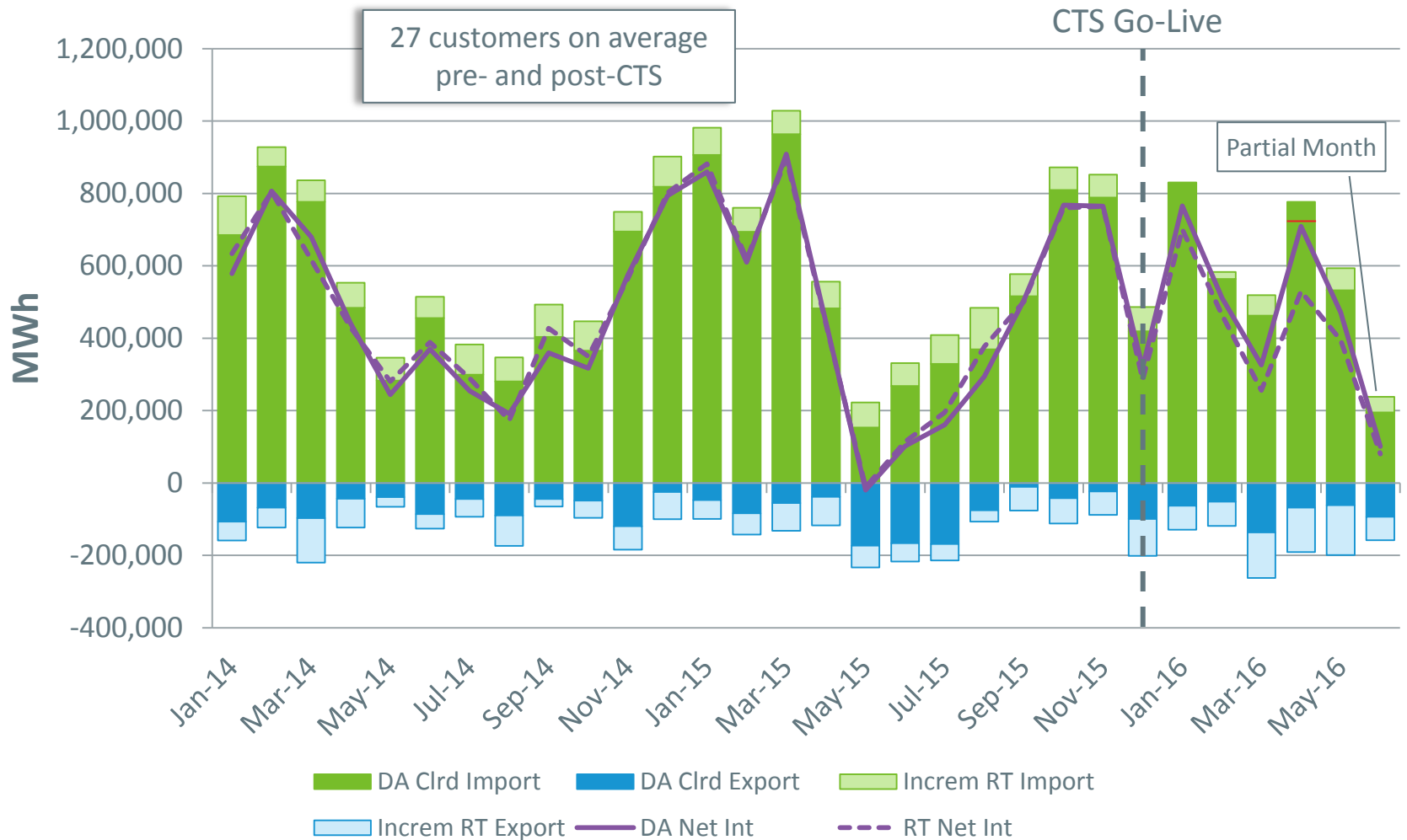| Hours where operator actions affected external transactions		
Condition	**Pre-CTS***	**Post-CTS‡**
Cut RT Only imports (Min Gen Warning)	22	7
Cut RT Only exports (Reserves)	23	1
Cut for Interchange ramp limits	174	34

- CTS has improved the system's operational flexibility, reducing the frequency of constraint events
- System operators indicate improvements are noticeable

* Same period (December 15 – June 15) 2014/15 and 2015/16
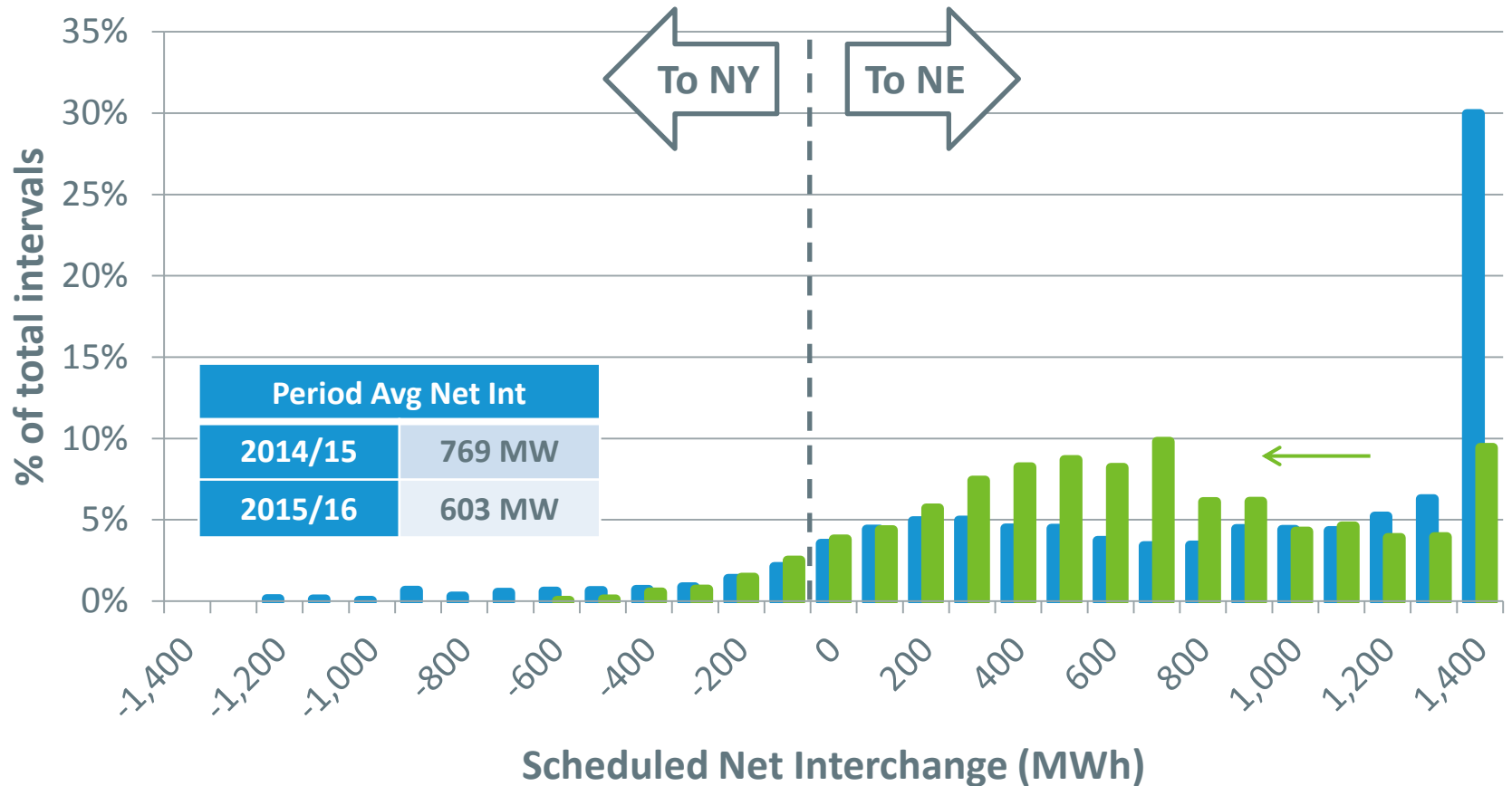‡ Ramp constraint limits are 500 MW/hour on non-NY-N interfaces

DA market remains primary vehicle

27 customers on average pre- and post-CTS

CTS Go-Live

Partial Month

Legend: DA Clrd Import, DA Clrd Export, Increm RT Import, Increm RT Export, DA Net Int, RT Net Int

December 2015 and June 2016 are partial months.

Net interchange has shifted toward exports
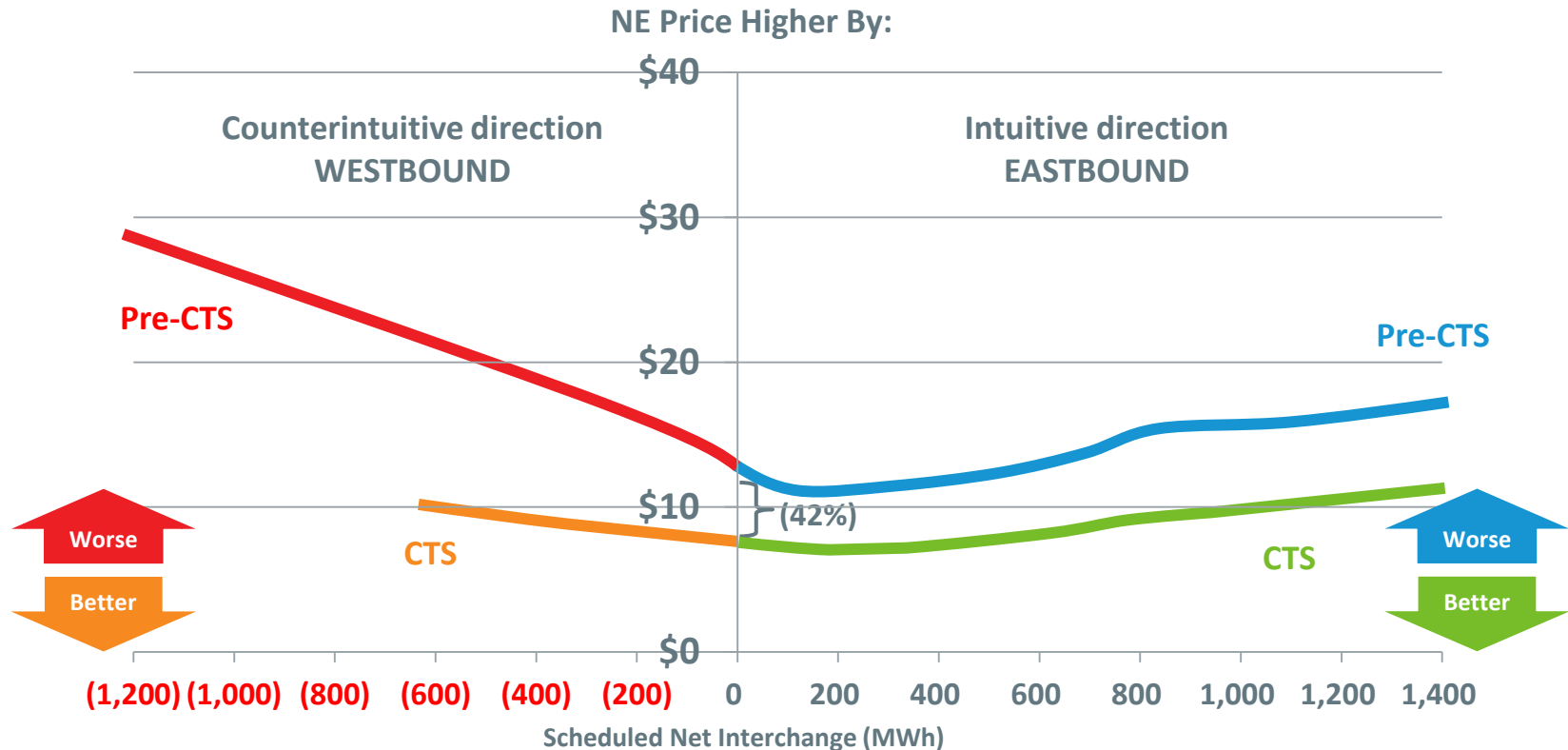## *Combined effect of smaller gas price basis and CTS in 2016*

Period Avg Net Int	
2014/15	**769 MW**
2015/16	**603 MW**

To NY ← | To NE →

% of total intervals (y-axis)

Scheduled Net Interchange (MWh) (x-axis)

■ Pre-CTS ■ CTS

December 15 – June 15, 2014/15 and 2015/16

Average price difference when NE actual price is higher than NY

NE Price Higher By:

Counterintuitive direction WESTBOUND

Intuitive direction EASTBOUND

Pre-CTS

Pre-CTS

Worse / Better

Worse / Better

CTS

CTS

(42%)

$40
$30
$20
$10
$0

(1,200) (1,000) (800) (600) (400) (200) 0 200 400 600 800 1,000 1,200 1,400

Scheduled Net Interchange (MWh)

- CTS is intended to drive price differences close to zero (convergence)
- Improved price convergence better utilizes the interface in the intuitive direction; reduces excess production cost in the counterintuitive direction

Pre-CTS and CTS periods reflect Dec. 15-June 15 of both years, unconstrained intervals only; Constraints include TTC, ramp, min gen, OP4.
Pre-CTS net interchange within 2% of TTC are assumed constrained; Graph lines developed via LOESS (locally weighted polynomial regression)

Average price difference when NY actual price is higher than NE
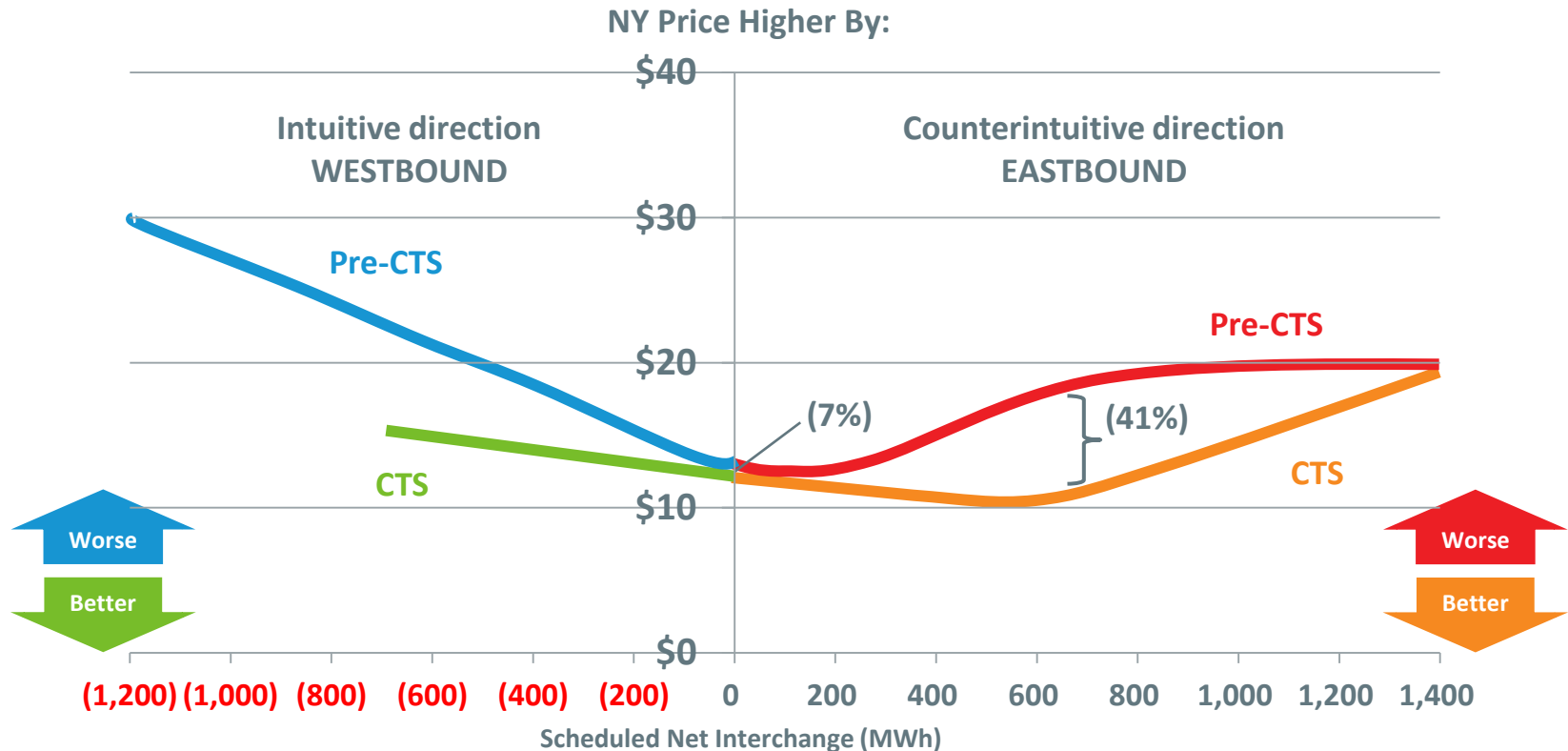
NY Price Higher By:

Intuitive direction
WESTBOUND

Counterintuitive direction
EASTBOUND

Pre-CTS

Pre-CTS

(7%)

(41%)

CTS

CTS

Worse

Better

Worse

Better

$40

$30

$20

$10

$0

(1,200) (1,000) (800) (600) (400) (200)   0   200   400   600   800   1,000   1,200   1,400

Scheduled Net Interchange (MWh)

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KEYS TO SUCCESS: ISO PRICE FORECASTING

Forecast price accuracy to-date

- Forecast price errors are centered near zero ✔

- Large errors are rare

- Primary factors impacting forecast accuracy
  - Unforecastable events (real-time contingencies)
  - Schedule changes on non-CTS interfaces ⎫
  - Generator offer and self-schedule changes ⎭ Post-forecast

- Additional data and analyses required to establish trends and refine ISO-NE's supply curve price forecast process
  - ISO's supply curve forecasting process is a complex new software system

ISO-NE forecast price errors are centered near zero; majority within +/- $5.00
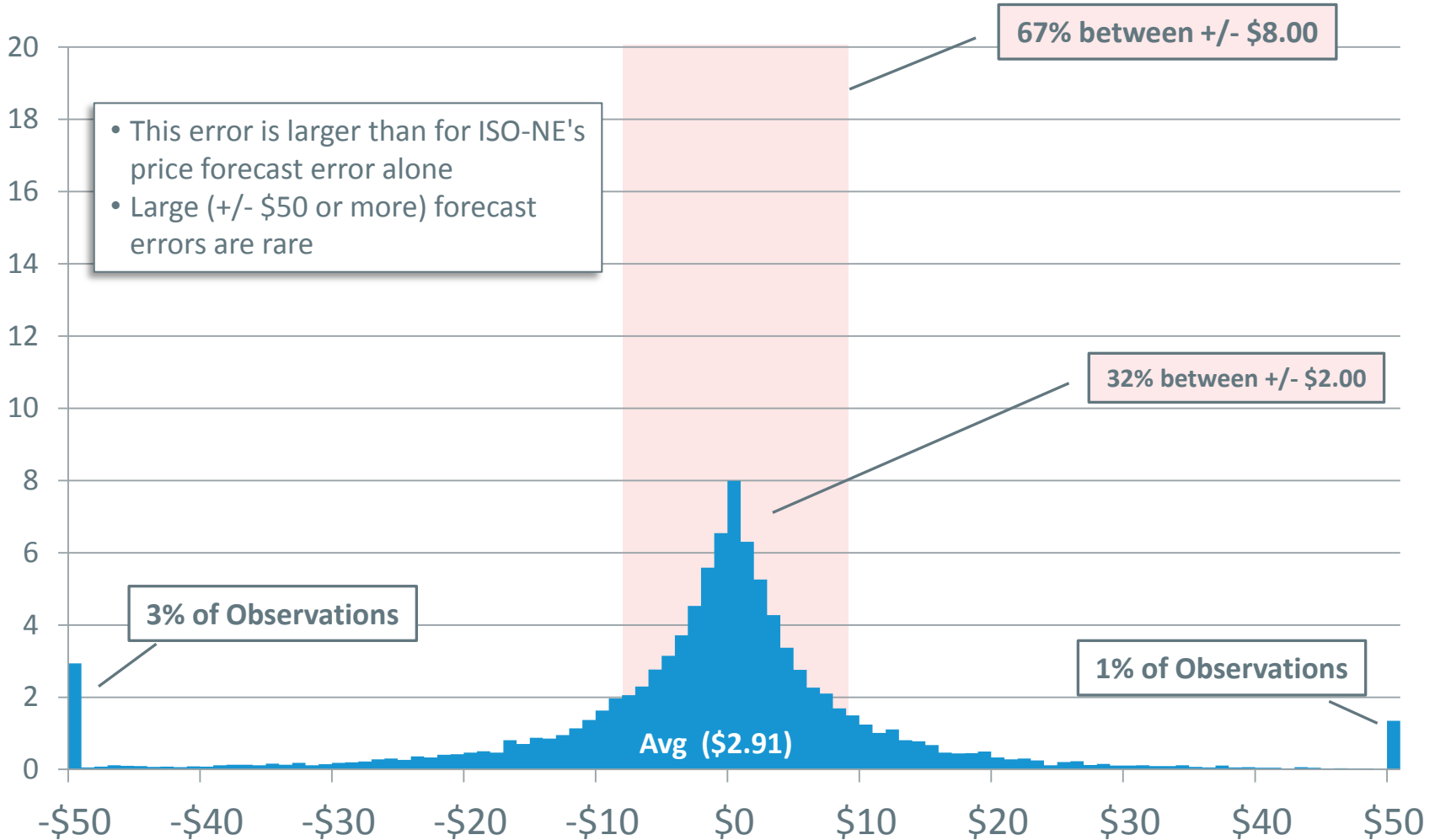
Pct of Obs

68% between +/- $5.00

50% between +/- $2.00
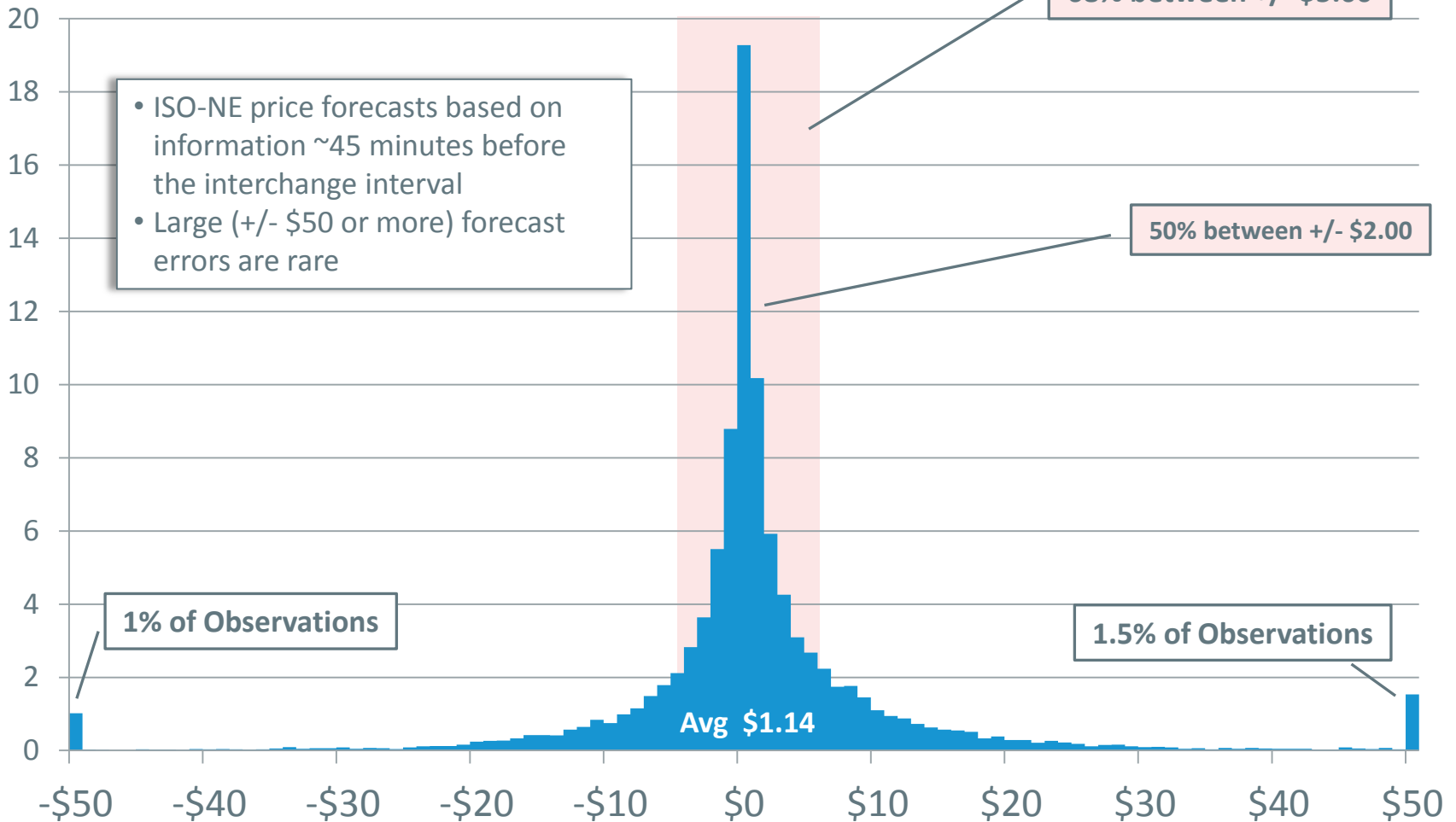
- ISO-NE price forecasts based on information ~45 minutes before the interchange interval
- Large (+/- $50 or more) forecast errors are rare

1% of Observations

1.5% of Observations

Avg $1.14

December 15, 2015 – June 15, 2016

New England forecast only.

ISO-NE and NYISO price <u>difference</u> forecast errors are centered near zero; majority within +/- $8.00

Pct of Obs

- This error is larger than for ISO-NE's price forecast error alone
- Large (+/- $50 or more) forecast errors are rare

67% between +/- $8.00

32% between +/- $2.00

3% of Observations

1% of Observations

Avg ($2.91)

December 15, 2015 – June 15, 2016

[NE forecast LMP – NY forecast LMP] – [NE Actual LMP – NY Actual LMP]

KEYS TO SUCCESS:
SPREAD BIDDING PARTICIPATION

More imports than exports are bid and cleared (supporting DA positions)
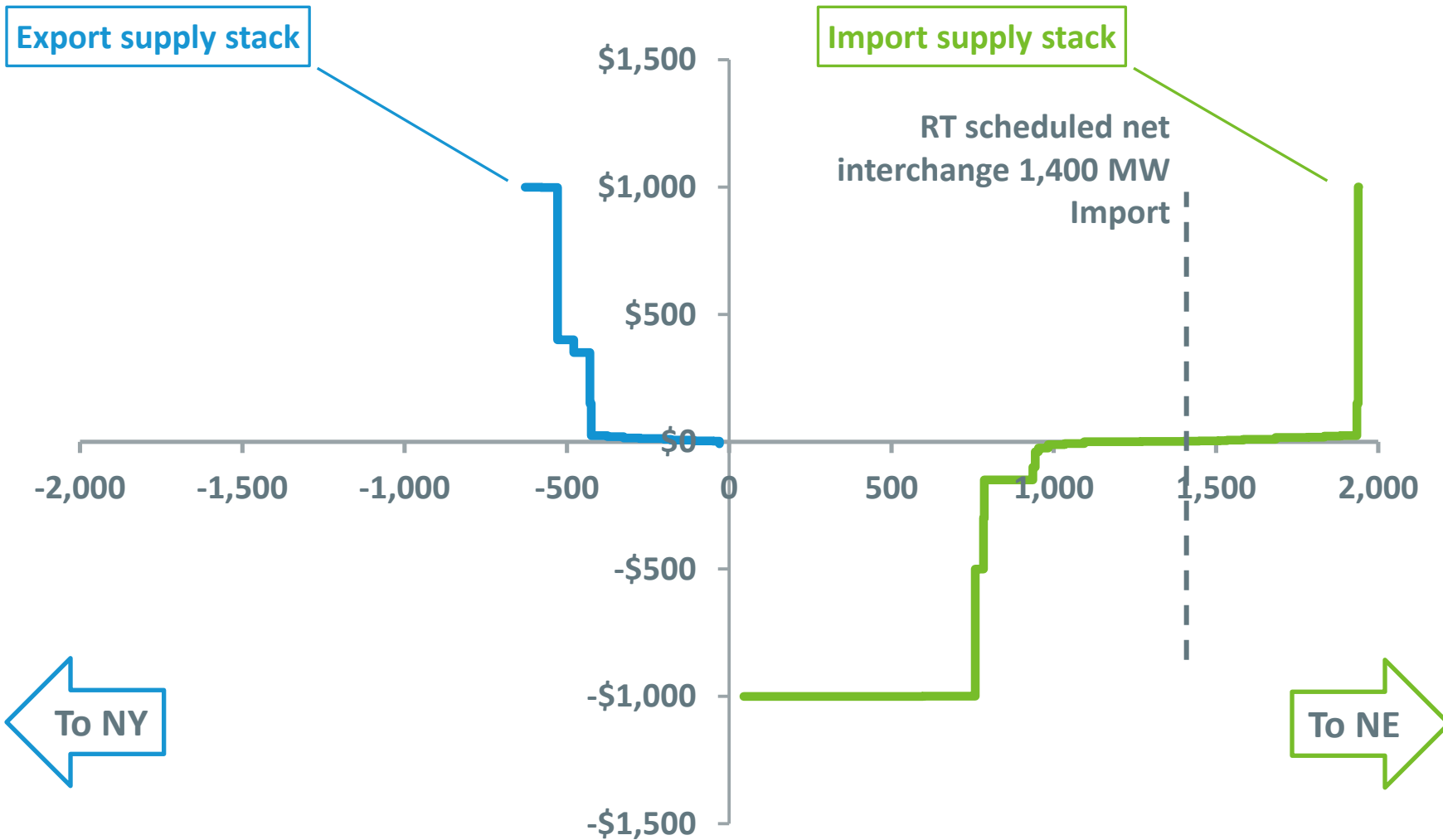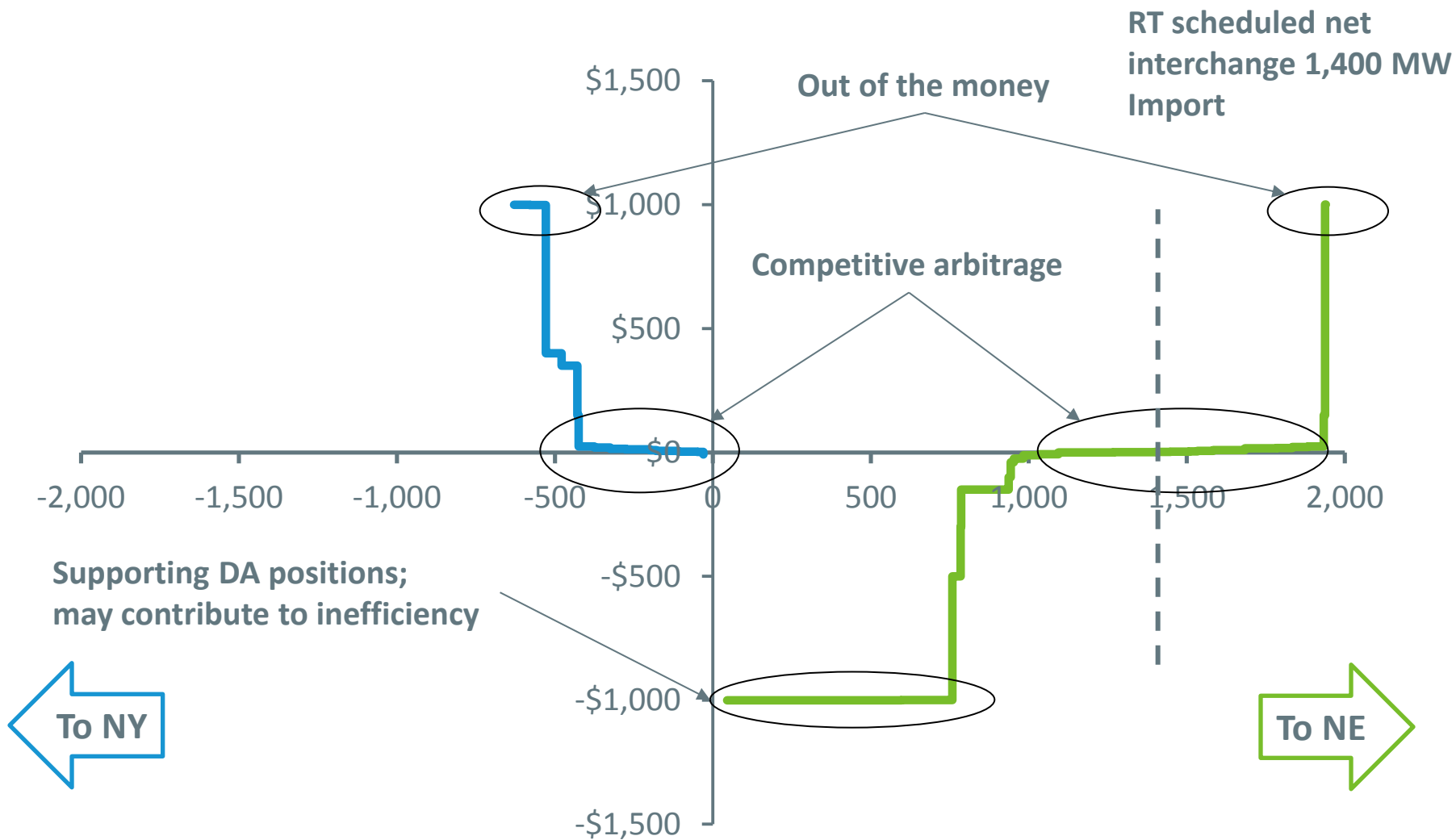
Exports
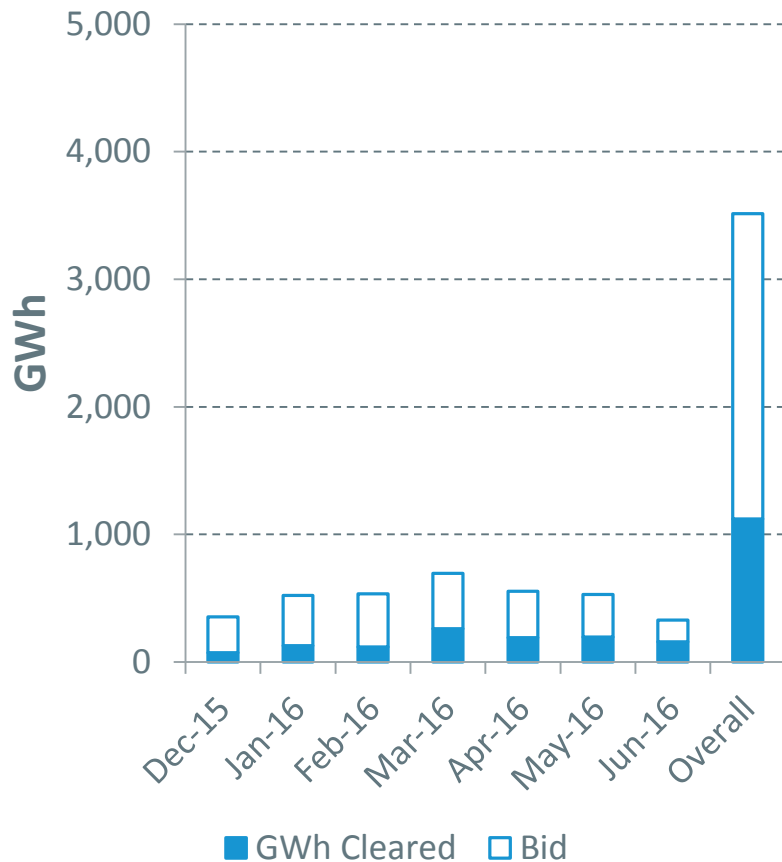
Imports
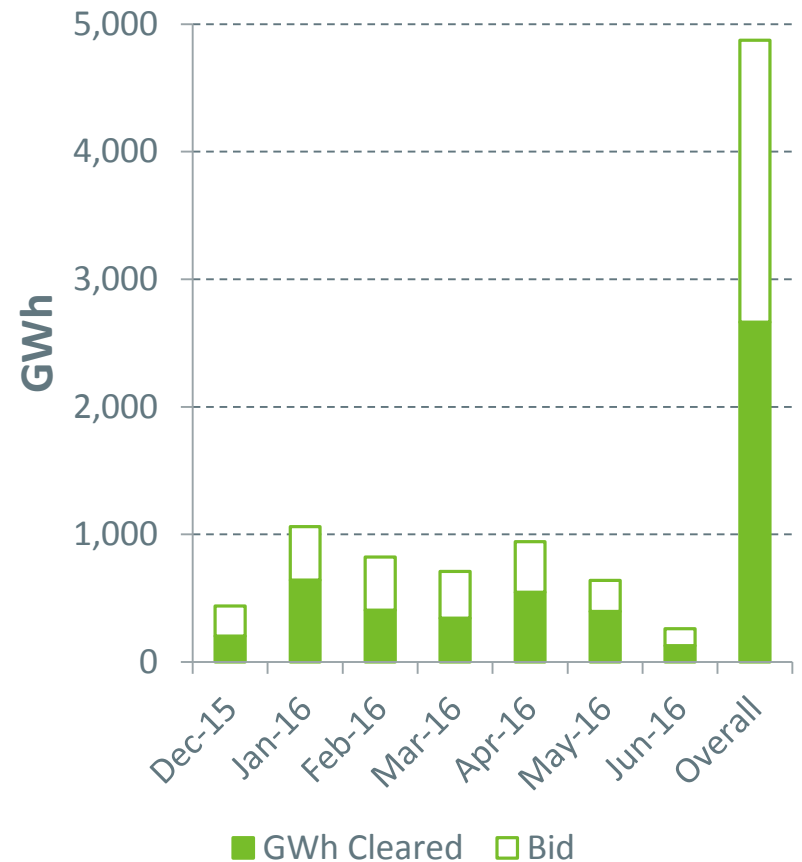
December 15, 2015 – June 15, 2016

Representative Spread Bid Supply Curve

Representative Spread Bid Supply Curve

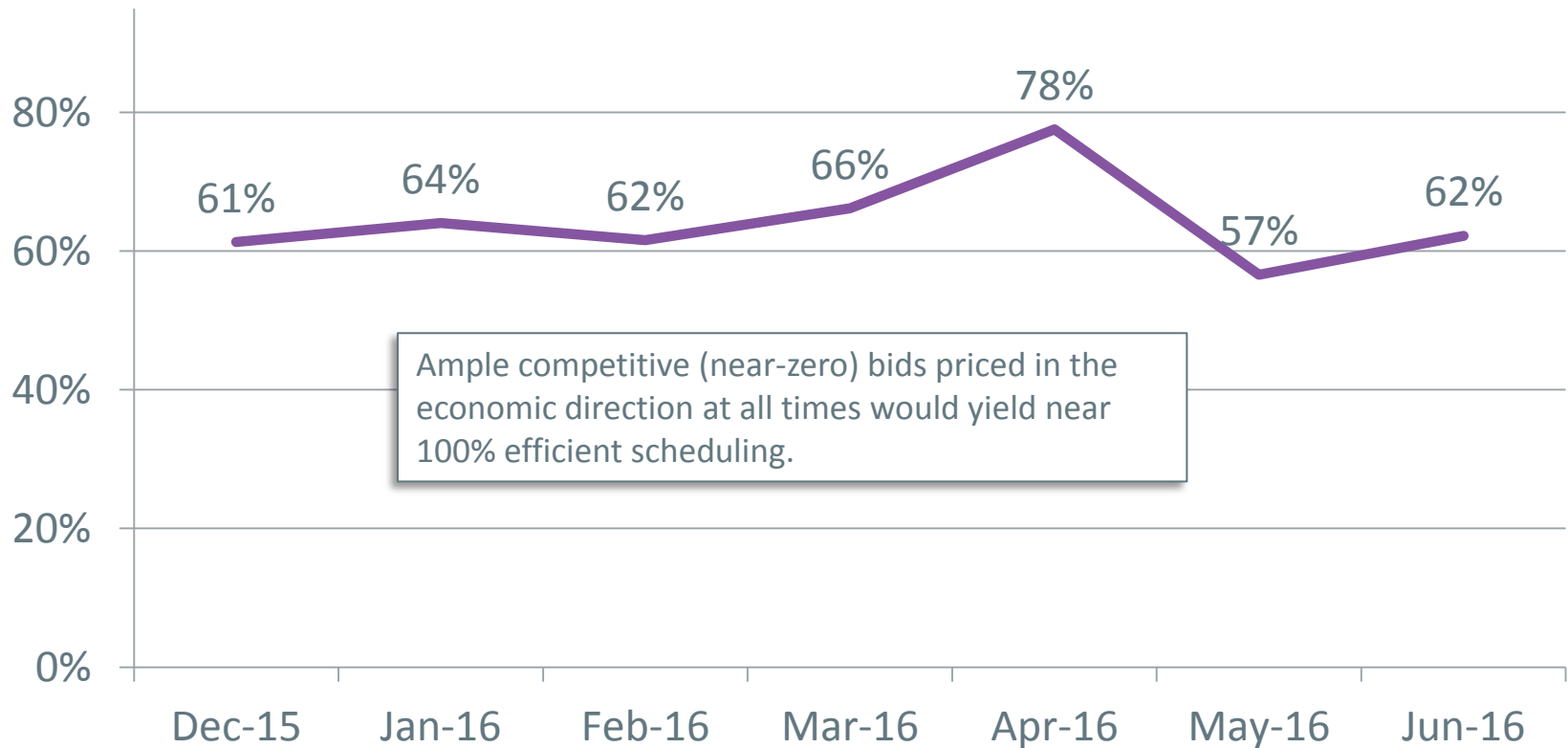# Marginal Spread Bid Prices by Price Range

	As published for 7/20/16 MC Meeting		Corrected*	
Price Range	Imports	Exports	Imports	Exports
($1,000) – ($50.00)	0.1%	0.0%	0.3%	0.0%
($49.99) – $0	48.6%	3.4%	45.6%	3.2%
$0.01 – $10.00	37.8%	5.7%	41.0%	5.3%
$10.01 – $25.00	3.2%	0.4%	3.4%	0.5%
$25.01 – $50.00	0.3%	0.1%	0.3%	0.1%
$50.01 – $1,000	0.2%	0.1%	0.1%	0.1%

- Negative spread bids, when they are marginal, can force CTS to schedule flows from the higher to the lower-priced region, i.e., in the wrong direction
- CTS would efficiently schedule counter-flow in these situations if there were additional, low-priced positive spread bids in the right direction (i.e., from the lower-price to the higher-priced region).

* Subsequent to the 7/20/16 meeting, an anomaly in the reporting databases used in this analysis was discovered. The marginality percentages are corrected here. There is no impact to market clearing or settlement.

Insufficient competitive spread bidding to-date prevents efficient scheduling from reaching 100%

% intervals scheduled toward forecasted higher priced region

Ample competitive (near-zero) bids priced in the economic direction at all times would yield near 100% efficient scheduling.

Chart data points: Dec-15: 61%, Jan-16: 64%, Feb-16: 62%, Mar-16: 66%, Apr-16: 78%, May-16: 57%, Jun-16: 62%

Note: Efficient scheduling describes when the direction of power flow is consistent with the direction indicated by the forecasted price difference between regions.

Additional spread bid participation would improve CTS scheduling efficiency

- Price insensitive bids (at times) reduce CTS effectiveness

- Negative bidding to support DA positions impacts the ability of the system to lower overall production costs and affects price convergence

- Analysis indicates that additional price-sensitive spread bids could improve flows in the low-to-high-priced direction
  - Increased export bid activity would promote efficiency

SUMMARY AND NEXT STEPS

Summary

- ISOs' operational transition has performed as expected
  - Platform is stable
  - Control area operational improvements notable

- CTS Keys to Success
  - ISO price forecasts are centered near zero, and large errors are rare
    - Will continue to monitor
    - More will be known at the end of the first year

  - Greater spread bidding participation should improve performance
    - Would enable CTS to schedule interface in economic direction
    - Trend is improving and experience may facilitate greater participation

Next Steps: Near Term

- Evaluate potential price forecasting system improvements

- Continue to monitor and report periodically

# APPENDIX: BACKUP DETAIL AND TERMINOLOGY

Definitions/Terms

|	
Interface Bid, or Spread Bid	Unified bid to flow energy across the CTS interface. Comprised of: direction, quantity, and price. The price is the (forecasted) price spread between the two regions that the Participant is willing to accept. If no interface bids clear, scheduled CETs will be zero.
Economic (or Intuitive) Flow	The situation when net scheduled interchange is in the direction toward the higher priced region (NY or NE). This is an outcome CTS implementation aims to achieve.
Settled Prices	Prices upon which settlements for the CTS location are based and where External Congestion is included these prices
Forecasted Prices	In this context, refers here to any price(s) that results from the RTC clearing engine's binding interval forecast; When reviewing Forecasted Prices, user must recognize the amount of External Congestion included in NY published solution data and if it is consistent with other data being reviewed and compared
Binding Interval	The first (of ten 15-minute) intervals in each solution provided by the pricing engine for the effective interval to be scheduled. The binding interval determines which interface bids will clear and what the scheduled CTS flow will be for that RT interval
External Congestion	Congestion costs resulting from the RTC solution when scheduled flow is limited by interface transfer capability; Due to TTC or other particular reliability constraints

Sources of Pricing Information

- **Forecast** pricing for both regions on NYISO website at: http://www.nyiso.com/public/markets_operations/market_data/custom_report/index.jsp?report=ext_rto_cts_prices
  - Select 'N.E._GEN_SANDY PD'
  - '1' denotes binding interval forecast

- **New York Settlement** prices (5-minute) on NYISO website at: http://www.nyiso.com/public/markets_operations/market_data/custom_report/index.jsp?report=rt_lbmp_gen
  - Select 'N.E._GEN_SANDY PD'
  - Need to integrate to 15-minute interval

- **New England Settlement** prices (15-minute) on ISO-NE website at: http://www.iso-ne.com/isoexpress/web/reports/pricing/-/tree/lmps-rt-fifteen-minute-final

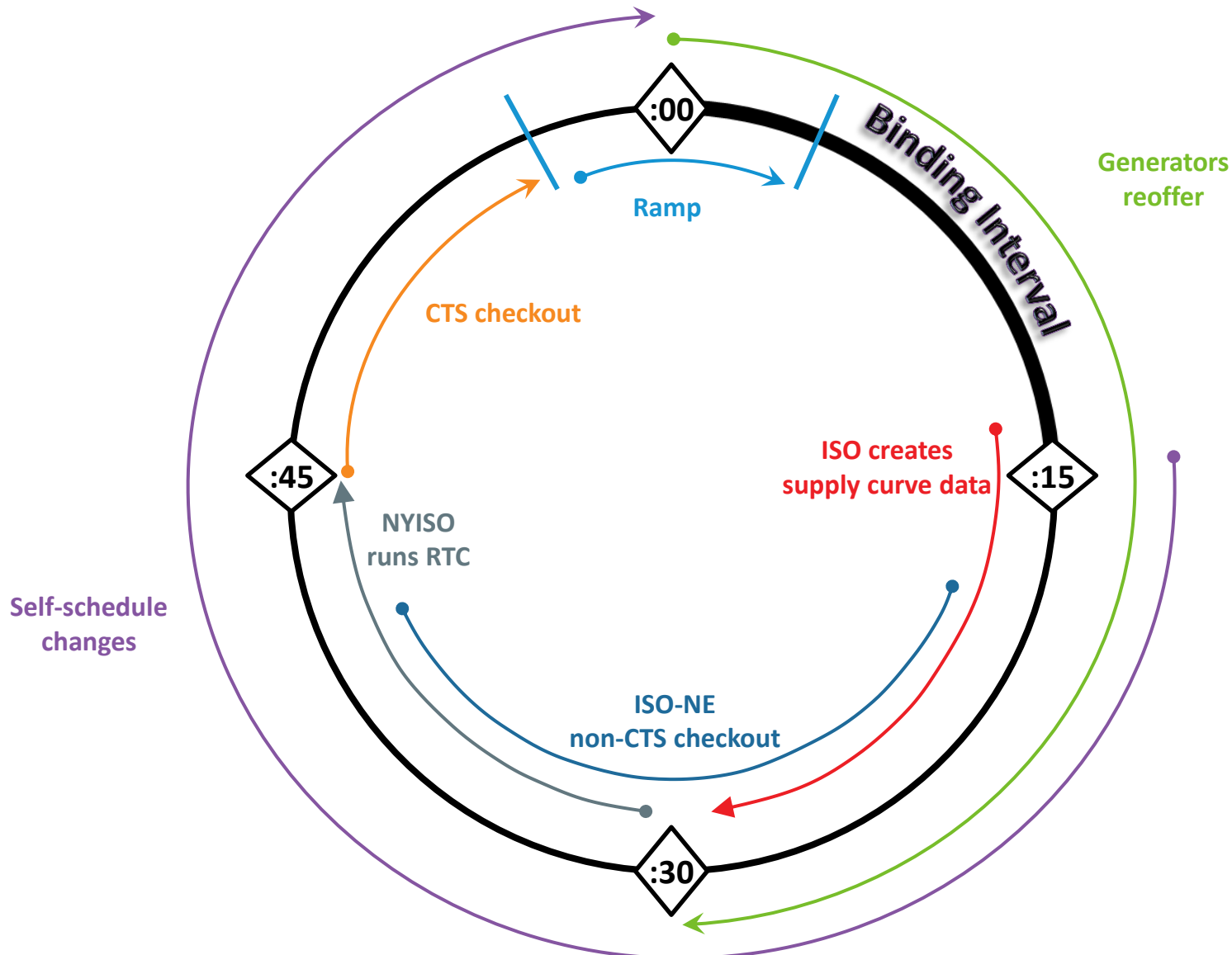# Number of customers participating on the NY interface was not affected by CTS
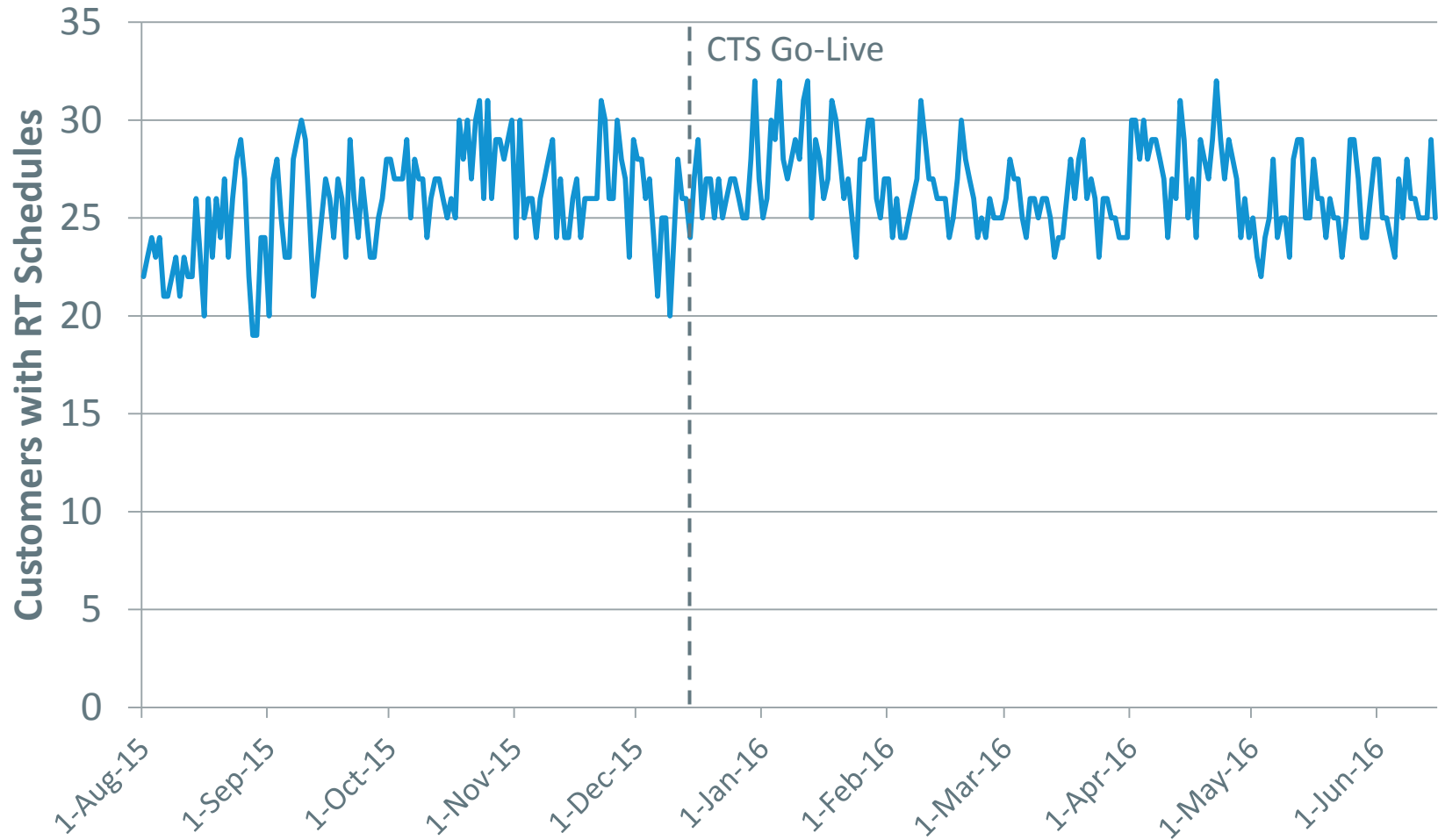
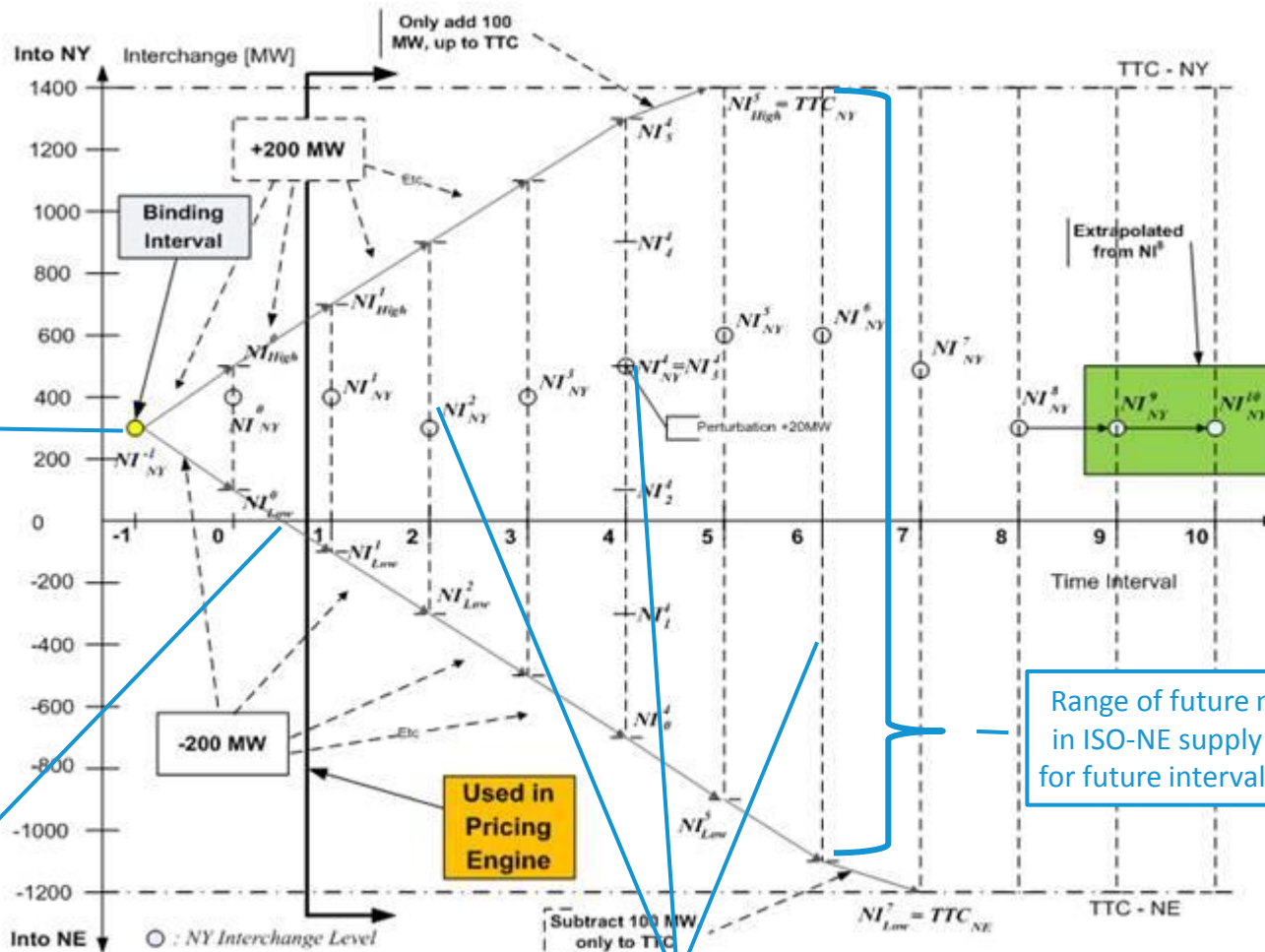# NYISO forecast price errors are centered near zero; majority within +/- $5.00

70% between +/- $5.00

48% between +/- $2.00

1.4% of Obs

0.3% of Obs

Avg ($1.77)
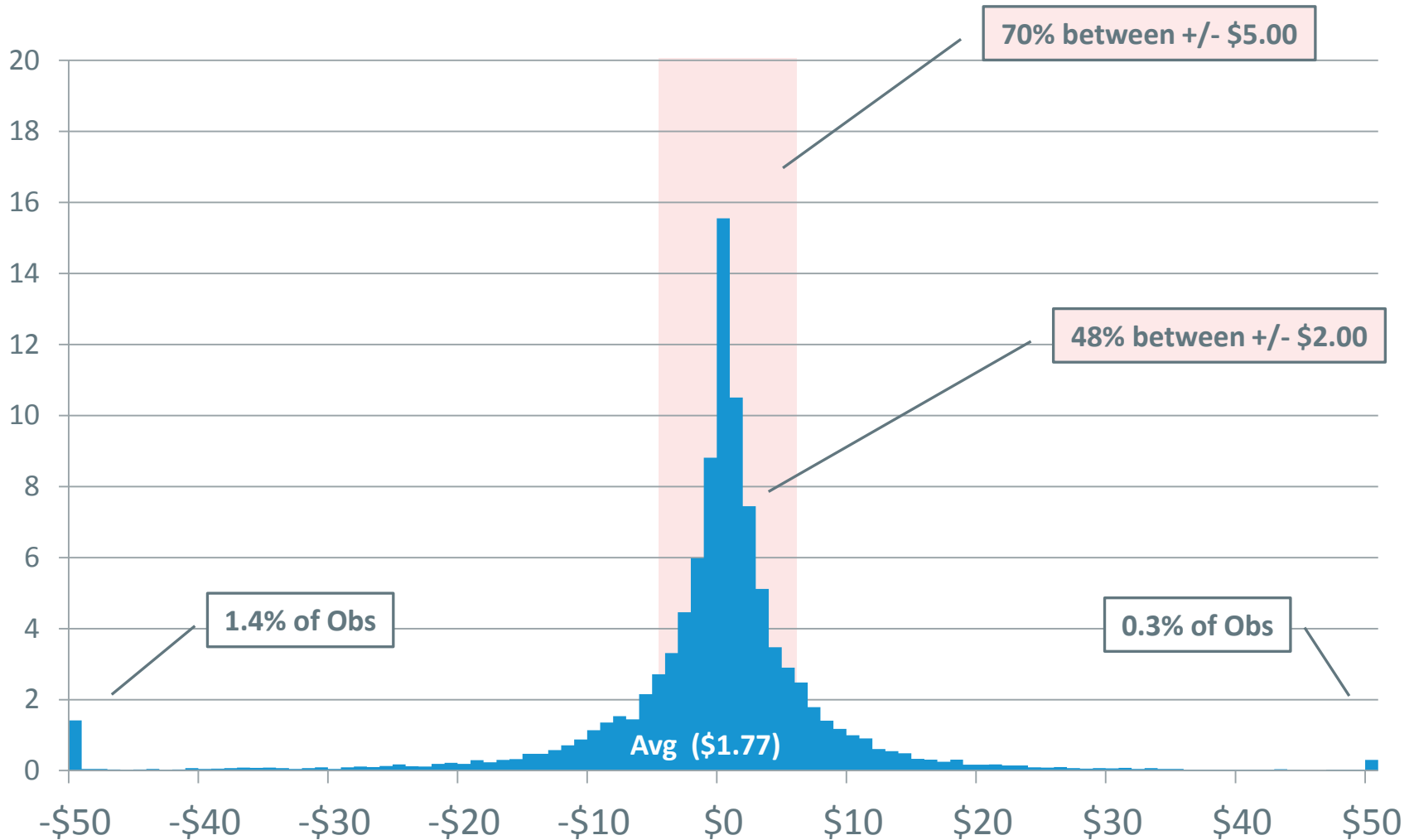
December 15, 2015 – June 15, 2016

New York forecast only.

CTS Clearing Process Timing

ISO-NE Price Forecasting System Schematic

Data Flow Schematic