WHY CAPACITY OBLIGATIONS AND CAPACITY MARKETS?

Paul L. Joskow

http://web.mit.edu/pjoskow/www/

massachusetts institute of technology

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DO COMPETITIVE ELECTRICITY MARKETS LEAD TO UNDER-INVESTMENT IN GENERATING CAPACITY?

- Growing concern among policymakers in the U.S. and Europe --- concerned about high prices and blackouts
- Investment in new generating capacity has slowed considerably in the U.S., Canada and the UK
- Growing number of plants have announced intention to close down
- Growing electricity demand and forecasts of pending shortages absent significant capacity additions
- Investment community argues that competitive markets yield too little revenue with too much volatility to stimulate “adequate” investment in generation
- Pressures for changes in market rules: long-term contracts, capacity obligations, supplementary capacity payments
- Changes (at least in the Northeast) need to be compatible with
  - retail competition
  - locational cost variations
  - market power mitigation

ARE INVESTMENT INCENTIVES A PROBLEM IN THE U.S.?

- There is excess generating capacity in many regions of the U.S. at the present time
  - With capacity significantly in excess of optimal reserve margins, prices and “rents” to cover capital costs should be very low
  - Excess exuberance during boom/bubble led to too much investment
  - Increases in natural gas prices have undermined economics of CCGTs
  - One view is “that’s life in competitive markets”
  - Also, investors in existing generating capacity have incentives to lobby for additional sources of revenue
  - But empirical evidence indicates that there really is a problem in the organized Eastern markets despite investment experience during the “bubble”

NEW U.S. GENERATING CAPACITY

YEAR	CAPACITY ADDED (MW)
1997	4,000
1998	6,500
1999	10,500
2000	23,500
2001	48,000
2002	55,000
2003	50,000
2004	20,000
	217,5000

Source: EIA

GENERATING CAPACITY UNDER CONSTRUCTION
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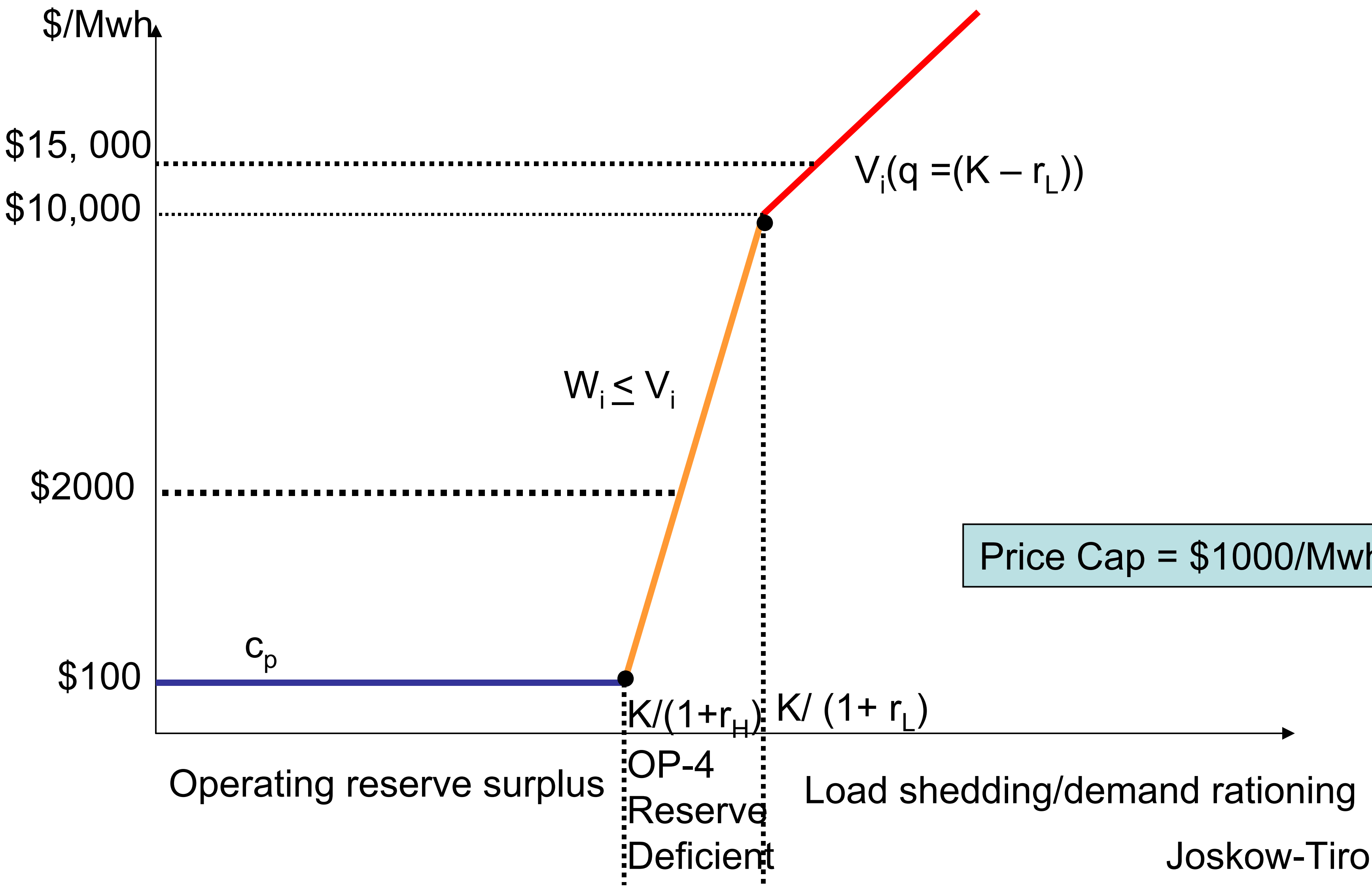
ISO-NE	3 Mw
NY-ISO	3,700 Mw (3,200 NYC)
PJM (traditional/APS)	1,800 Mw
ERCOT (Texas)	785 Mw
CA-ISO	4,500 Mw

Source: Argus

IDEALIZED "PEAK PERIOD" WHOLESALE MARKET PRICE PATTERNS



Joskow-Tirole (2004)

LONG RUN EQUILIBRIUM "PEAKER" INVESTMENT CONDITIONS (simplified)

Investment:

$C_k = \Sigma(p_i - c) = E(w_i) + E(v_i)$

Marginal cost of peaker = expected marginal net revenue (rent)

Demand/supply balance during "scarcity" conditions:

$p_j = w_j(q_j, X_j, r_j, K)$ [operating reserve deficiency]
$p_i = v_i(q_i, X_i, r_L, K)$ [load shedding]

An optimal level of capacity K* and associate "planned Reserve Margin" $R = K - E(q_p)$ is_implied by the above relationships and the probability distribution of peak demand realizations and generating unit availability

SCARCITY RENTS PRODUCED DURING OP-4 CONDITIONS ($1000 Price Cap) ($/Mw-Year)

YEAR	ENERGY		OPERATING	OP-4 HOURS/
	MC=50	MC=100	RESERVES	(Price Cap Hit)
2002	$ 5,070	$ 4,153	$ 4,723	21 (3)
2001	$15,818	$14,147	$11,411	41 (15)
2000	$ 6,528	$ 4,241	$ 4,894	25 (5)
1999	$18,874	$14,741	$19,839	98 (1)
Mean	$ 11,573	$ 9,574	$10,217	46 (6)

Peaker Fixed-Cost Target: $60,000 - $70,000/Mw-year

PJM

Table 2-31 - New entrant gas-fired combustion turbine plant (Dollars per installed MW-year): Theoretical net revenue for calendar years 1999 to 2004

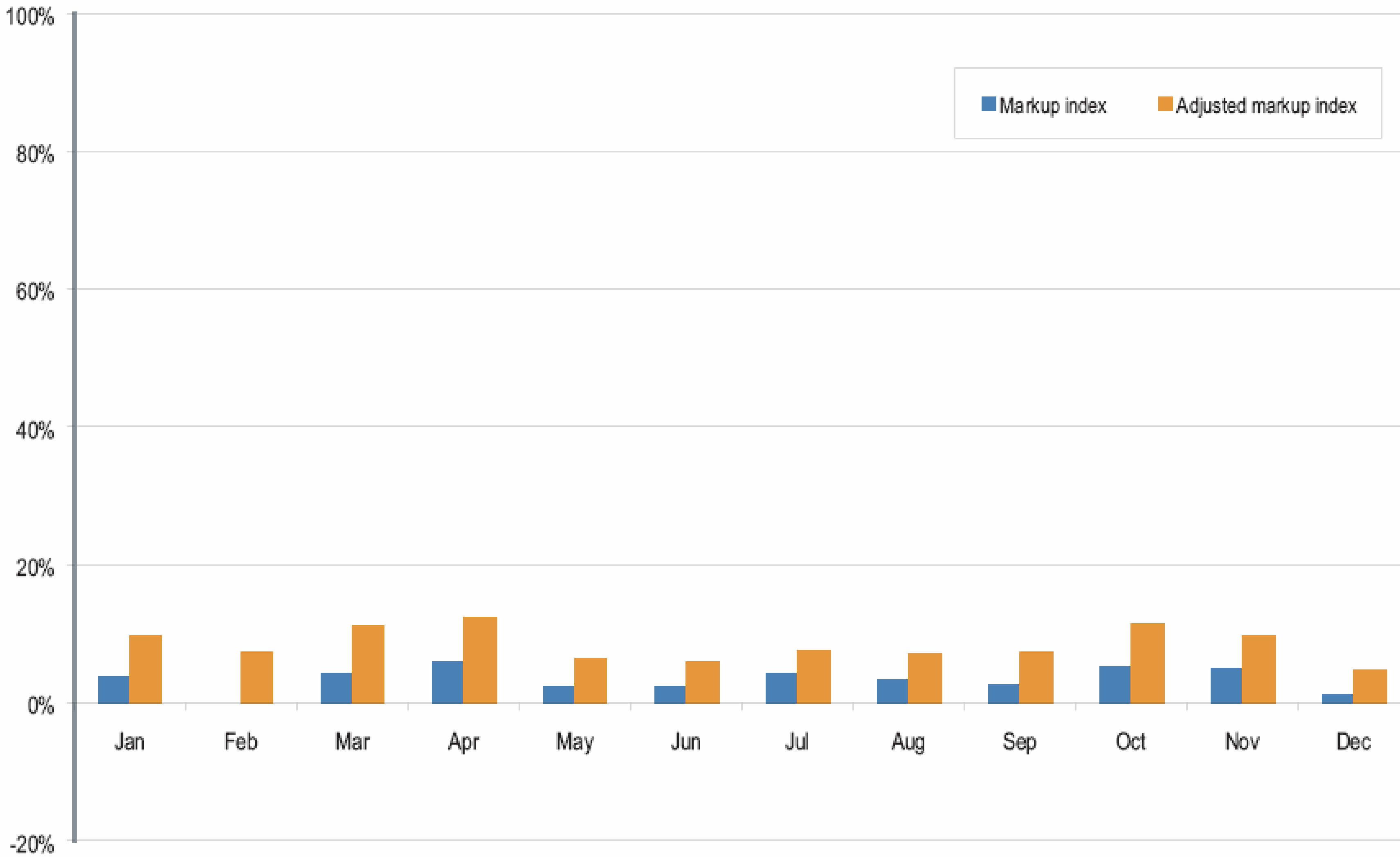
Year	Energy	Capacity	Spin	Regulation	Reactive	Total
1999	$62,065	$16,677	$0	$0	$2,390	$81,131
2000	$16,476	$20,200	$0	$0	$2,390	$39,066
2001	$39,269	$30,960	$0	$0	$2,390	$72,619
2002	$23,232	$11,516	$0	$0	$2,390	$37,139
2003	$12,154	$5,554	$0	$0	$2,390	$20,099
2004	$8,063	$5,376	$0	$0	$2,390	$15,829

Average: $26,876 $15,047 $2,390 $44,313

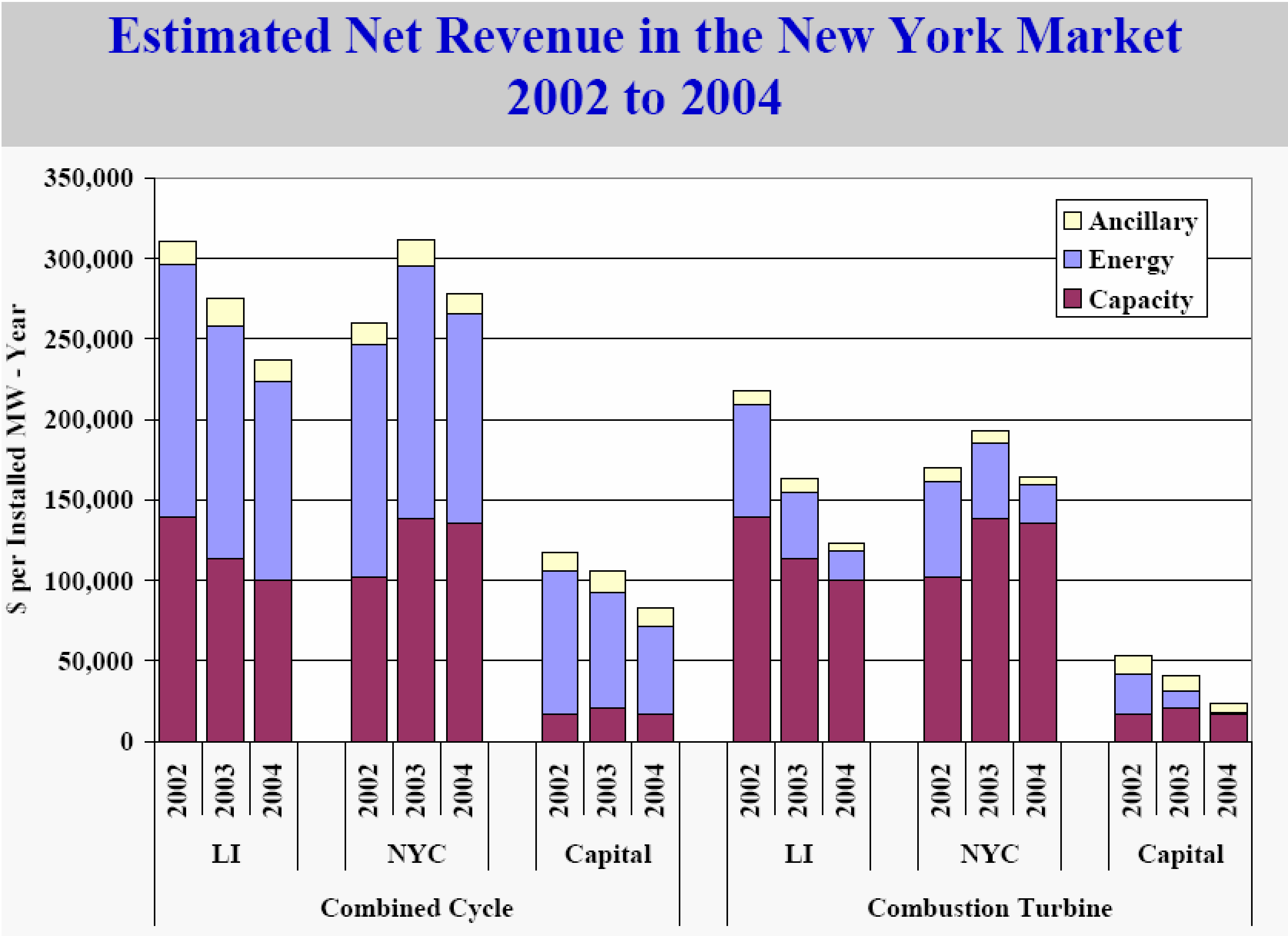
Annualized 20 Year Fixed Cost: $72,000

Source: PJM State of the Market Report 2004

Figure 2-6 - Average monthly load-weighted markup indices: Calendar year 2004



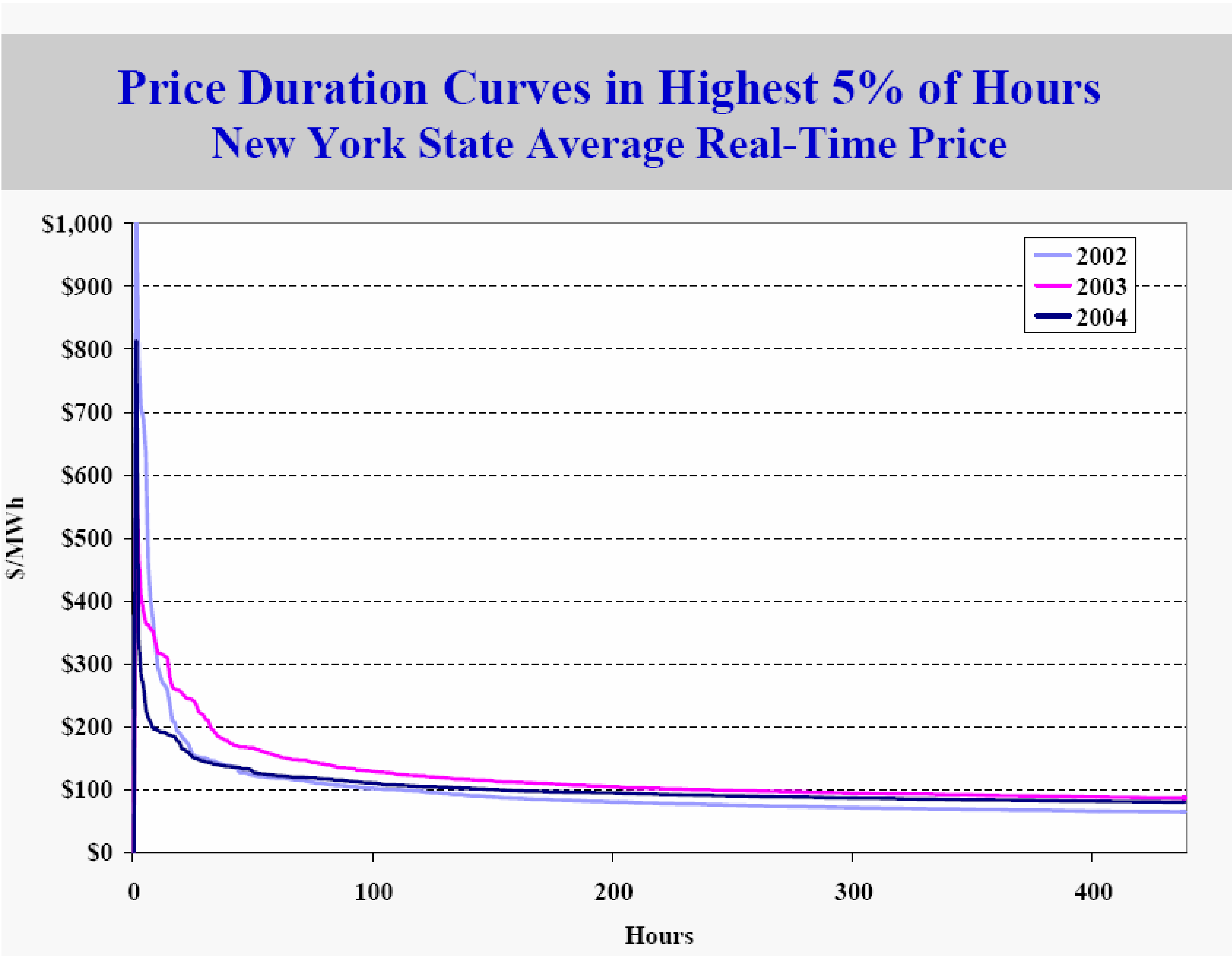
Source: PJM State of the Market Report 2004



Source: New York ISO (2005)

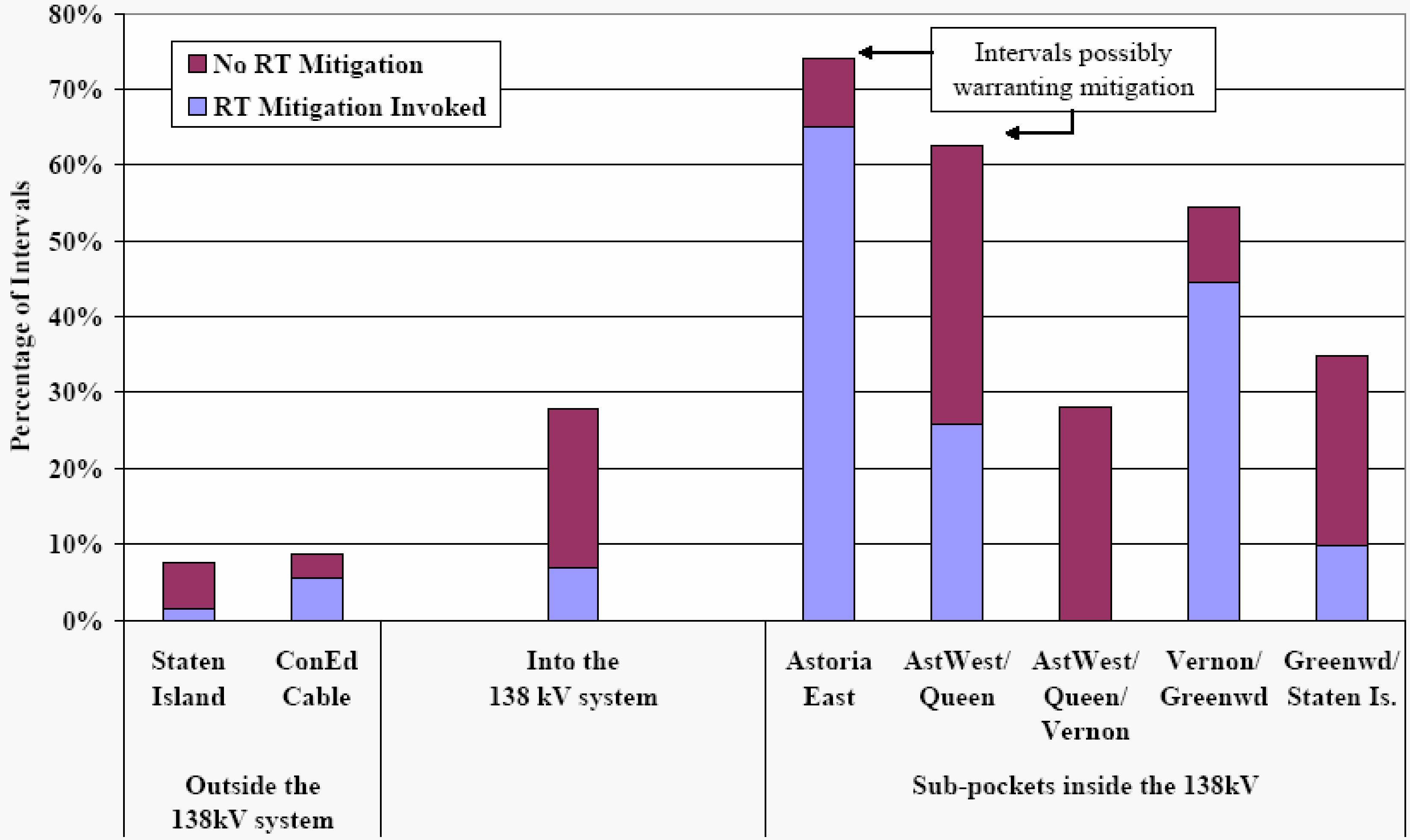
WHY DON'T "ENERGY-ONLY" MARKETS PROVIDE ADEQUATE PRICE SIGNALS?

- Several factors "truncate" the upper tail of the distribution of spot energy prices
  - Price caps and other market power mitigation mechanisms
    - Where did $1000/Mwh come from?
  - Prices are too low during operating reserve deficiency conditions for a variety of challenging implementation problems
  - Administrative rationing of scarcity rather than demand/price rationing of scarcity depresses prices
  - "Reliability" actions ahead of market price response keep prices low
  - SO dispatch decisions that are not properly reflected in market prices (OOM; too few "products" to manage the network?)
- Consumer valuations may be inconsistent with traditional reliability criteria
  - The implicit value of lost load associated with one-day of a single firm load curtailment event in ten-year criterion is very high and inconsistent with reliability of the distribution system (NPCC ~ $300,000/Mwh)
  - Administrative rationing increases the cost of outages to consumers



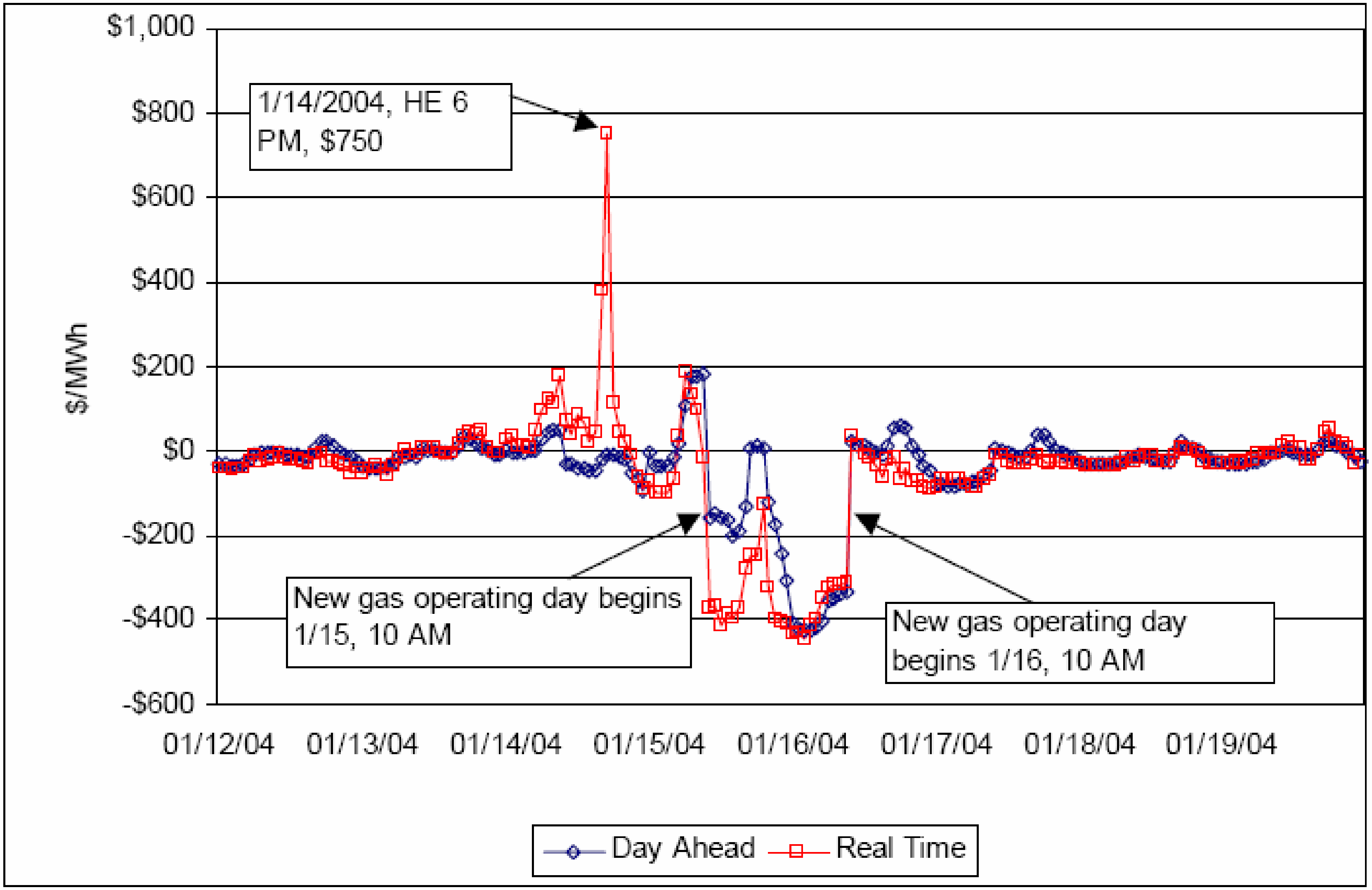
Source: NYISO (2005)

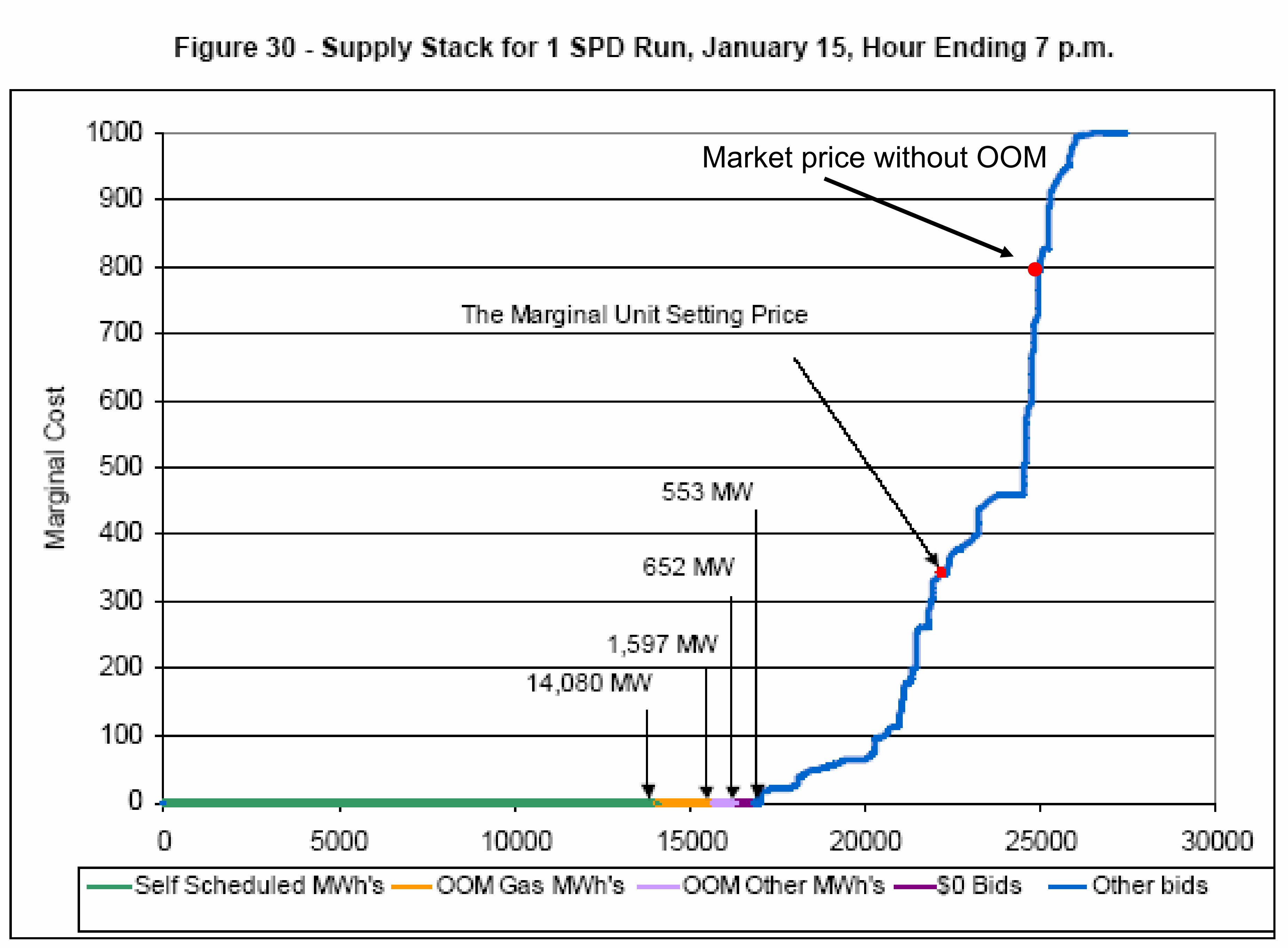
Frequency of Real-Time Constraints and Mitigation
New York City Load Pockets in 2004



Source: NYISO (2005)

Figure 12 - Day-Ahead and Real-Time Spark Spreads for a Gas-Fired Unit with an 8MMBtu/MWh Heat Rate, January 12 - January 19, 2004





Source: ISO NE

Figure 29 - Supply Stack for 1 SPD run, January 15, Hour Ending 2:00 p.m.

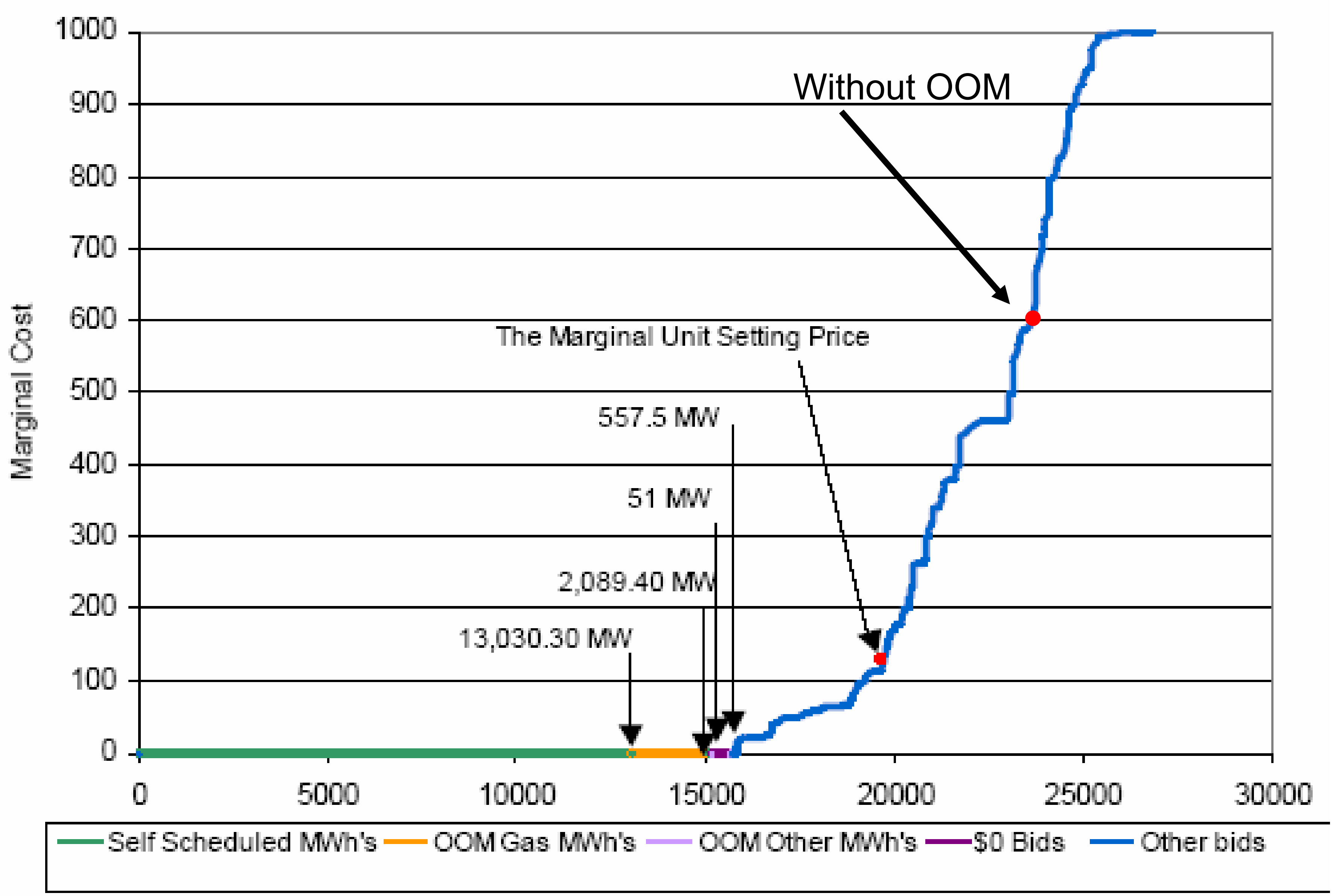


Table 30 – Demand Response Program Enrollments, August 1, 2004

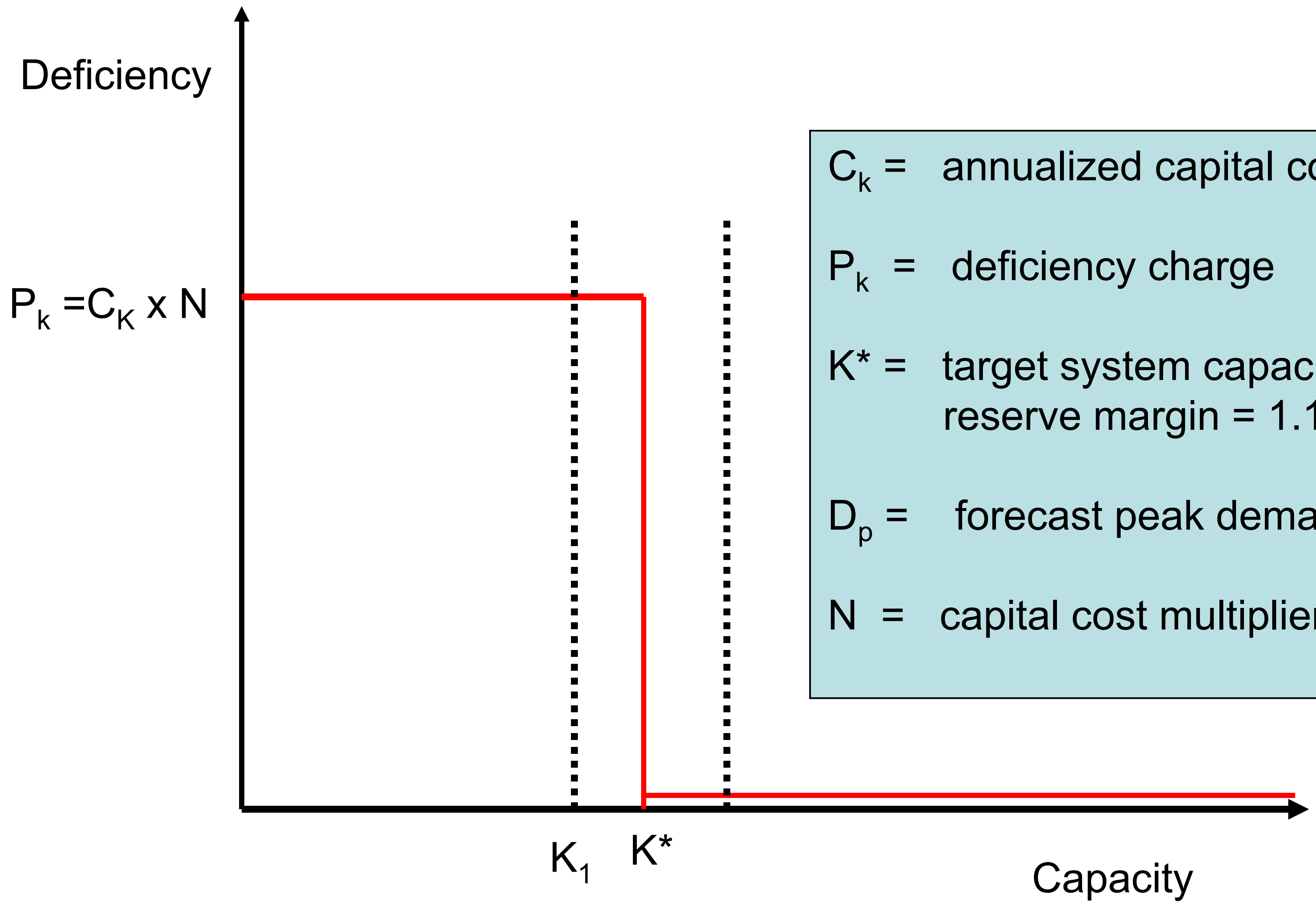
	Ready to Respond Assets (MW)					Approved Assets (MW)				
Zone	No. of Assets	RT Price Response	Demand Response 30 min.	Demand Response 2 Hr	Profiled	No. of Assets	RT Price Response	Demand Response 30 min.	Demand Response 2 Hr	Profiled
CT	126	30.7	145.8	0.4	0.0	10	1.1	1.8	0.0	0.0
ME	5	1.5	0.0	1.0	76.0	0	0.0	0.0	0.0	0.0
NEMA	117	39.4	3.3	1.5	1.4	1	0.0	24.0	0.0	0.0
NH	2	0.2	0.4	0.0	0.0	0	0.0	0.0	0.0	0.0
RI	12	3.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
SEMA	83	8.5	0.5	0.0	0.0	10	1.0	0.0	0.0	0.0
VT	17	7.5	0.1	0.0	5.9	0	0.0	0.0	0.0	0.0
WCMA	99	12.7	2.2	9.3	0.0	7	0.9	0.3	0.0	0.0
Total	461	103.4	152.3	12.3	83.2	28	3.0	26.1	0.0	0.0

Source: ISO New England

EASTERN ISOs ANTICIPATED THIS PROBLEM

- Market designs included capacity obligations that required LSEs to acquire capacity equal to ~ 1.18 of peak load
- PJM (but not NE or NY) applied transmission "deliverability" criteria to generators seeking to be "capacity resources"
- Capacity trading/credit markets have been introduced to allocate capacity and determine capacity prices
- Capacity prices are supposed to provide a market-clearing "safety valve" for imperfections in energy and operating reserve markets (see Joskow-Tirole 2004)
- Investors argue these features are inadequate:
  - Prices are too volatile
  - Price caps on capacity prices (deficiency charges) as well
  - Locational considerations are not adequately reflected
- Other problems have emerged:
  - Market power problems in capacity as well as energy markets
  - Payments for capacity that is not available at peak
  - Capacity prices not properly reflected in spot prices further undermining demand-side responses

INITIAL CAPACITY MARKET DESIGN



C_k = annualized capital cost of peaker

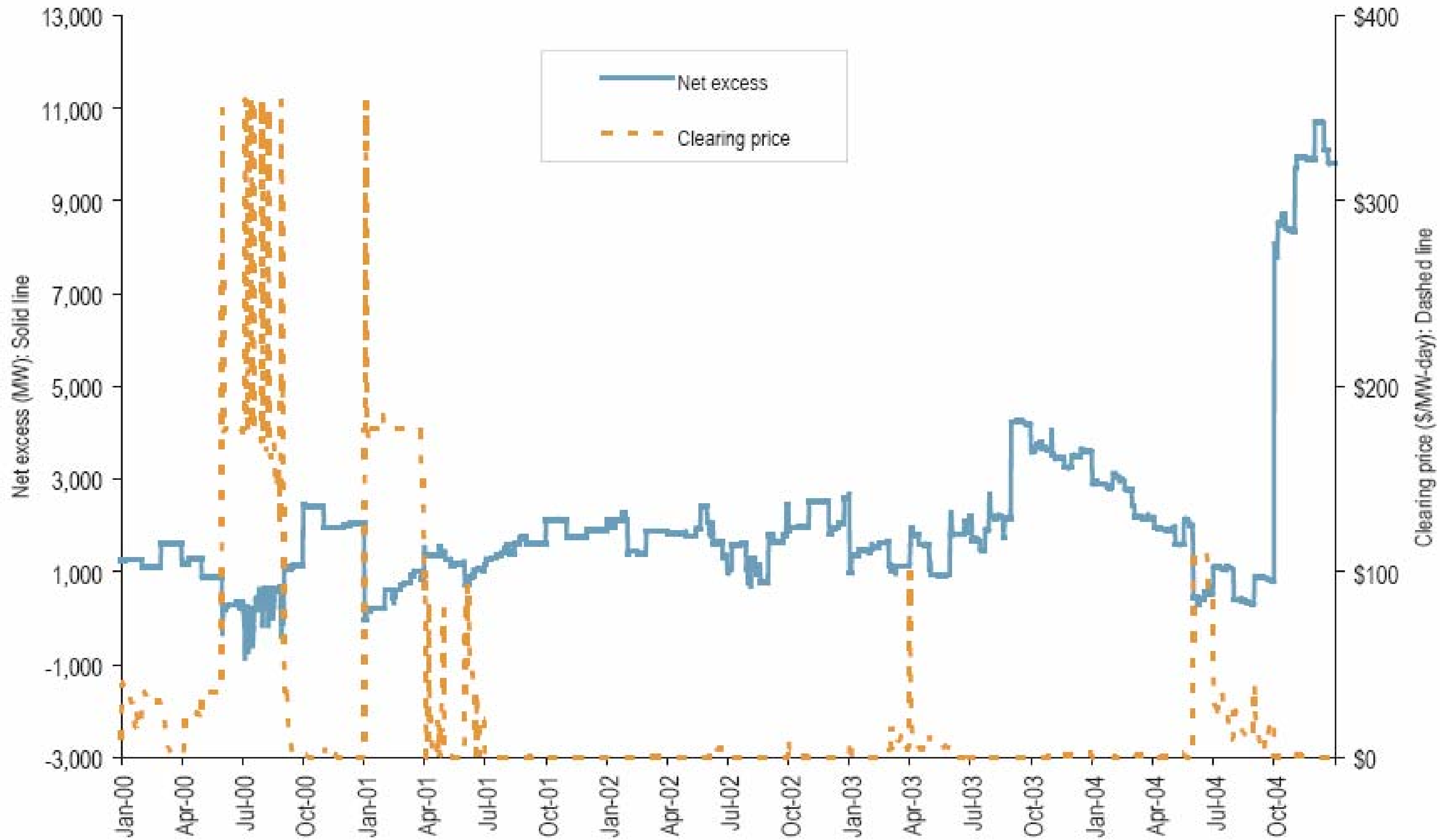
P_k = deficiency charge

K^* = target system capacity included reserve margin = $1.18D_p$

D_p = forecast peak demand

N = capital cost multiplier (1,2,3)

Figure 4-9 - The PJM Capacity Market's net excess vs. capacity credit market-clearing prices: January 2000 to December 2004



WHAT TO DO?

- Continue to improve the performance of the spot market for energy and operating reserves
  - Raise the price caps to reflect reasonable estimates of VOLL
  - Allow prices to rise faster and higher under OP4 conditions
  - Minimize use of OOM or define a wider array of wholesale market products that are fully integrated with markets for related products (e.g. NE Forward reserve market)
  - Continue efforts to bring active demand side into the spot market for energy and reserves
  - Re-evaluate reliability criteria to better reflect consumer valuations

WHAT TO DO?

- Implement "capacity price" or "capacity obligation" mechanisms as a "safety valve" to produce adequate levels to support investment consistent with reliability criteria
  - "safety valve," not be a permanent major source of net revenues
  - Consistent with continued evolution of spot wholesale markets and demand side participation
  - Capacity values (peaker rents) should be low when actual capacity is greater than K*
  - Capacity values (peaker rents) should be high when actual capacity is significantly less than K*
  - On average (expected value) capacity price should work out to the cost of a peaker C_k .
  - Smoothing around K* makes sense since there is reliability value when K > K*
  - Capacity <u>payment</u> target should net out peaker scarcity rents that are produced by the spot market (C_k – peaker scarcity rents)
  - Demand side should see a price (payment) consistent with the VOLL that underlies the reserve margin and peaker construction and carrying cost assumptions