

Scarcity Pricing in New York and New England

**Prepared by
Scott M. Harvey**

**Prepared for
The California ISO**

November 1, 2007

LECG

TOPICS

- Reserve Shortages and Pricing
- Hockey Stick Bidding and Price Setting
- Reserve Shortage Pricing
 - Overview
 - NYISO
 - ISO-New England
- Setting Shortage Values

RESERVE SHORTAGES

System operators generally have enough capacity to generate energy to meet load even during shortage conditions.

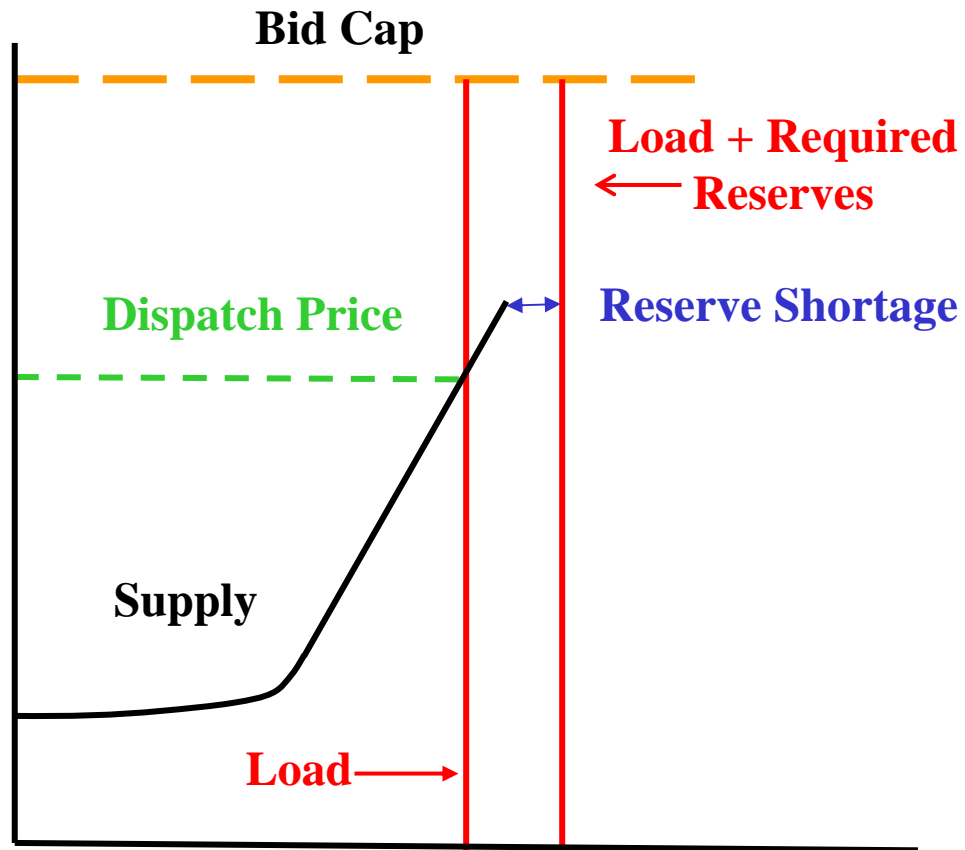
- Shortages arise because there is not enough capacity to *reliably* meet load (i.e., not enough capacity to maintain reserve margins and provide regulation).
- Historically, most purchases of high-priced energy by control area operators were intended to maintain or restore operating reserves.

RESERVE SHORTAGES

The potential for high prices arising from shortages is related to NERC and WECC policies that require control area operators to maintain operating reserves.

- During high-price periods, low-cost energy often remains undispached because the capacity capable of providing low-cost energy is needed to maintain operating reserves.
- High prices usually arise from a shortage of capacity, not energy, but high-priced imported energy is often purchased as a means of meeting reliability criteria by backing down internal generation to maintain operating reserves.

Cost-Based Bidding in a Shortage



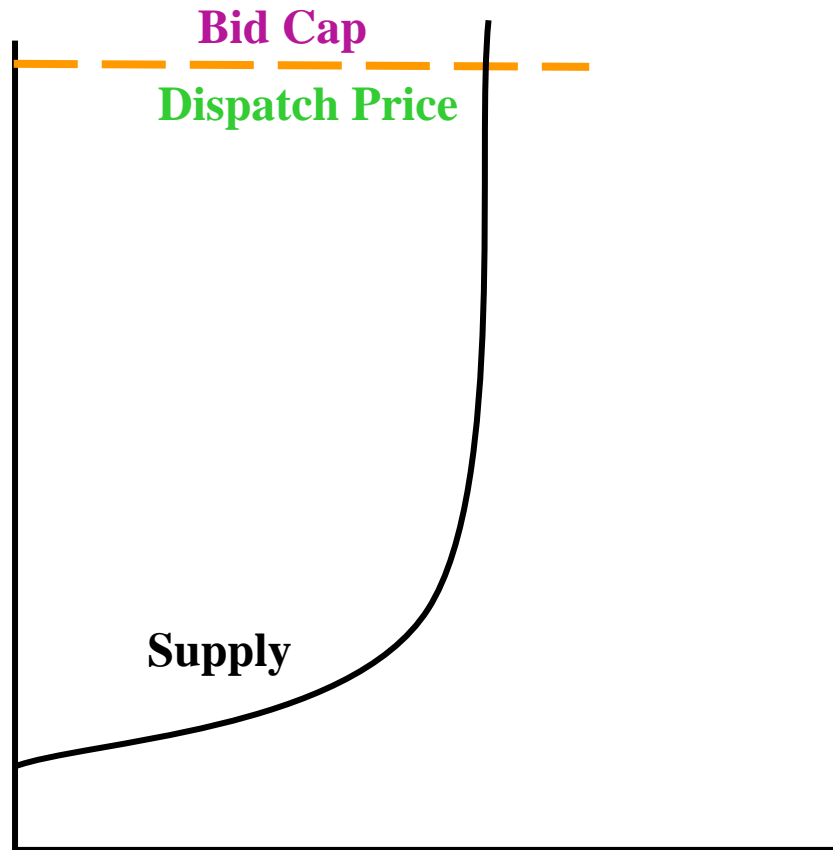
RESERVE SHORTAGES

Absent some form of reserve shortage pricing, it is possible for energy prices to remain low even during a shortage situation in which the control area operator is unable to maintain the target level of operating reserves.

Low real-time prices during adverse operating conditions:

- Do not provide an incentive for the commitment of additional resources in the day-ahead market.
- Do not provide a price signal for demand response or the scheduling of imports.
- Do not provide an incentive for generation operators to incur extraordinary costs in order to keep generation on-line or return generation to service.
- Do not ensure that imports scheduled day-ahead flow in real-time.

Hockey Stick Bidding in a Shortage

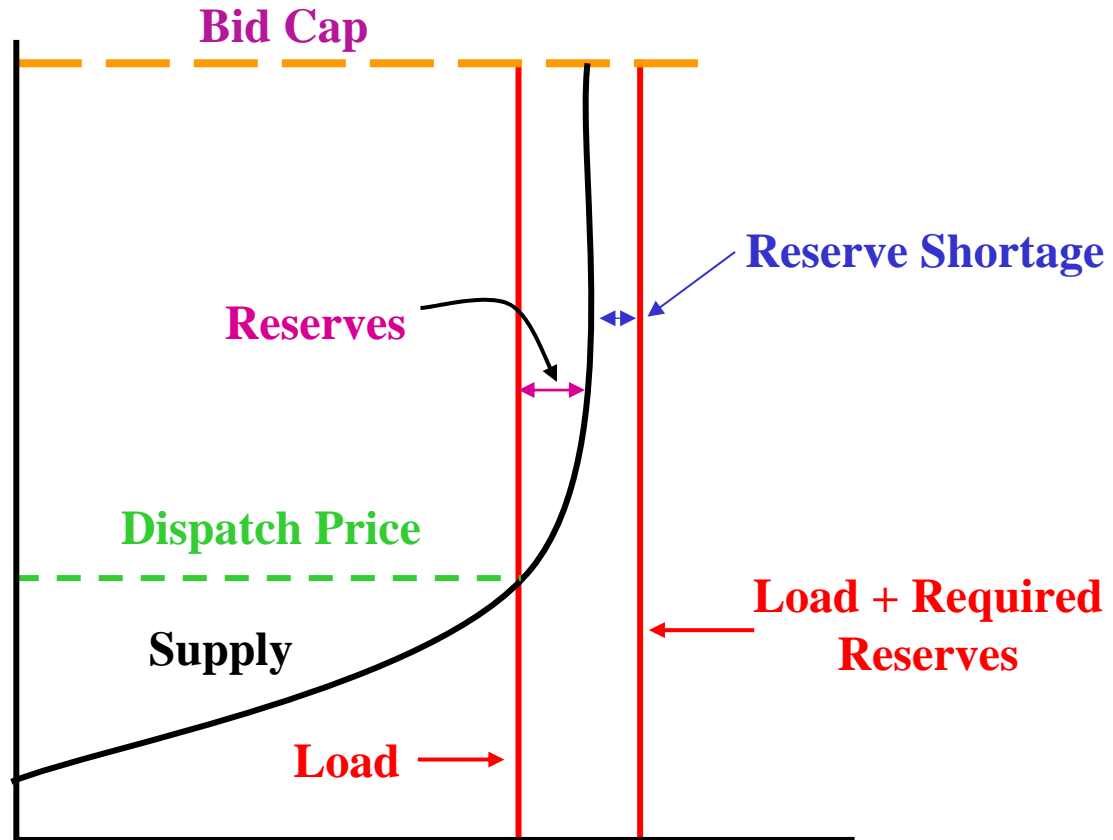


HOCKEY STICK BIDS

Hockey stick bids are a mechanism that suppliers can use to drive market prices to the price cap during reserve shortage conditions.

- ERCOT's proposal to rely on scarcity pricing to assure resource adequacy by raising the bid cap appears to envision hockey stick bids as the pricing mechanism during shortage conditions.
- If hockey-stick bids set market-clearing prices, they may be perceived as an exercise of market power rather than shortage pricing. Indeed, prices would be lower if the offer prices were lower.

Hockey Stick Bidding with Reserves in a Shortage

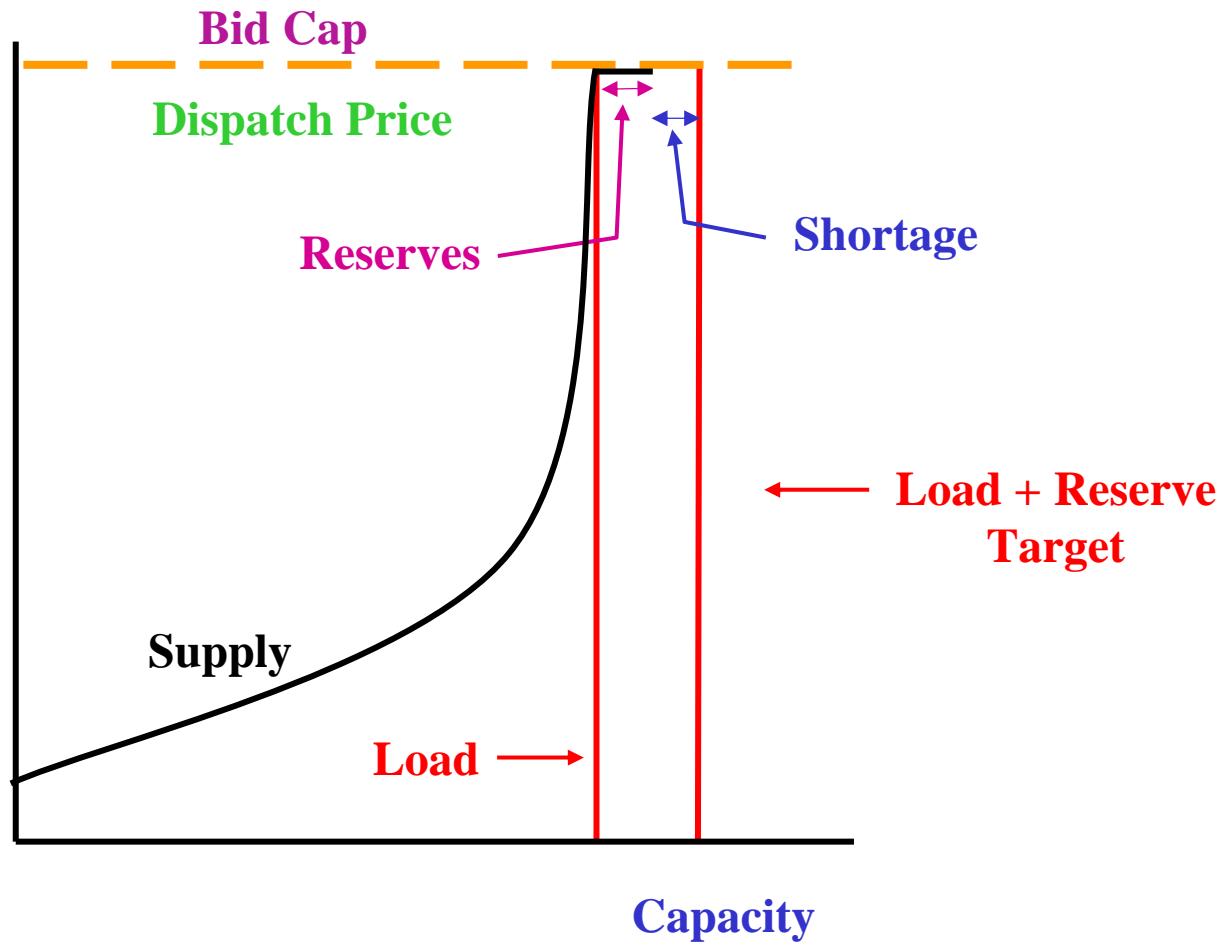


HOCKEY STICK BIDS

Hockey stick bids on the last fraction of a MW may not set energy prices, even during shortage conditions.

- If the system operator shifts reserves across units in real time to minimize costs (as would happen in a market that co-optimizes energy and reserves), capacity with a high offer price will be used for reserves.
- Hockey stick bids on the last fraction of a MW will not impact energy prices because the high-priced megawatt will be used for reserves and energy prices will not reflect shortage conditions.

Hockey Stick Bidding with Reserves in a Shortage



HOCKEY STICK BIDS

A variant of hockey stick bidding would be to submit high offer prices covering capacity equal to a unit's 10-minute ramp rate plus a fraction of a MW.

- The high offer price capacity corresponding to the unit's 10-minute ramp rate could be used to provide 10-minute reserves; the high offer price for this capacity would not affect energy prices.
- If the RTO had to dispatch the last .1 MW of capacity to meet load, the energy price would be set by the offer price on that last .1 MW of capacity.

HOCKEY STICK BIDS

If multiple suppliers submit hockey stick bids covering the 10-minute ramp capacity of a variety of units, there is a potential for inefficient outcomes in which the offer prices impact energy prices in non-shortage situations.

There is also a potential for prices to remain low during shortage situations.

- RTO reserve requirements will generally be quite large relative to the 10-minute ramp capacity of even a number of units.
- Even if several units submit high-priced offers on capacity capable of providing reserves, there will likely be low-priced capacity providing reserves, and setting energy prices, at the margin.

HOCKEY STICK BIDS

Hockey stick bids are therefore an imperfect mechanism for implementing shortage pricing.

- Reserve scheduling practices will often make it impossible for hockey stick bids to set prices even during sustained reserve shortages, unless the offer prices apply to much more than the last fraction of a megawatt.
- If supplier expectations are incorrect, high offer prices for capacity expected to provide reserves could understate the opportunity cost of carrying reserves on these units, reduce the efficiency of the dispatch, and inefficiently raise prices during non-shortage conditions.

HOCKEY STICK BIDS

- If unexpected congestion patterns are present in real-time, capacity with high offer prices that was expected to provide reserves could be needed for congestion management with the hockey stick bids setting locational energy prices during a non-shortage situation.
- Given imperfect expectations, it can be hard to distinguish efforts to price efficiently during anticipated shortage conditions from efforts to exercise market power.

Rather than relying on high energy offer prices to set market prices during shortage conditions, an alternative is to let the reserve shortage condition itself determine energy and reserve prices.

- A penalty cost can be attached to violating RTO reserve targets (i.e., capacity needed to satisfy the reserve target is dispatched to meet load) and this penalty cost can be reflected in reserve and energy prices.
- With such an approach, all market participants could submit cost-based bids (i.e., they do not need to anticipate shortage conditions and change their bidding strategy), yet prices would reach appropriate levels during shortage conditions.
- New York ISO and ISO-New England have implemented reserve shortage pricing as part of their ancillary services market designs.

Shortage values and demand curves for ancillary service capacity can and should be combined with co-optimization of energy and reserves. In such a market:

- The shortage value for an ancillary service can set the price of energy as well as the price of the ancillary service.
- The market price of energy will generally exceed the running costs of the marginal unit when an ancillary service price is determined by a shortage value.
- Situations can arise in which reserve prices in a region exceed the price of energy because the supply of reserves in the region is ramp-constrained, not capacity-constrained.

The NYISO SMD system, implemented February 1, 2005, includes shortage pricing for 30-minute, 10-minute and spinning reserves in the day-ahead and real-time markets.

NYISO ANCILLARY SERVICE PRICING		
	Shortage Values	Requirement
Total NYISO Spinning Reserves	\$500/MW	600 MW
Eastern 10-Minute Reserves	\$500/MW	1,000 MW
Total 10-Minute Reserves	\$150/MW	1,200 MW
Total 30-Minute Reserves	\$200/100/50/MW	1,800 MW
Eastern Spinning Reserves	\$25/MW	300 MW
Eastern 30-Minute Reserves	\$25/MW	1,000 MW
Long-Island Spinning Reserves	\$25/MW	60 MW
Long Island 10-Minute Reserves	\$25/MW	120 MW
Long Island 30-Minute Reserves	\$300/MW	270-540
Regulation	\$250/300/MW	

The NYISO reserve shortage values are additive.

- All spinning reserves are counted toward the requirement for 10-minute and 30-minute reserves, so the spinning reserve price is the sum of the shadow prices for spinning reserve, 10-minute reserves and 30-minute reserves.
- Since a shortage of spinning reserve would, in practice, not persist unless the NYISO were also short of 10-minute and 30-minute reserves, a statewide spinning reserve shortage would result in energy prices in excess of \$850/MWh ($\$200 + \$150 + \500), independent of energy offer prices.

The NYISO reserve shortage values are also locational.

- If a reserve shortage exists for a locational reserve requirement, then the shortage value will only affect energy and reserve prices within the region of the locational requirement.
- For example, if the reserve shortage were of 10-minute eastern reserves, the shortage value would only affect energy and reserve prices east of Central East. Western energy and reserve prices would be unaffected.

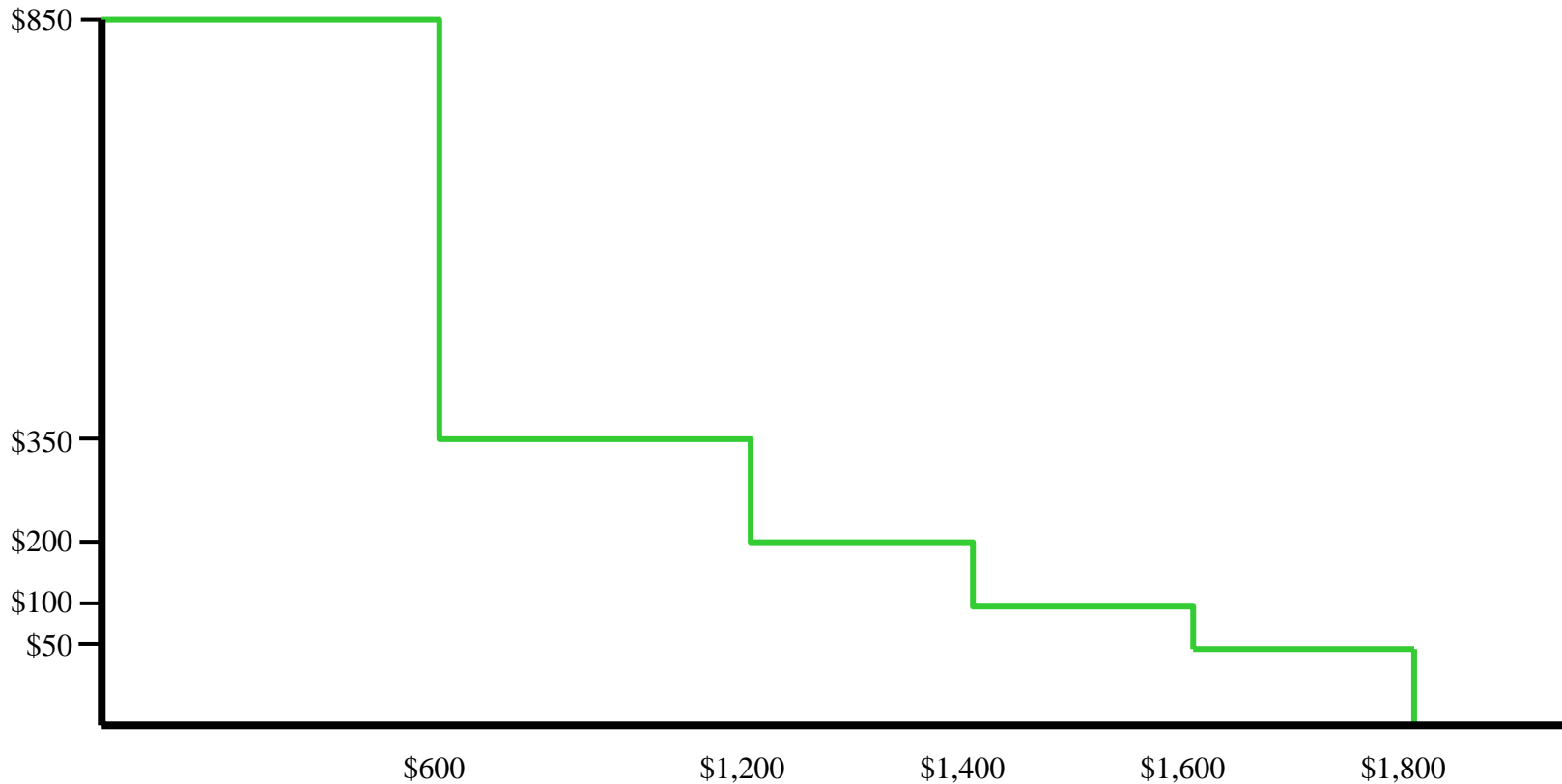
Prior to implementing shortage pricing for reserves in 2005, the New York ISO implemented a demand curve for 30-minute reserves during summer 2002. This demand curve remained in effect under SMD.

Under the demand curve the amount of 30-minute reserves scheduled is reduced both day ahead and in real time by:

- 200 MW if the shadow price of reserves exceeds \$50/MW.
- By another 200 MW if the shadow price exceeds \$100/MW.
- And by another 200 MW (to zero) if the shadow price of 30-minute reserves exceeds \$200/MW.

30-MINUTE RESERVE DEMAND CURVES 2005		
Reserve Price		
1,800	≤ Reserves	\$0
1,600	≤ Reserves < 1,800	\$50
1,400	≤ Reserves < 1,600	\$100
1,200	≤ Reserves < 1,400	\$200
600	< Reserves < 1,200	\$350
	Reserves < 600	\$850

The combination of the demand curve for 30-minute reserves and reserve shortage values for 10-minute and spinning reserves defines a demand curve for 30-minute reserves with prices ranging from zero up to \$850.



The NYISO reserve shortage values automatically enter into the determination of reserve prices when reserves fall below the specified levels. No declaration or other action by the NYISO is required.

- If internal NYISO 30-minute reserves fall below 1,800, the price of 30-minute reserves rises to \$50/MW.
- The NYISO may take actions to maintain 30-minute reserves as defined by NERC, such as designating non-firm exports as recallable and providing reserves, but the shortage of PSC 30-minute reserves would still set 30-minute reserve prices.

These reserve shortage values also directly and automatically enter into the determination of NYISO energy prices. In a reserve shortage the dispatch of an incremental megawatt of generation to meet load increases the reserve shortage by one megawatt.

- Suppose the incremental generator has an energy offer price of \$100 and the NYISO has exactly 1,800 MW of 30-minute reserves, including 1,300 megawatts of 10-minute reserves and 700 MW of spinning reserves.
- The dispatch of an additional megawatt of generation with an offer price of \$100 reduces the level of 30-minute reserves to 1,799 MW.
- The incremental cost of meeting load rises from \$100 to \$150/MWh.

INCREMENTAL COST OF MEETING LOAD	
Offer Price of Incremental Supply	\$100/MW
Shortage Cost for Reducing 30-Minute Reserves	\$50/MW
Total Cost	\$150/MW

While these reserve shortage values will generally cause the NYISO to start 30-minute gas turbines to maintain 10-minute or spinning reserves, this will not always be the case. Suppose there are 700 MW spinning reserves, 1,150 MW 10-minute reserves, and 1,900 MW 30-minute reserves.

- Shortage value for 10-minute reserves is \$150, while other shortage values are zero.
- If the lowest cost off-line 30-minute GT had an offer price of \$400/MWh, while the highest cost dispatchable on-line unit had an offer price of \$200/MWh, then it would be uneconomic to start the 30-minute unit.

Incremental Cost of Restoring 1 Megawatt 10-minute Reserves =
 $\$400 - \$200 = \$200$

Shortage value of Incremental 10-Minute Reserves = \$150

Since New York pays real-time demand response (EDRP) the higher of \$500/MWh or the real-time price,¹ and Special Case Resources (ICAP) are paid the higher of their minimum payment nomination or the real-time price,² the NYISO's reserve shortage values can raise compensation to demand response, particularly during shortages of eastern 10-minute reserves or spinning reserves.

- Since activation of demand response tends to avoid reserve shortages by reducing load, the NYISO will generally activate demand response (EDRP and SCR) in anticipation of reserve shortages.
- These programs will therefore generally already have been activated when a reserve shortage occurs, unless the shortage is due to sudden unforeseen events.

¹ New York Independent System Operator Inc., FERC Electric Tariff, Original Volume 2, Attachment G, Section 10, Sheet No. 463.

² Section 5.12.11(a), Sheet 140A.

Since real-time prices are used to settle deviations from day-ahead schedules, resources with day-ahead schedules that trip off-line or fail to start as directed will have to cover their positions at appropriately high prices during shortage conditions, thereby providing efficient performance incentives.

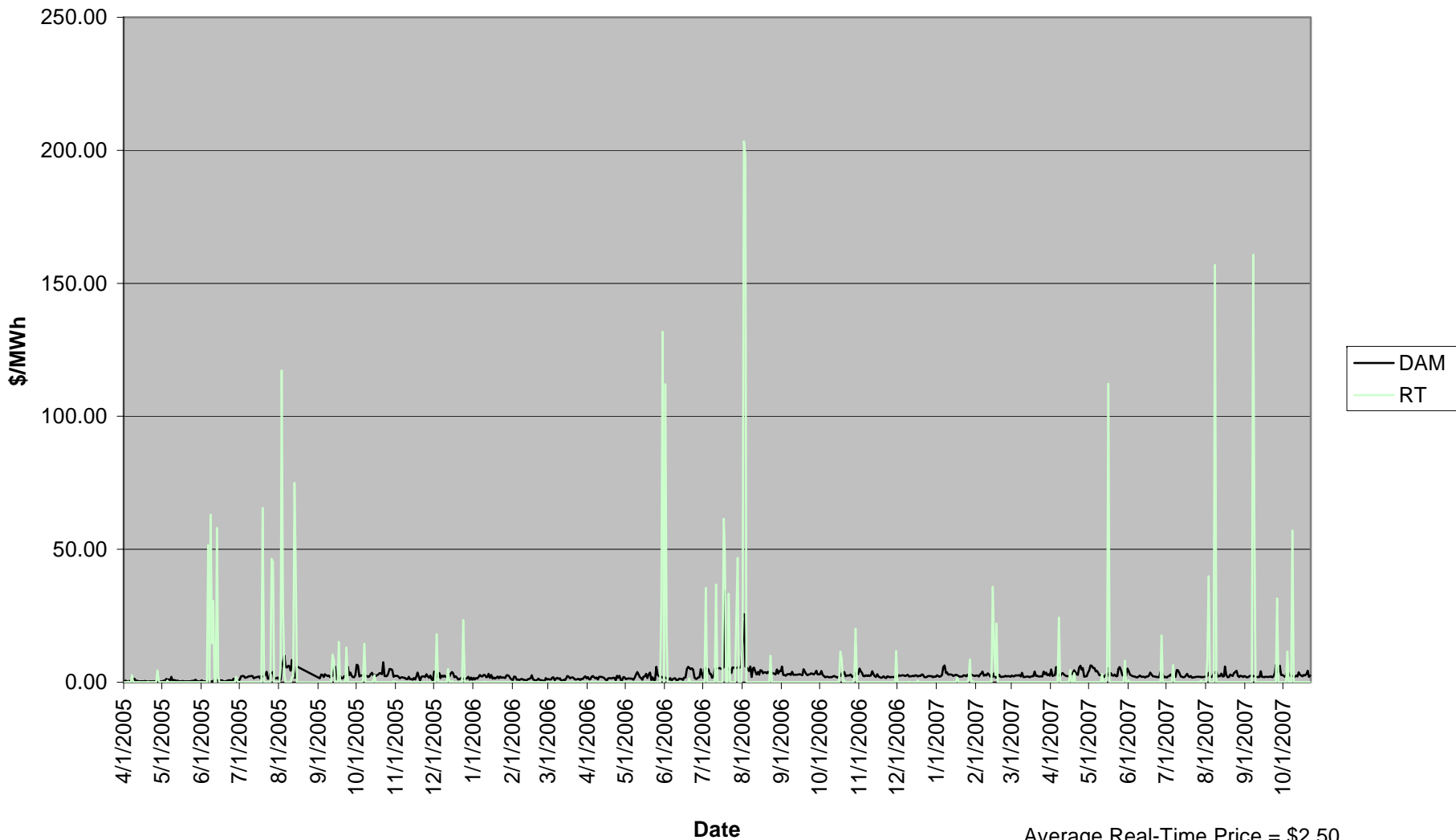
- Imports scheduled day-ahead that do not flow in real-time during reserve shortages will also have to cover their day-ahead schedules at appropriately high prices.
- If LSEs covered all of their real-time load in the day-ahead market, the financial impact of real-time shortage pricing due to generator trips or imports that did not flow in real-time would fall entirely on the non-performing suppliers.

Since real-time reserve offer prices are set to zero in New York (all capacity offered for dispatch is available to provide reserves based on its ramp rate), all positive reserve prices in real time result from either opportunity costs or reserve shortages.

- Zero real-time reserve offer prices mean that suppliers are not able to economically withhold reserves in real time.
- Physical withholding of capacity (providing energy or reserves) in real time is still possible and can raise real-time energy and reserve prices if it creates a reserve shortage.

Ten-minute reserves, in particular, almost always have zero prices in real-time, but when the prices are non-zero they tend to be far above day-ahead market prices.

Daily Average Day-Ahead Market and Real-Time 10 Minutes Reserve Prices April 1, 2005 - October 22, 2007

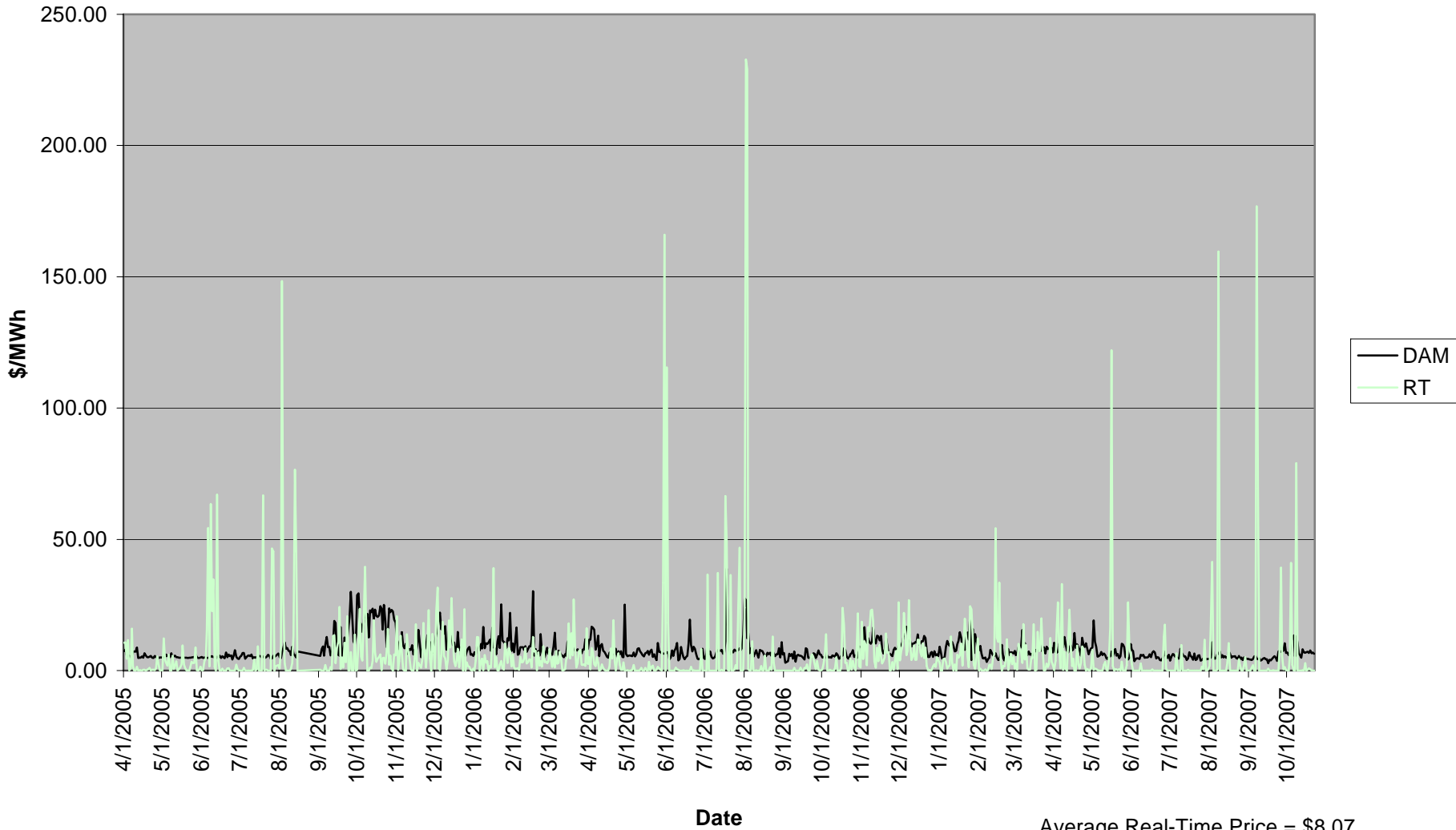


Average Real-Time Price = \$2.50
Average Day-Ahead Market Price = \$2.89

Real-time spinning reserve prices are also determined only by shortage costs or opportunity costs.

- Real-time spinning reserve prices are therefore often close to zero as well, even over an entire day.

Daily Average Day-Ahead Market and Real-Time Eastern Spin Prices April 1, 2005 - October 22, 2007

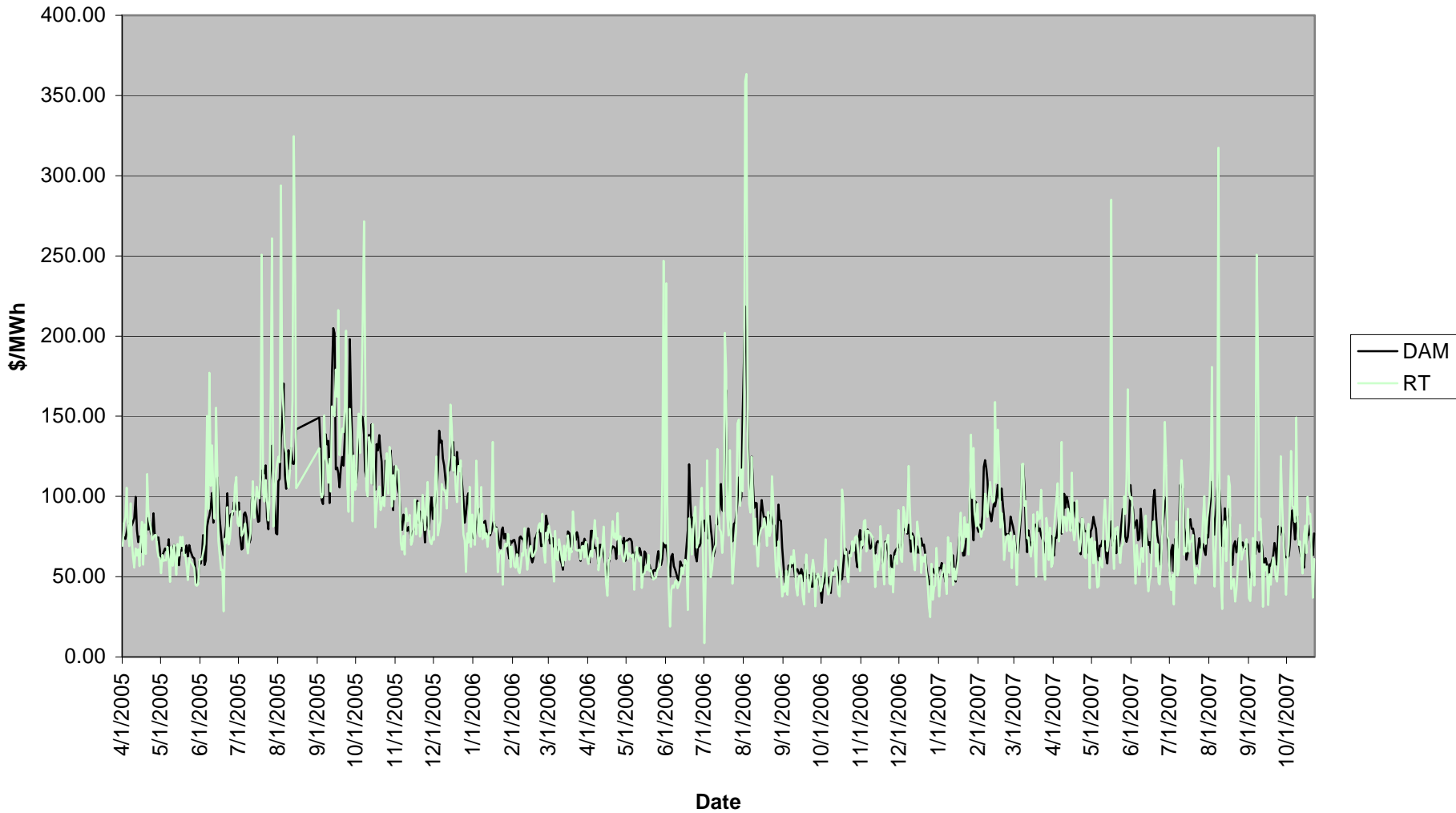


Average Real-Time Price = \$8.07
Average Day-Ahead Market Price = \$6.27

Shortage values for eastern 10-minute reserves and spinning reserves have created considerable volatility in real-time 10-minute reserve, spinning reserve and Zone J energy prices.

- The potential for high reserve shortage-driven energy prices in Zone J during real time provides an incentive both for physical loads to schedule more load day-ahead and for the submission of virtual demand bids when the potential for shortages is foreseen.
- High levels of load clearing in the day-ahead market tend to increase the amount of capacity committed day-ahead.

Daily Average Day-Ahead Market and Real-Time Zone J LBMPs April 1, 2005 - October 22, 2007



Average Real-Time Price = \$80.56
Average Day-Ahead Market Price = \$81.00

The cascading of real-time energy and reserve prices ensures that resources offer energy or reserves will be indifferent between providing reserves or energy during shortage conditions.

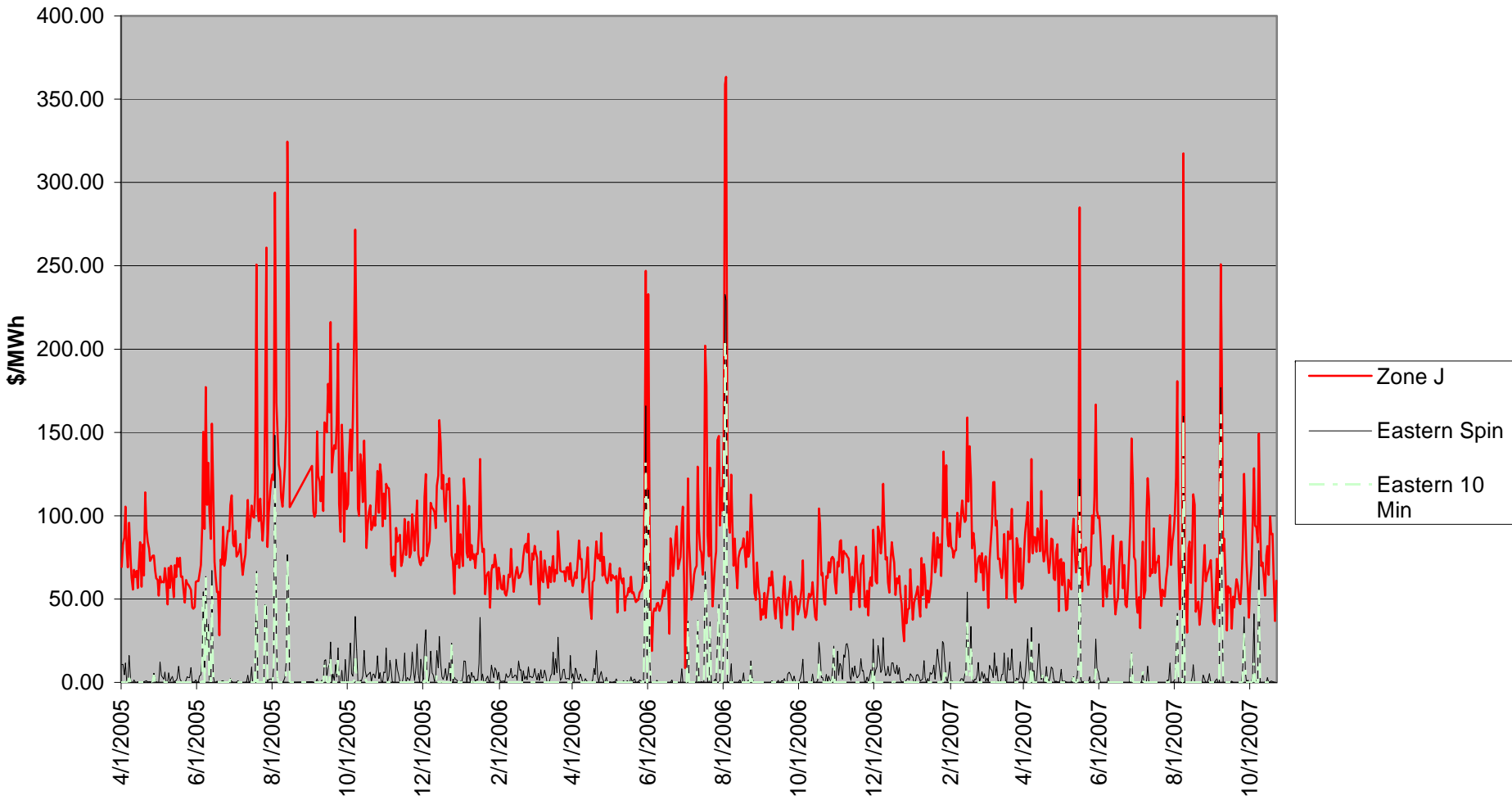
- The two-settlement system for energy and reserves ensures that capacity scheduled to provide reserves in the day-ahead market is not paid twice if it is dispatched for energy in real-time.
- Cascading of energy and reserve prices also ensures that capacity scheduled to provide reserves in the day-ahead market does not incur losses if it is dispatched for energy in real-time.

SHORTAGE PRICING

For example, if 10-minute eastern reserve prices were \$500 as a result of a reserve shortage

- A resource scheduled day-ahead to provide reserves that was dispatched for energy in real-time would have to cover its day-ahead reserve schedule at real-time reserve prices (\$500/MWh).
- The reserve shortage value would also be reflected in eastern energy prices, which would exceed the offer price of the marginal supplier by \$500/MWh.
- A resource would only be dispatched for energy if the LMP price at its location exceeded its offer cost by at least \$500/MWh.

Daily Average Real-Time Zone J, Eastern Spin and Eastern 10 Min Reserve Prices April 1, 2005 - October 22, 2007



Date

Average 10 Min Price = \$2.50
 Average Spin Price = \$8.07
 Average Zone J Price = \$80.56

In practice, shortage values for eastern 10-minute reserves, NYISO control area spinning reserves and NYISO control area 30-minute reserves directly impact real-time prices, but do not set prices in the day-ahead market cleared against bid load (i.e., price capped load is bid at prices below the shortage value for eastern 10-minute reserves).

- This outcome is perhaps rational given load forecast uncertainty, as reserve shortages in real time are not likely to a sure thing two days in advance.
- This outcome may also be influenced by the reliability commitment in the day-ahead market, and the NYISO installed capacity market.

- The potential for real-time prices set by reserve shortage values does, however, increase the incentive for LSEs to fully schedule their load in the day-ahead market and provides an incentive for virtual demand bids. Both actions tend to ensure that available capacity is committed when market participants foresee the potential for reserve shortages.

The reserve shortage cost pricing introduced on February 1, 2005 has elements of a demand curve for several NYISO/New York Public Service Commission reserve targets that are in excess of NERC/NPCC standards.

	Shortage Value	Target Level (MW)
Long Island Spinning Reserves	\$25/MW	60
Long Island 10-Minute Reserves	\$25/MW	120
Eastern Spinning Reserves	\$25/MW	600
Eastern 30-Minute Reserves	\$25/MW	1,000

These shortage values determine the costs the NYISO will incur in order to maintain reserves in these locations, rather than simply meeting the statewide requirement.

The shortage values for Long Island and Eastern spinning reserves are particularly likely to affect the unit commitment on low-load days when not many units are needed on-line to meet load.

- Suppose there is a shortage of Eastern spin for 5 hours in the day-ahead market.
- The value of committing a unit in the East capable of providing 10 megawatts of spin would be only \$1,250 (5 hours * 10 megawatts * \$25).
- This provides very little economic incentive for SCUC to commit units that are uneconomic in the energy market in order to maintain 10-minute spinning reserves east of Central East rather than west of Central East.

The current shortage values in the NYISO market are capable of producing shortage prices for reserves as high as \$1,400/MW for reserve shortages that prevail both statewide and east of Central East.

- These price levels are not sufficient on their own to support resource adequacy and are supplemented by a NYISO capacity market.
- In principle, an energy-only resource adequacy system could be implemented by establishing higher shortage values so that reserve shortages produced values for capacity ranging from \$5,000 to \$10,000/MWh.

The revenue effects of reserve shortage pricing are accounted for in the NYISO capacity market through the deduction of expected net energy and reserve revenues from the estimated cost of new capacity that is used to determine the capacity market demand curve (i.e., an ex ante adjustment).

- The expected revenue impact of prospective changes in reserve shortage values could be calculated from historic price data and incorporated prospectively into the determination of the capacity market demand curve used in NYISO auctions.
- Changes in market revenues due to changes in shortage pricing would not be automatically reflected in the price paid for ICAP under long-term bilateral constraints unless the contract provided for such adjustment.

ISO-NEW ENGLAND RESERVE SHORTAGE VALUES	
Total New England 10-Minute Spinning Reserves	\$50/MW
Total New England 10-Minute Reserves	\$850/MW
Total New England 30-Minute Operating Reserves	\$100/MW
Local 30-Minute Operating Reserves	\$50/MW

ISO-New England implemented real-time shortage pricing covering 30-minute operating reserves, 10-minute reserves and 10-minute spinning reserves, effective October 1, 2006.

SETTING SHORTAGE VALUES

In assessing reserve shortage values it is important to distinguish between mandatory requirements established by regional reliability organizations (NPCC and NERC for NYISO and ISO-New England; WECC for CAISO) and local reliability targets established by states or the RTO.

- RTOs may choose not to meet local reliability targets if the cost exceeds the shortage value.
- RTOs must attempt to meet regional reliability criteria even if the cost exceeds the shortage value.
- In practice, however, it does not appear that FERC requires RTOs to pay more than \$1,000/MW to meet NERC reserve requirements

NYISO shortage values were intended to be consistent with the actions NYISO operators or software would take to restore reserves such as scheduling imports at a price of \$1,000/MW.

- Other shortage values, such as those relating to PSC requirements, reflected a balancing of operator PSC, and market participant preferences.

¹ Affidavit of David Patten, Docket ER04-230, November 26, 2003, pp. 19-23.

ISO-New England apparently derived its \$100/MW shortage value for 30-minute reserves from the observed opportunity cost for “significant amounts” of 30-minute reserves over an historic period.¹

The shortage value for 10-minute reserves was set at \$850/MW to allow dispatch of essentially all internal resources and schedule imports at offer prices of \$1,000 ($\$850 + \$100 + \text{energy offer}$) to maintain 10-minute reserves.²

¹ Direct testimony of Marc Montalvo, February 6, 2006, pp. 41-42.

² Montalvo direct testimony, pp. 43-44.

ISO-New England intended the \$50/MW shortage value to apply both during periods of temporary ramp constraint when only the spinning reserve shortage value would apply and during periods in which capacity shortages affect spinning reserves as well as 10-minute reserves, with total shortage values of \$1,000/MW.³

¹ Montalvo direct testimony, p. 44.

SETTING SHORTAGE VALUES

In setting reserve shortage values, it is important to recognize that only a small portion of reserve value accrues to the control area carrying the operating reserves.

- Under a one-day-in-ten-year reliability standard, capacity will very rarely be low enough that incremental reserves affect the level or likelihood of load shedding within the control area carrying the reserves.
- NERC policies require control areas and transmission owners to take costly steps during reserve shortage conditions, both to prepare for and avoid load shedding.
- NERC operating reserve requirements are not set by the control area; they are imposed on the control area by NERC to reduce the risks to other control areas.

SETTING SHORTAGE VALUES

The shortage value for 10-minute reserves and spinning reserves are single values, not demand curves.

- As reserves drop to the level at which involuntary load shedding is implemented, reserve shortage values should at least rise to be roughly consistent with the value of lost load.

SETTING SHORTAGE VALUES

If NERC reserve requirements and control area shedding policies were internally consistent, the shortage value of reserves would be capped by the value of lost load as a control area can always restore reserves by shedding load.

- It is not clear, however, that all pre-RTO era reliability requirements are internally consistent.