PSERC, Cornell University, 5/16/06

Trying to Maintain Generation Adequacy in "Deregulated" Markets

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OUTLINE

- **Consequences of the Californian Crisis**
  - Suppress price spikes in the spot market
  - Insufficient investment in new generation
- **Paying for Reliability: The Textbook Solution**
  - NERC's short-run and long-run reliability standards
  - Locational capacity requirements for New York State
  - Optimal composition of generating capacity
- **Paying for Reliability: Alternative Solutions**
  - Average price duration curves and long-run average costs
  - Price spikes in the spot market (Australian market)
  - Augmented capacity auction (New York's "demand" curve)
  - Capacity auction in theory and in practice
  - Conclusions

PART 1

The Indirect Consequences of the Californian Energy Crisis On Generation Adequacy

References on <www.e3rg.pserc.cornell.com>

1. Yoo-Soo Lee
   "Risk Premium in Forward Prices during the Californian Crisis"
2. Xiaobin Cai
   "Investment Incentives for new Generation Capacity"

Spot Prices in Southern California and Price Caps in the CAISO Spot Market

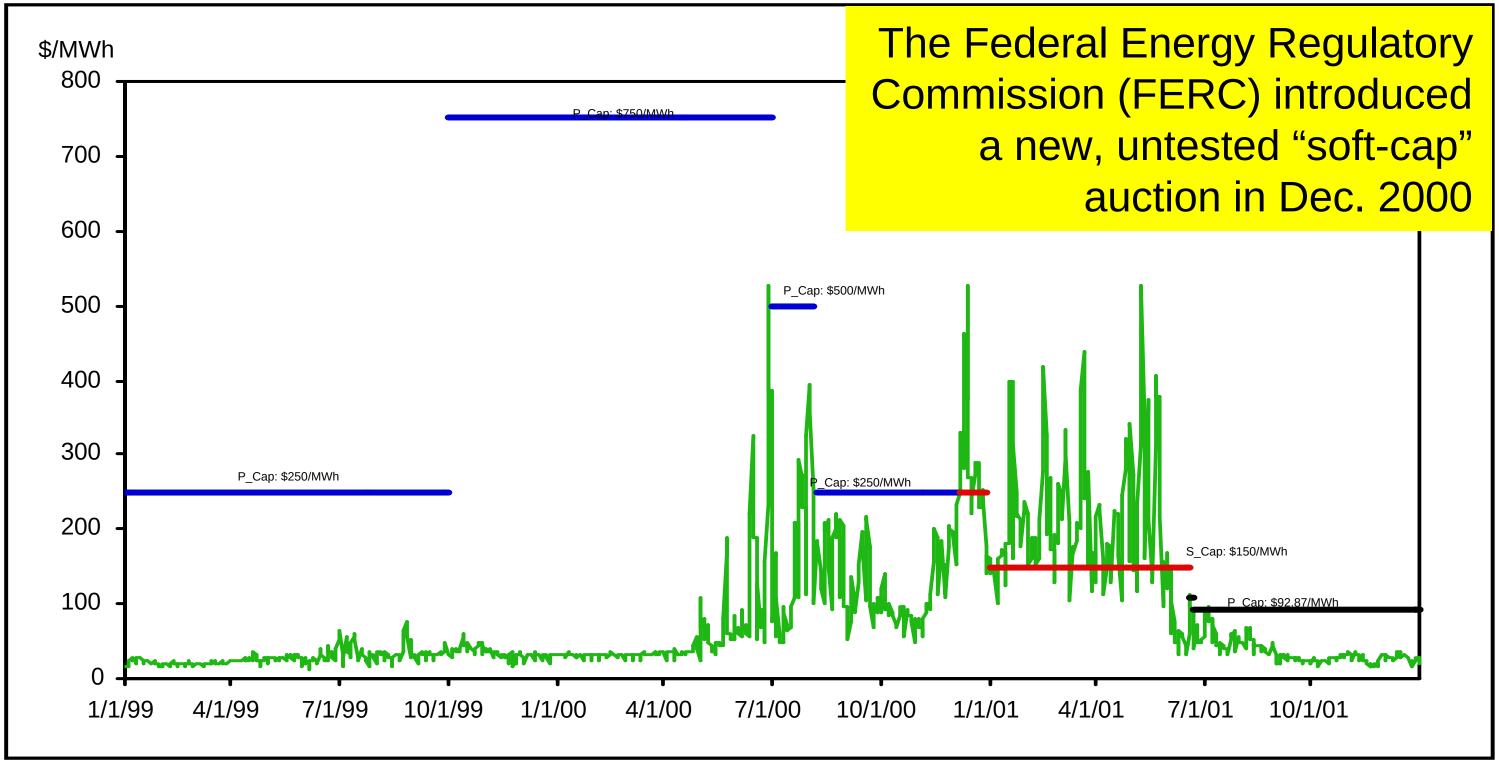


Figure 1: Spot Prices at Southern California and the Price Caps in California,

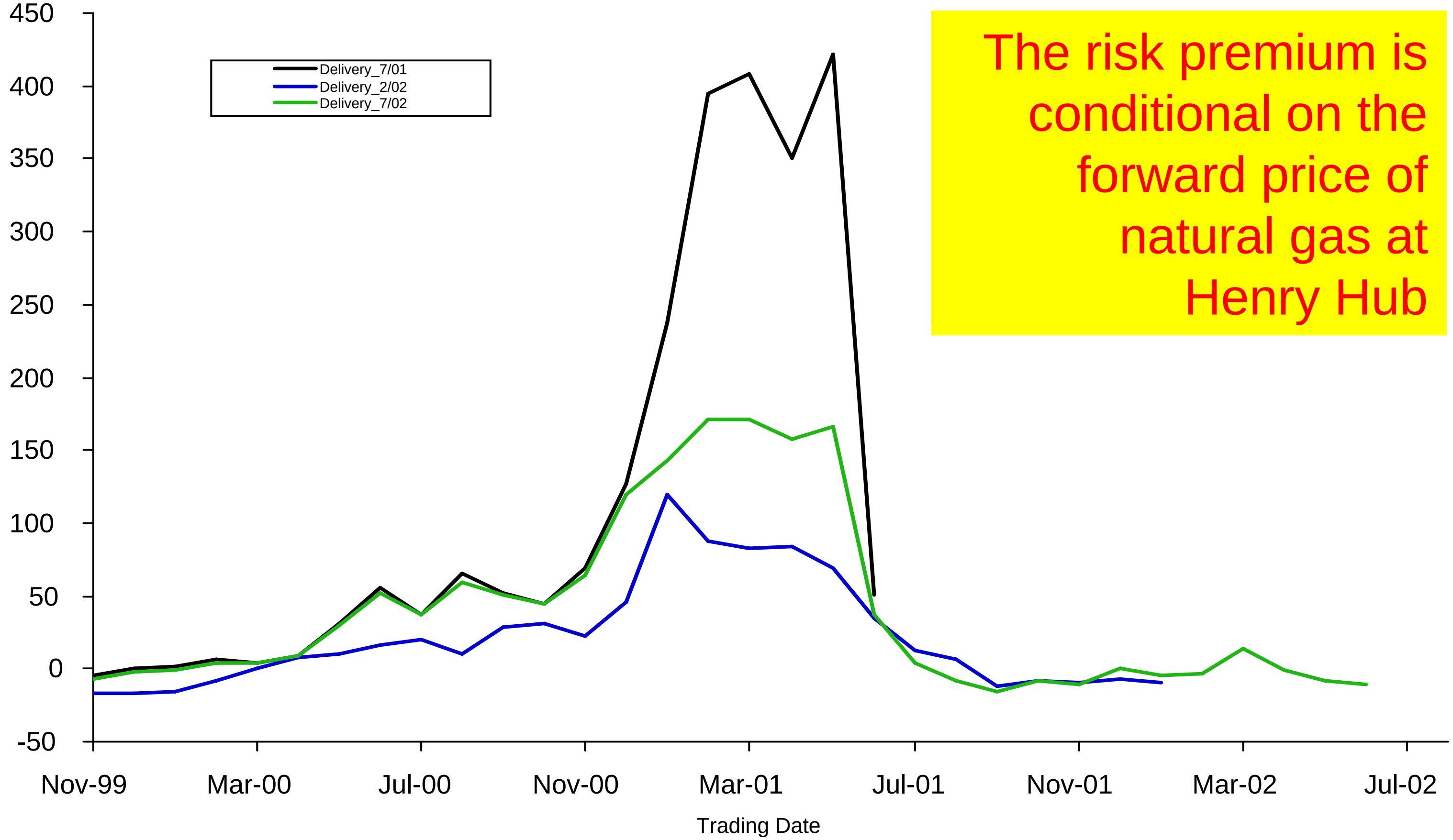
Blue CAISO Hard Cap

Red CAISO Soft Cap

Black WECC Hard Cap

(Source, Energy Market Report and the CAISO)

The Estimated Risk Premium in the Forward Market for Electricity for Three Delivery Months at the Palo Verde Trading Hub



The risk premium is conditional on the forward price of natural gas at Henry Hub

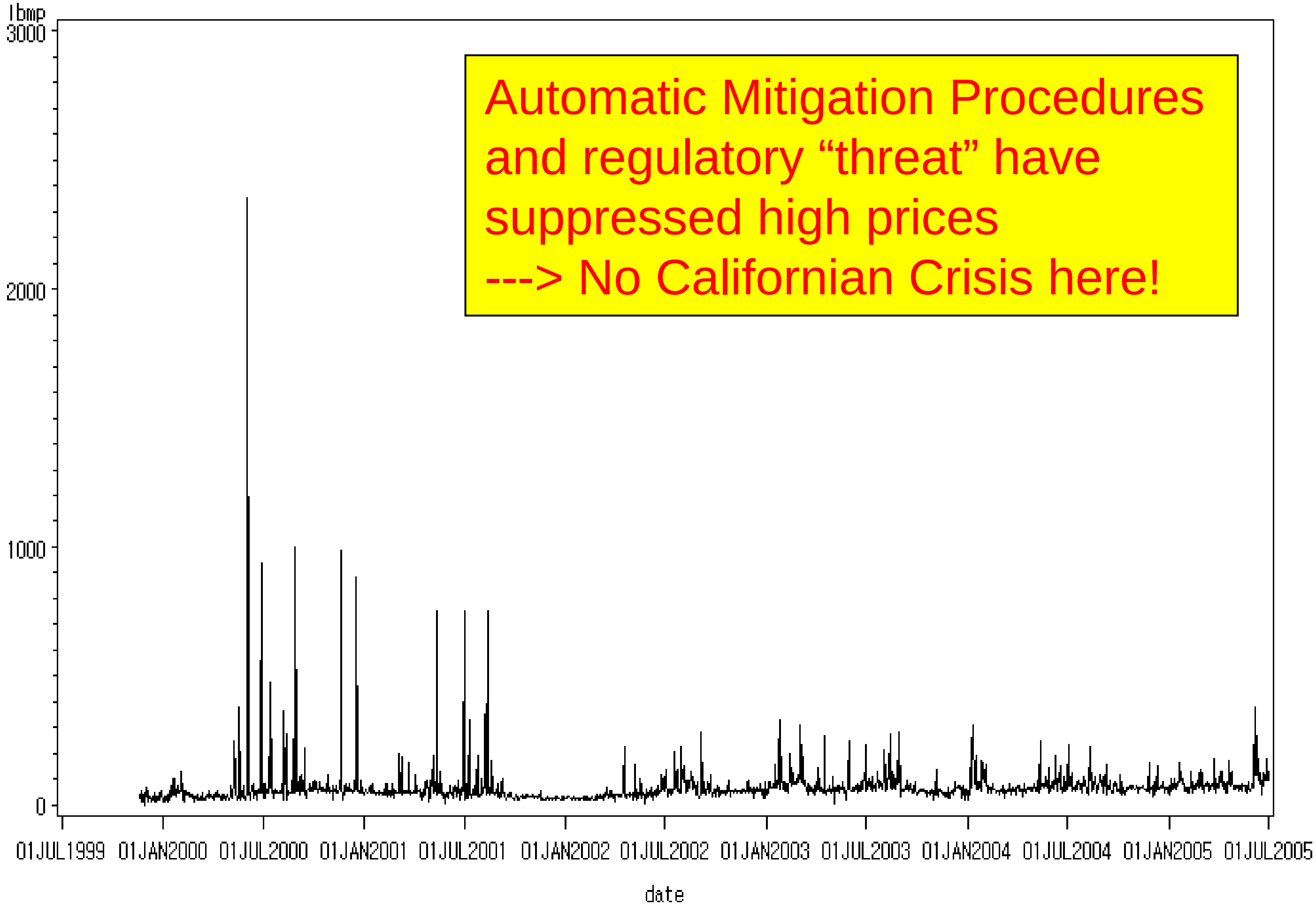
The Indirect Consequences in New York State

Daily Spot Prices in New York City

(1/7/99 - 1/7/05 at 2PM, $/MWh)

N.Y.C. real time price time plot(14:00)

Price $/MWh



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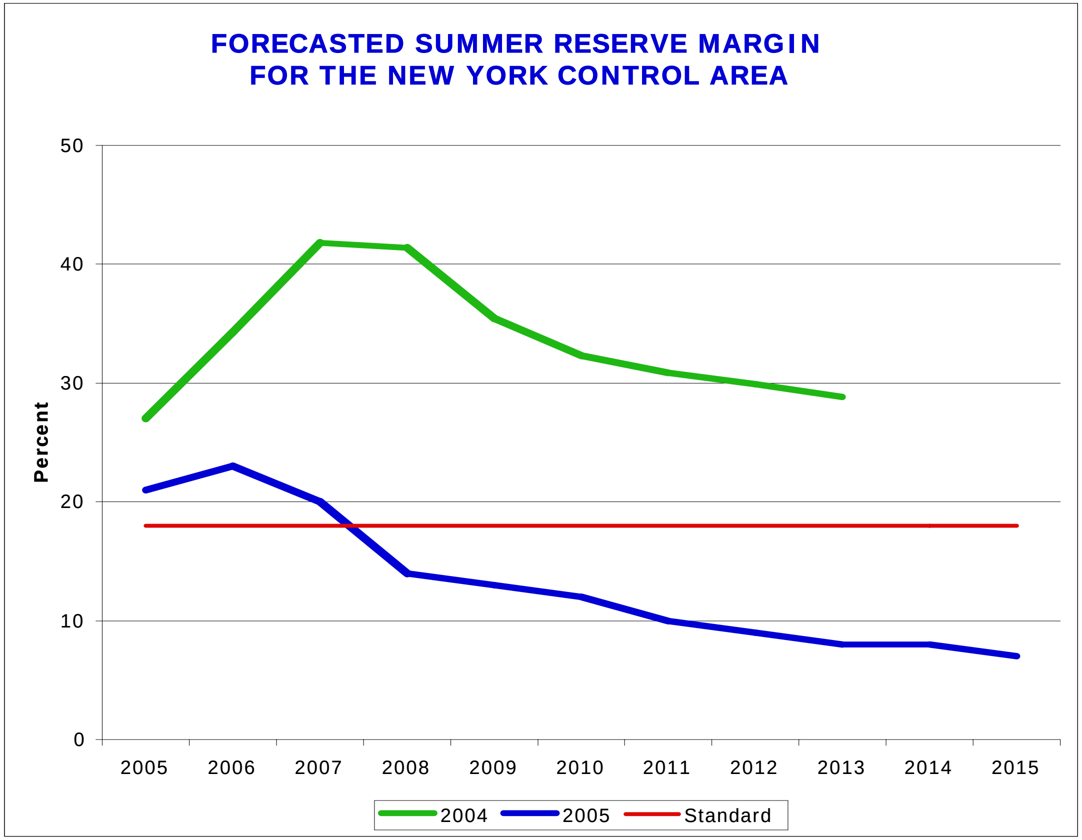
THE PROBLEM: Some new power plants (with construction licenses) have been cancelled in New York State ---> Possible threat to reliability



NYISO standard ---
A reserve margin of 18% is needed to meet NERC reliability (Fail <1 day in 10 years)

Reserve Margin is the amount of Installed Capacity above the Forecasted PEAK Load (%)

Source: NYISO PowerTrends

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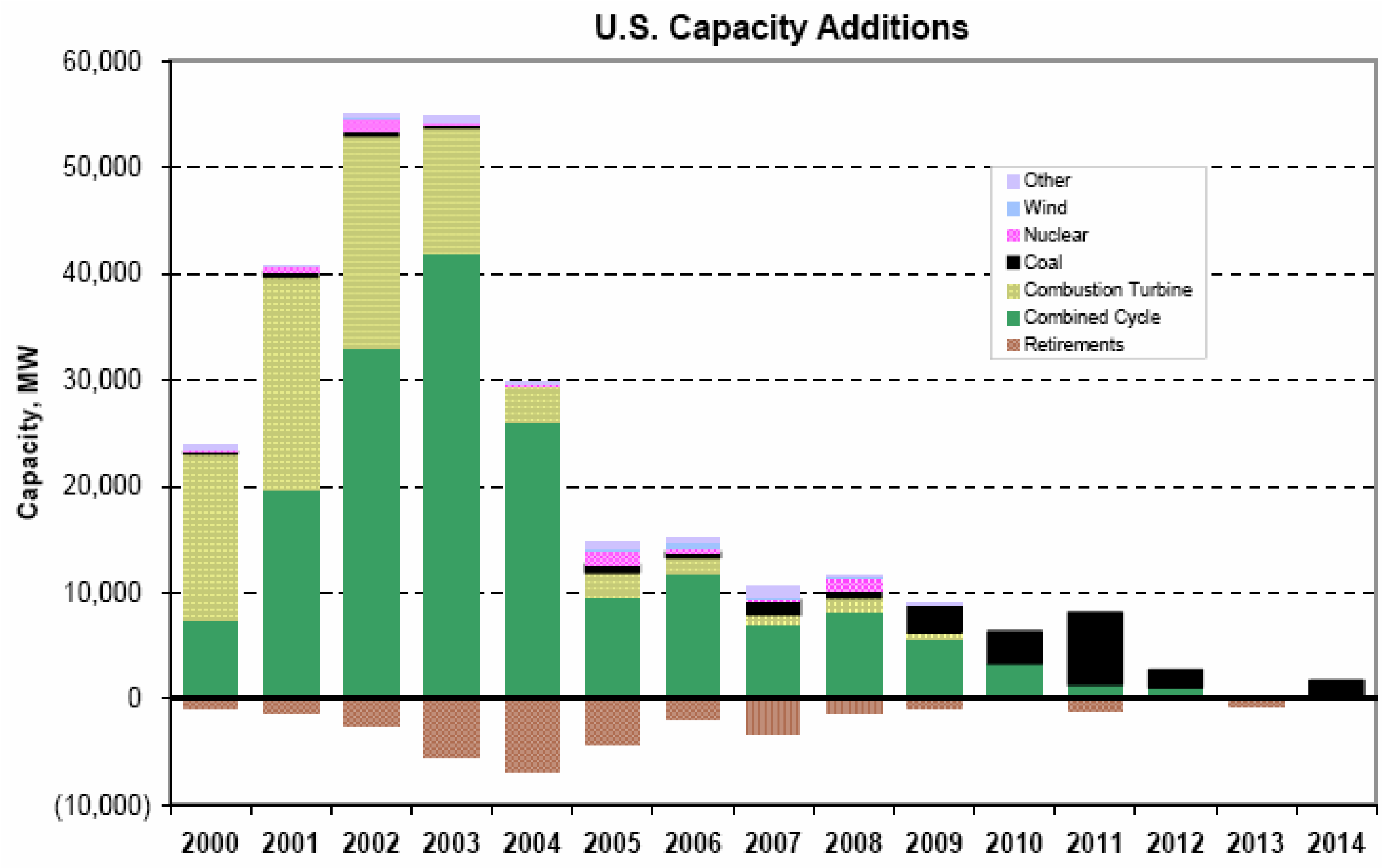
The lack of investment in new power plants is really a national problem



Source: "2005 NERC Long-Term Reliability Assessment", Fig. 4

PART 2

Paying for Reliability in "Deregulated" Markets: The Textbook Solution

Current Reliability Standards I
Two Different NERC Criteria

DEFINITIONS OF RELIABILITY
North-American Electric Reliability Council (NERC), 2005

1. ***Adequacy*** *— The ability of the electric system to supply the aggregate electrical demand and energy requirements of customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.*
   [Ensuring there is enough generation and transmission capacity --- the investors' problem]

2. ***Operating Reliability*** *— The ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated failure of system elements.*
   [Determining the dispatch of installed capacity and levels of reserves --- the system operators' problem]

Current Reliability Standards II

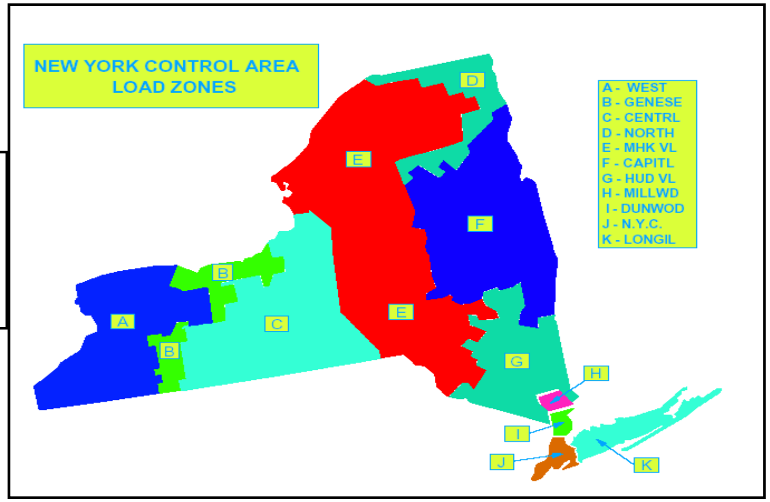
Capacity requirements set by state regulators for the New York Control Area (NYCA)

Locational Capacity Requirements for New York State in 2005/06

Locality	Forecasted Peak Load MW	Locational ICAP % of Peak	Required Locational ICAP, MW	Actual ICAP, MW	Actual ICAP % of Peak	Ratio of Actual ICAP to Required
NYC	11,315	80	9,052	9,887	87	1.09
LI	5,231	99	5,179	5,318	102	1.03
NYCA	31,692	118	37,715	39,647	125	1.05

Source: NYISO 2/17/05

NYC	New York City (J)
LI	Long Island (K)
NYCA	New York Control Area



Current Reliability Standards III

Power plants needed to maintain reliability in New York City and Long Island

Capacity Factors for Major Power Plants in NYC and LI (2004)

lame	Zone	*Unit and Fuel Type**	*Summer Capacity MW*	*Generation GWh*	***Capacity Factor %****
.. Ravenswood ST 01-03	LI	ST F06/NG	1765	4751	**31**
. Barrett ST 01-02	LI	ST NG/F06	390	1336	**39**
. Far Rockaway ST 04	LI	ST NG/F06	107	264	**28**
. Glenwood ST 04-05	LI	ST NG	238	545	**26**
. Northport 1-4	LI	ST NG/F06	1539	7507	**55**
. Wading River 1-3	LI	GT/F02	245	306	**14**
. Port Jefferson 3-4	LI	ST F06/NG	385	1399	**41**
. Flynn	LI	CC NG/F02	136	1069	**89**
. East River 6-7	NYC	ST F06/NG	304	543	**20**
0. Brooklyn Navy Yard	NYC	CC NG/F02	262	1983	**86**
1. Cogen Tech-Linden	NYC	GT/NG	661	4286	**74**
2. Poletti 1	NYC	ST F06/NG	882	2629	**34**
3. Arthur Kill ST 2-3	NYC	ST NG/F06	860	675	**9**

Only 1 of the 9 conventional power plants (> 80MW) in New York City and Long Island has a capacity factor > 50%

* ST Steam Turbine
CC Combined Cycle Turbine
GT Combustion Turbine
NG Natural Gas
F06 Residual Oil
F02 Distillate Oil

** Capacity Factor = 100xGWhGenerated/(365.25x24xMWSummer Capacity/1000)

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Current Reliability Standards IV
FERC is now in charge of enforcing standards

The Energy Policy Act of 2005 (EPAct05) was signed into law in August 2005, and it gives greater authority to the Federal Energy Regulatory Commission (FERC) to enforce reliability standards by imposing penalties on end-users if the standards are violated.

In addition, a new organization, the Electric Reliability Organization (ERO), will be given the authority to establish these reliability standards. Prior to EPAct05, FERC was primarily an economic regulator of the wholesale transactions and tariffs on the bulk power system. At this time, it is not clear exactly how FERC will implement the new responsibilities for enforcing reliability.

[FERC will enforce standards for Operating Reliability but not for System Adequacy?]

Load Duration Curves for 2002-05
New York City and Long Island

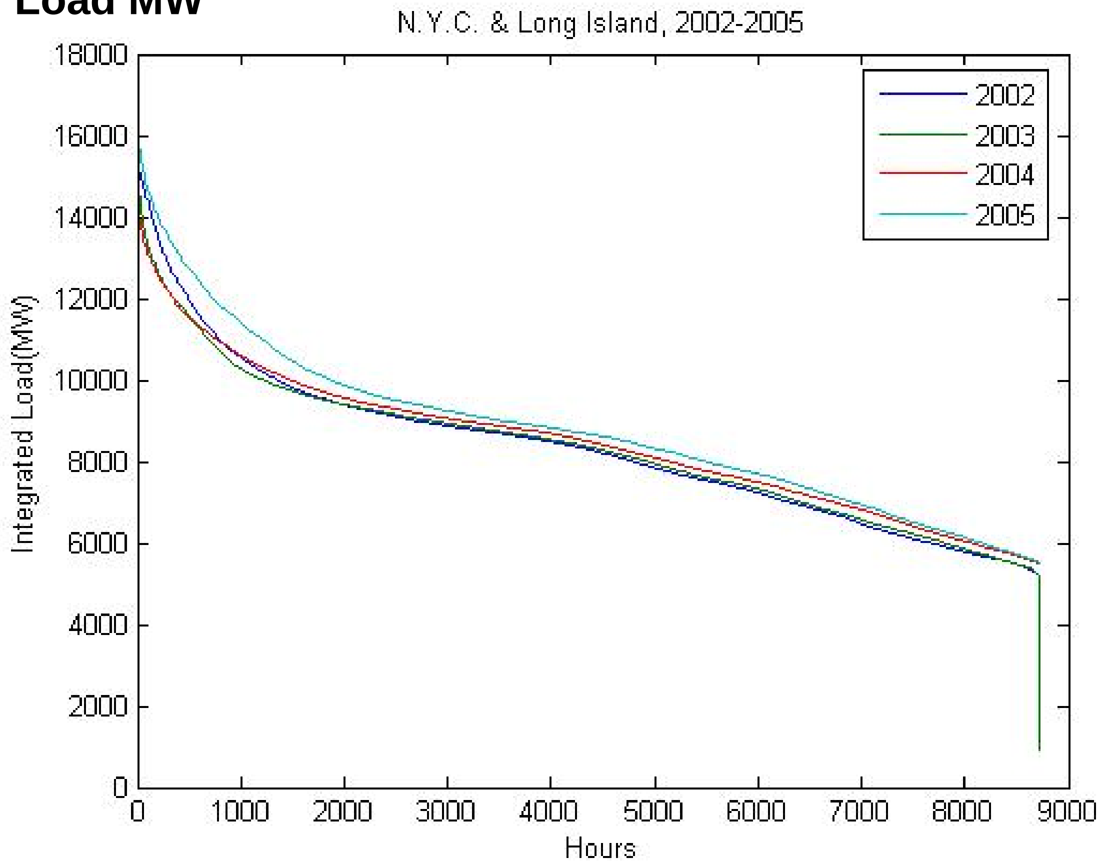
Load MW

Reserves --->

Peak --->

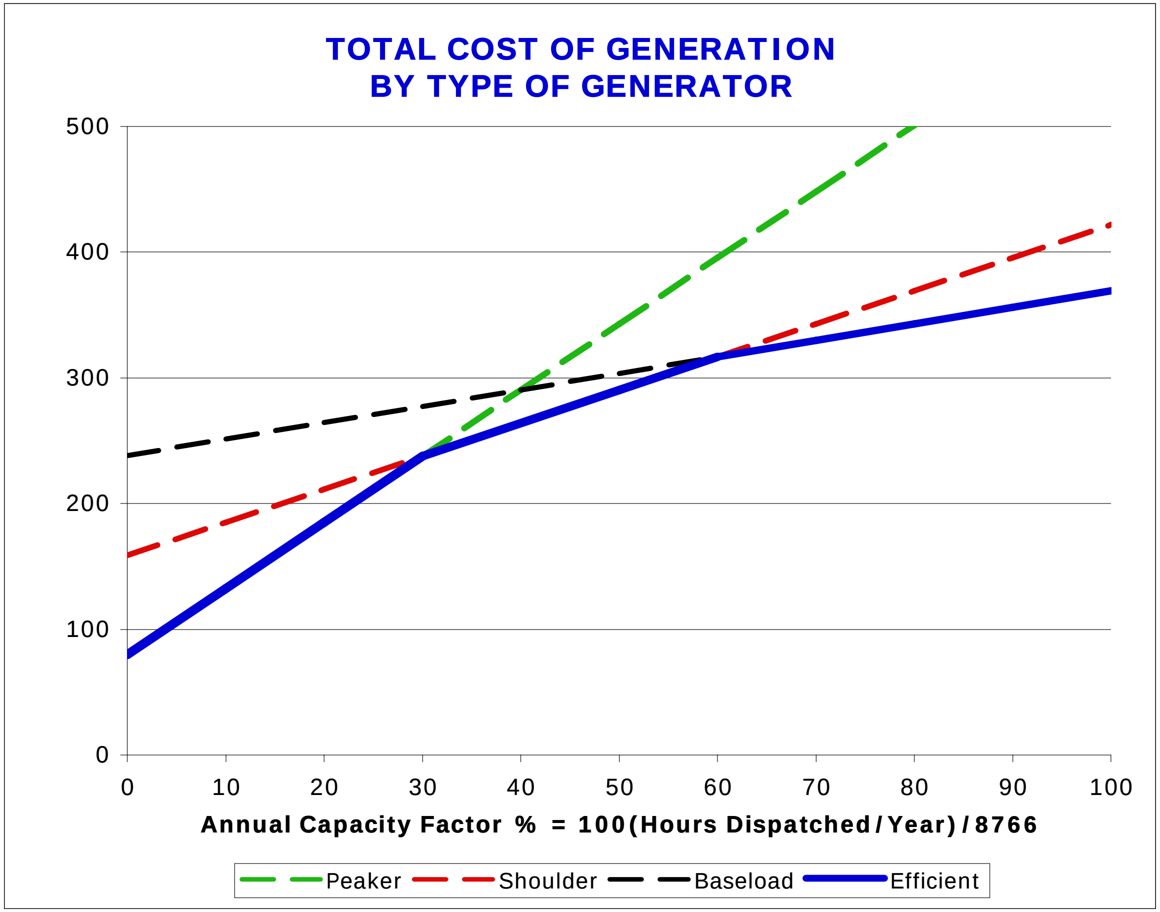
Shoulder --->

Baseload --->



Hours/Year

Total Cost of Generation/Year by Type of Generator



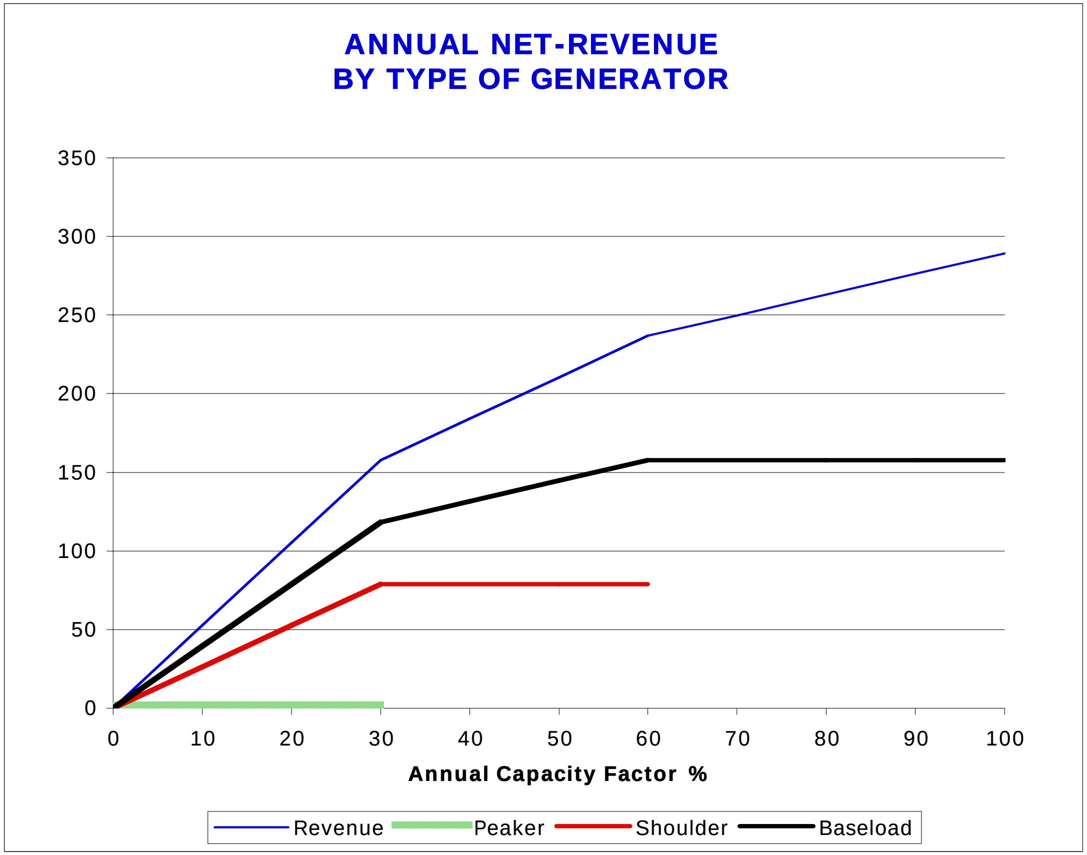
Specified Costs

	Variable ($/MWh)	Capital (k$/MW/Year)
Peak	60	80
Shoulder	30	159
Baseload	15	238

Capacity Factors for Least-Cost Choices

Peak	< 30%
Shoulder	30-60%
Baseload	> 60%

Annual Net-Revenue Using Short-Run Competitive Prices = Marginal Operating Cost



Specified Costs

	Variable ($/MWh)	Capital (k$/MW/Year)
Peak	60	80
Shoulder	30	159
Baseload	15	238

Additional Revenue Needed to Cover the Capital Costs

(k$/MW/Year)

Peak	80
Shoulder	80 = 159 - 79
Baseload	80 = 238 - 158

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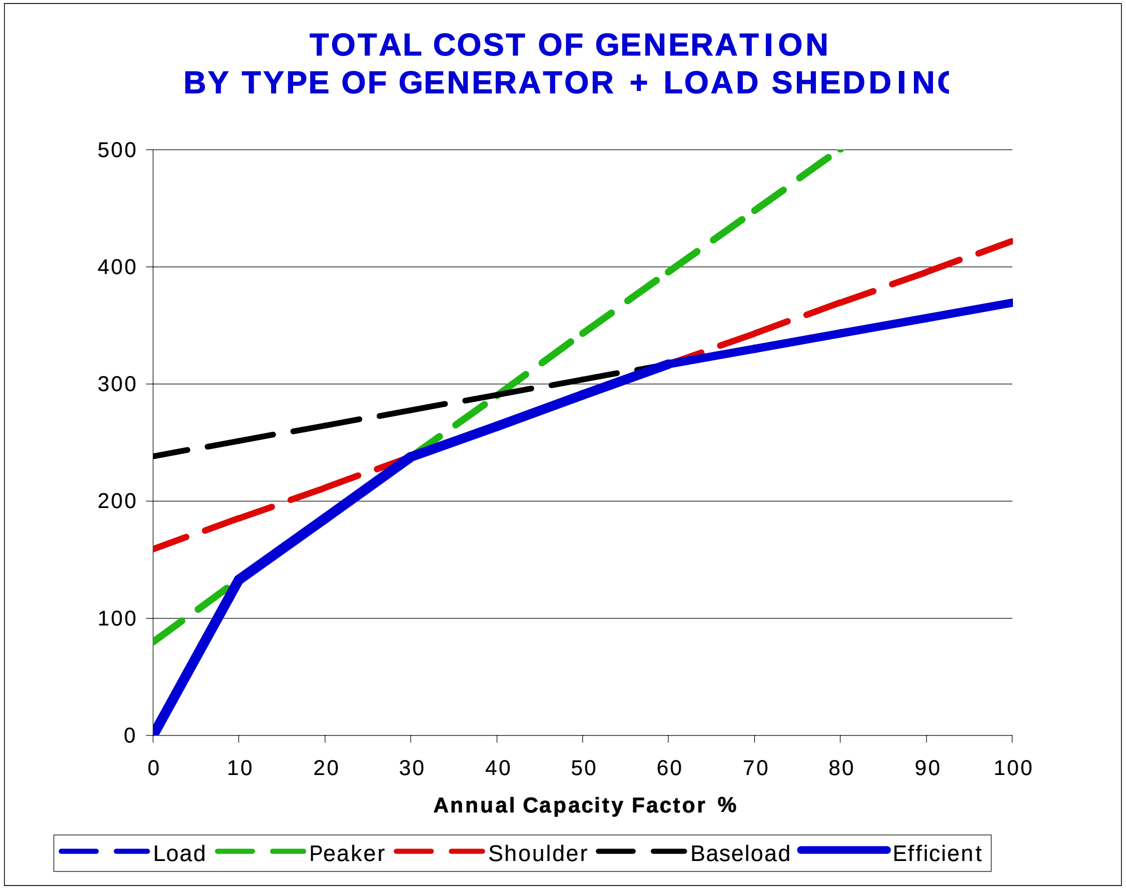
Total Cost of Generation/Year by Type of Generator + Load Shedding [Textbook Solution]



Specified Costs

	Variable ($/MWh)	Capital (k$/MW/Year)
Peak	60	80
Shoulder	30	159
Baseload	15	238

Capacity Factors for Least-Cost Choices

Shed Load	<10%
Peak	10-30%
Shoulder	30-60%
Baseload	>60%

Shed Load

(10% = 36.5 Days/Year)

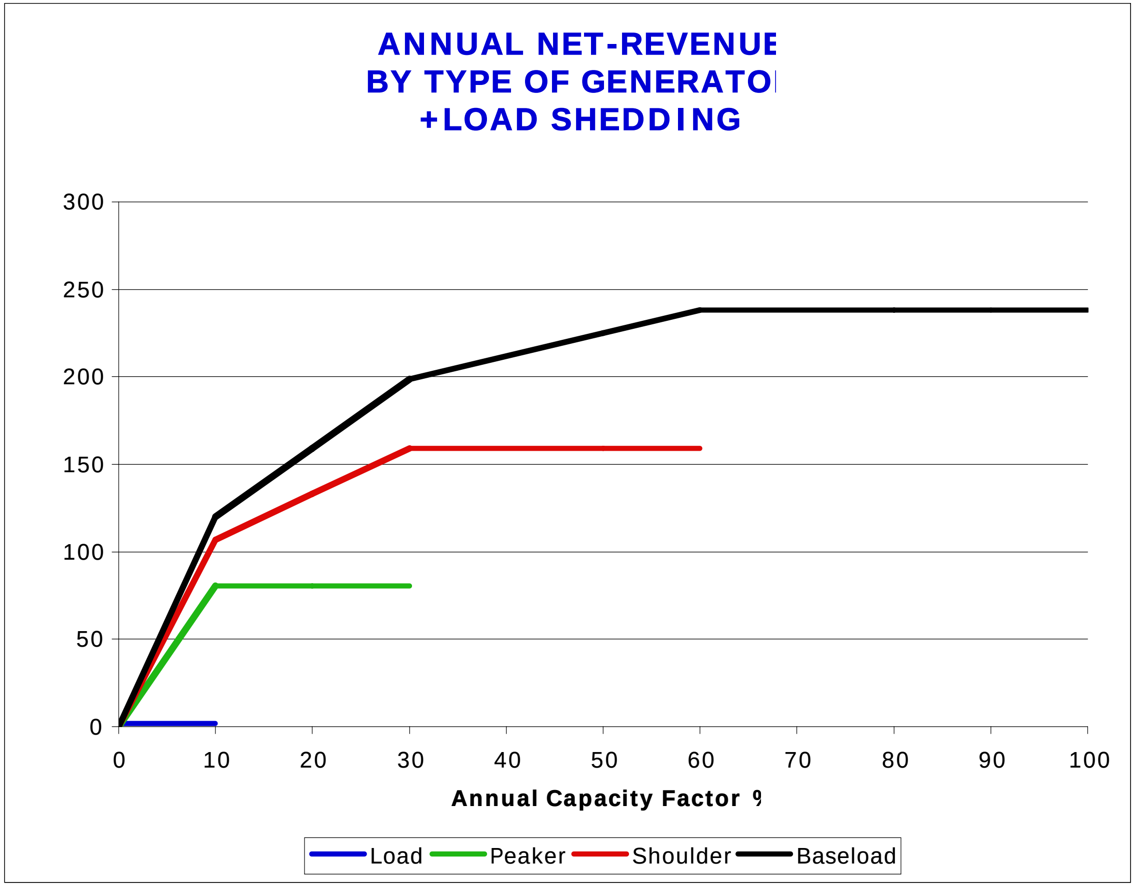
$152/MWh

NERC Reliability Standard

(2.4 Hours/Year)

$33,393/MWh

Annual Net-Revenue
Using Short-Run Competitive Prices + Load Shedding



Specified Costs

	Variable ($/MWh)	Capital (k$/MW/Year)
Peak	60	80
Shoulder	30	159
Baseload	15	238

Additional Revenue Needed to Cover the Capital Costs

(k$/MW/Year)

Peak	0 = 80 - 80
Shoulder	0 = 159 - 159
Baseload	0 = 238 - 238

Problem Solved!

PART 3

Paying for Reliability in "Deregulated" Markets: Alternative Solutions

References not yet on <www.e3rg.pserc.cornell.com>

1. **Jaeuk Ju**
   "Spatial Prices and the Value of Transmission Congestion Credits"
2. **Surin Maneevitjit**
   "Paying for Reliability in Deregulated Markets"
3. **Steen Videbaek**
   "Testing Alternative Market Designs for Energy and VArs"

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Alternative Ways of Covering the "Missing" Capital in a Competitive Market
(+$80k/MW/Year needed using Short-Run Competitive pricing)

1. **Traditional Regulation**

   Set the rates paid by customers to yield a target rate of return on the BOOK value of capital

2. **Deregulated Market + Shedding Load (Textbook solution)**

   Focus on SHORT-RUN competitive prices, and use load-not-served as an expensive source of "supply" that has NO capital costs

3. **Deregulated Market + ICAP (NE states & California?)**

   Pay all Installed CAPacity the REPLACEMENT capital cost of a Peaker for being available (showing up) in the spot market

4. **Deregulated Market + Price Spikes (Australia & Texas?)**

   Allow price spikes and place the primary regulatory focus on maintaining LONG-RUN competitive prices

5. **Performance Based Regulation (UK & National Grid?)**

   Share profits and losses based on target operating costs

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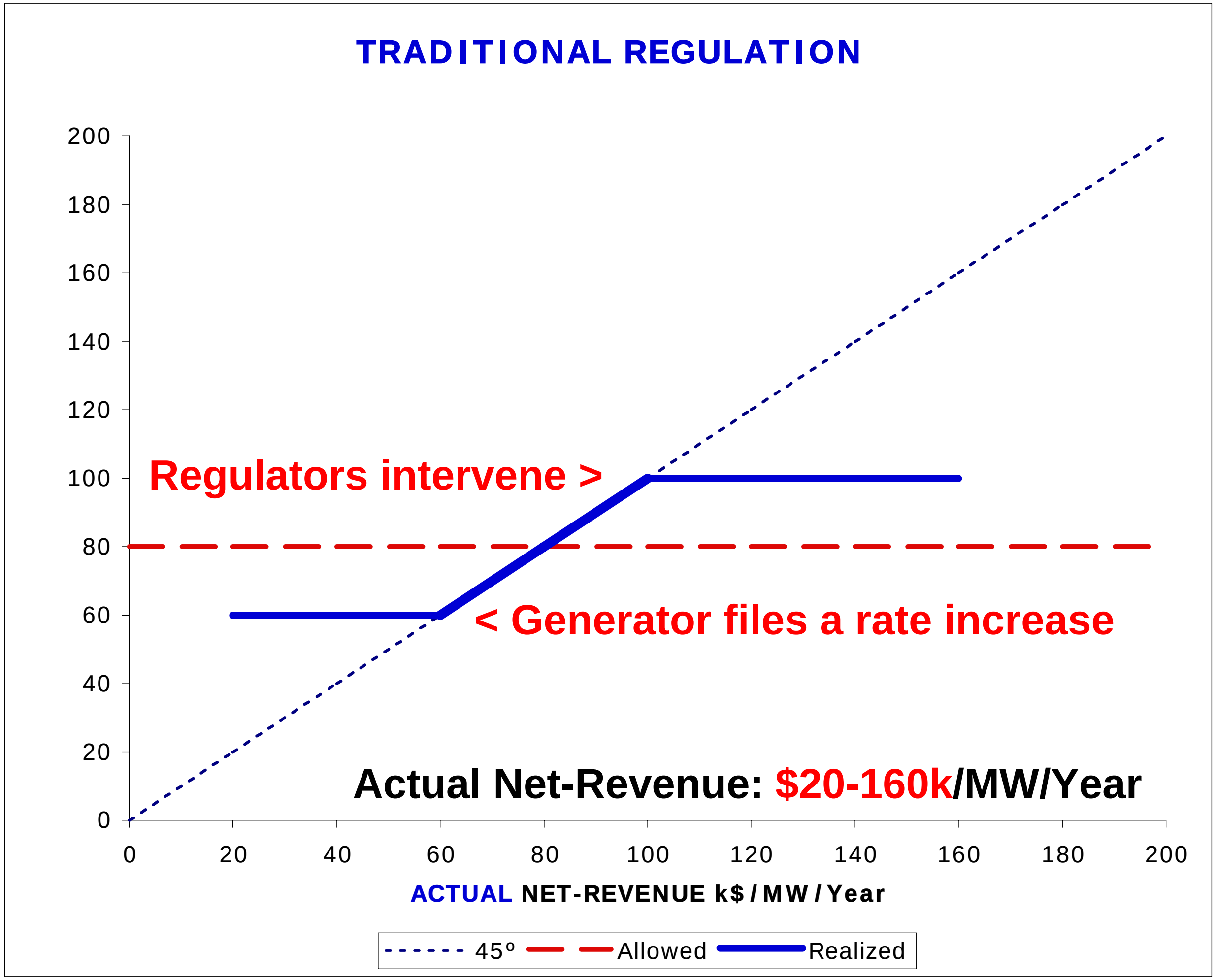
Annual Earnings of a Generator
1. Traditional Regulation



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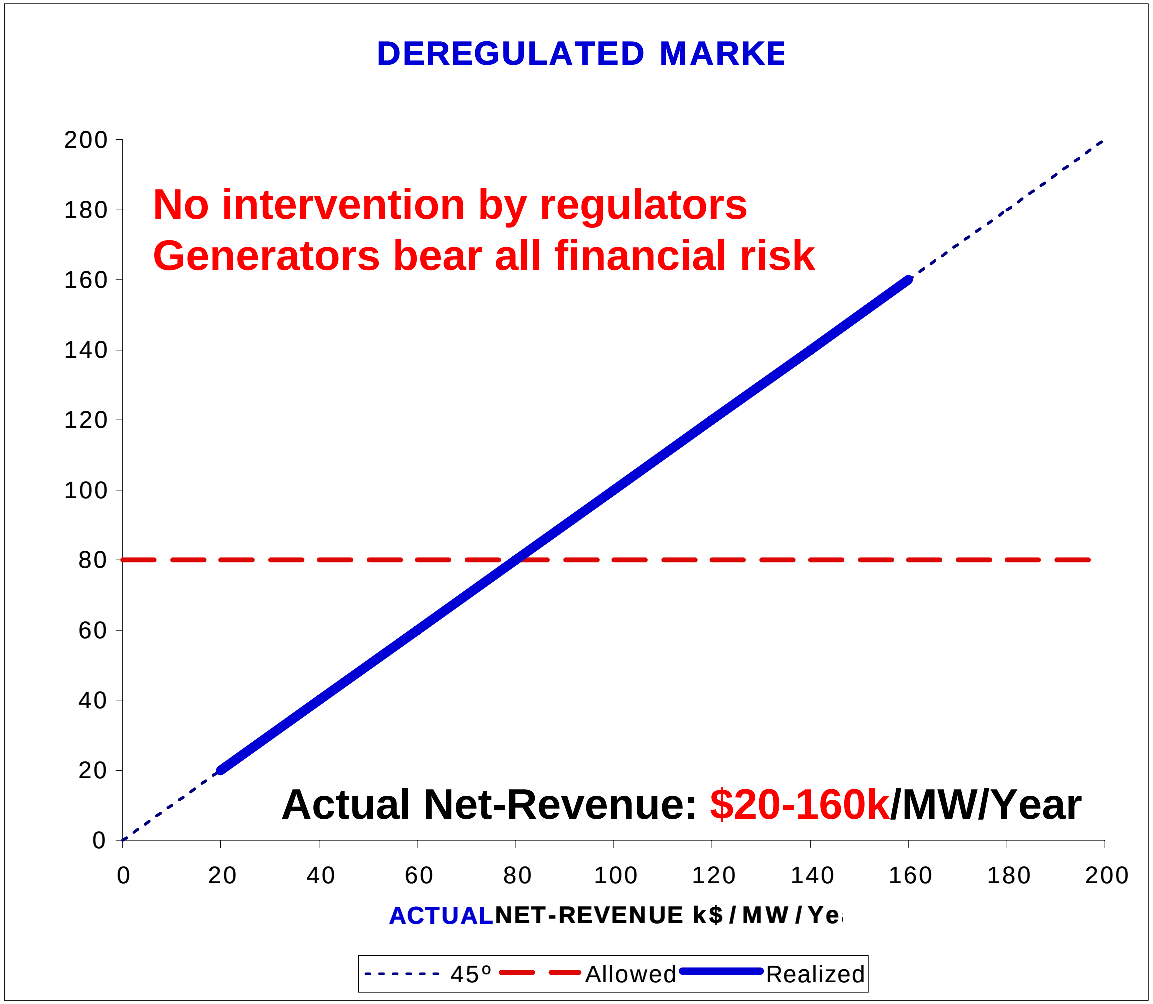
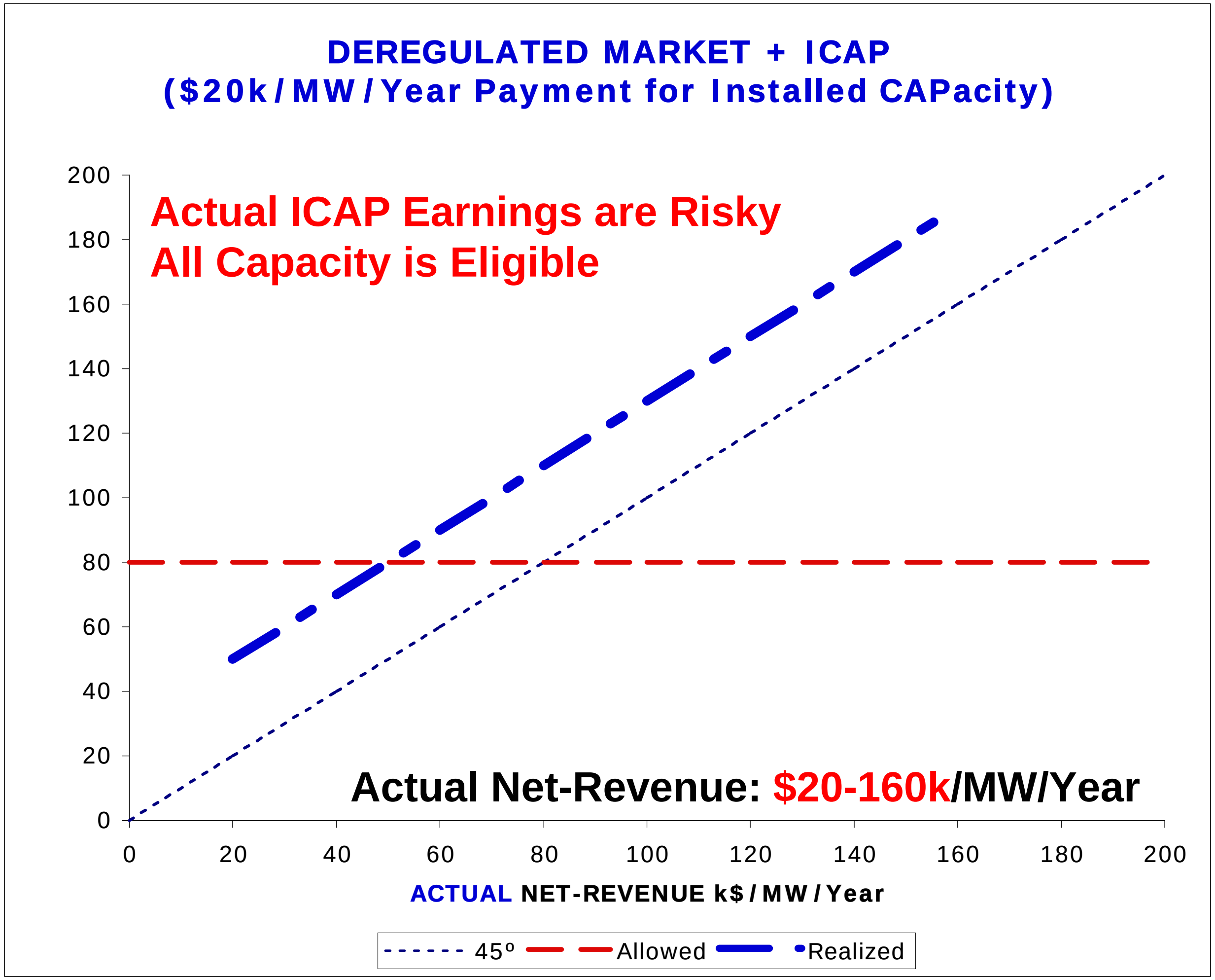
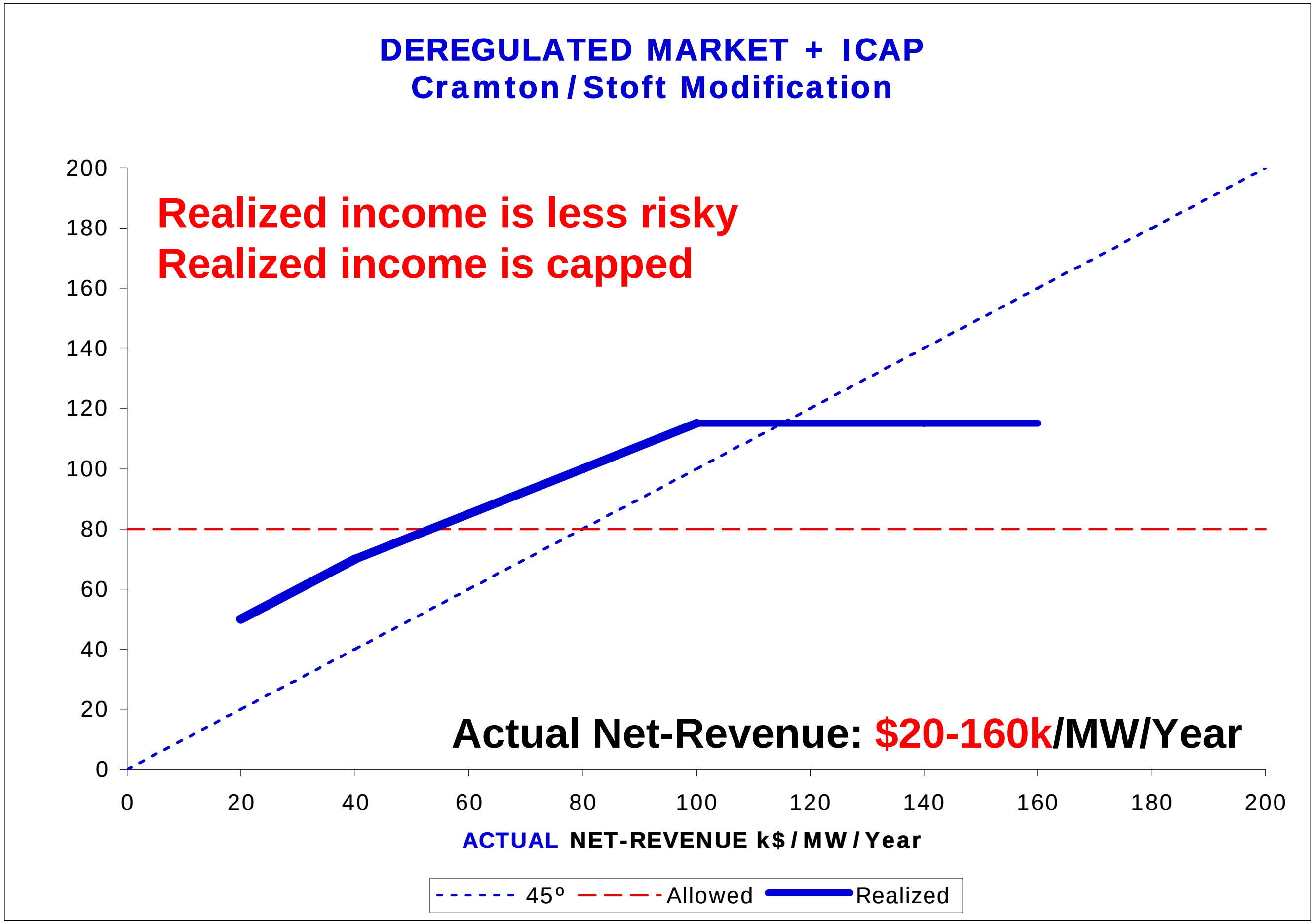
Annual Earnings of a Generator
2. Fully Deregulated Market



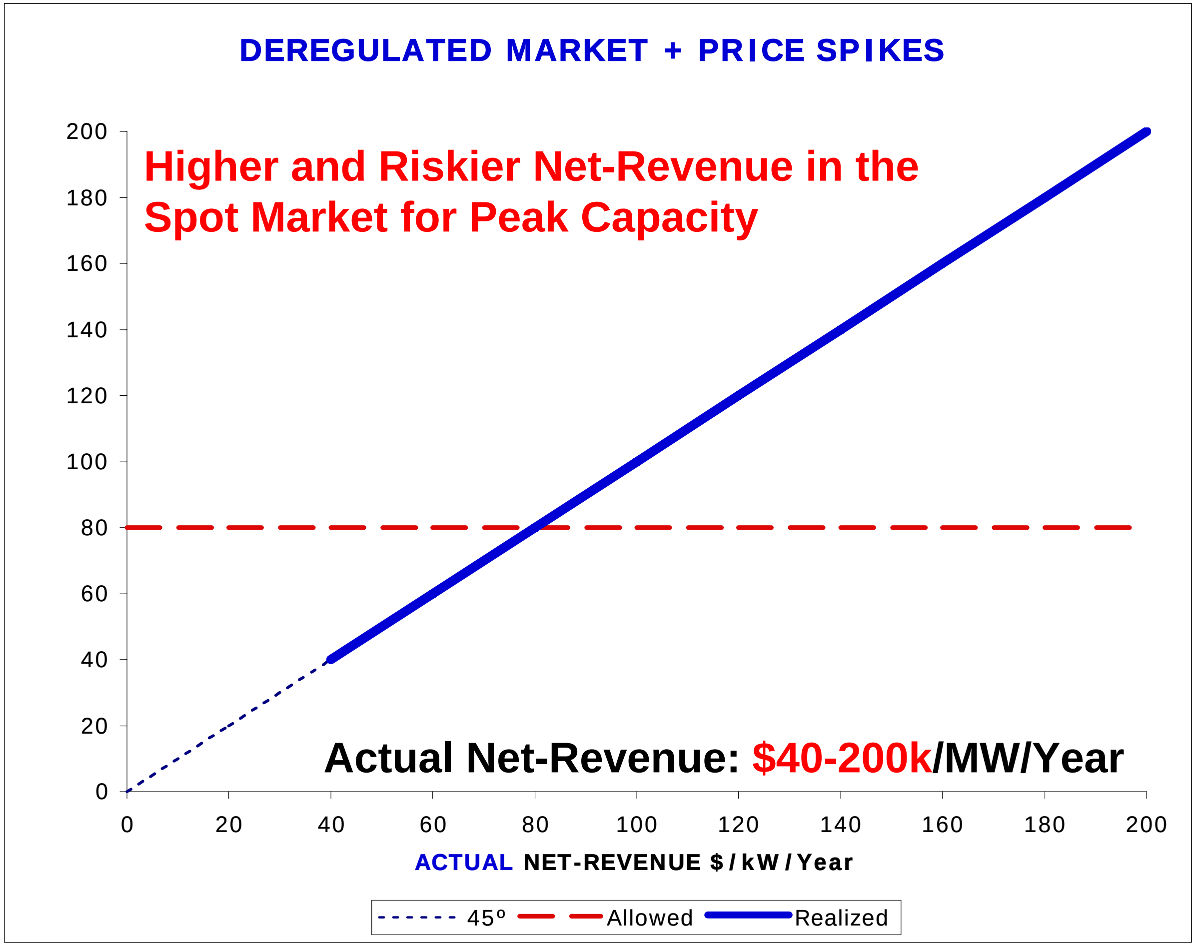
Annual Earnings of a Generator
3. Deregulated Market + ICAP



Annual Earnings of a Generator
3b. Deregulated Market + ICAP



Annual Earnings of a Generator
4. Deregulated Market + Price Spikes



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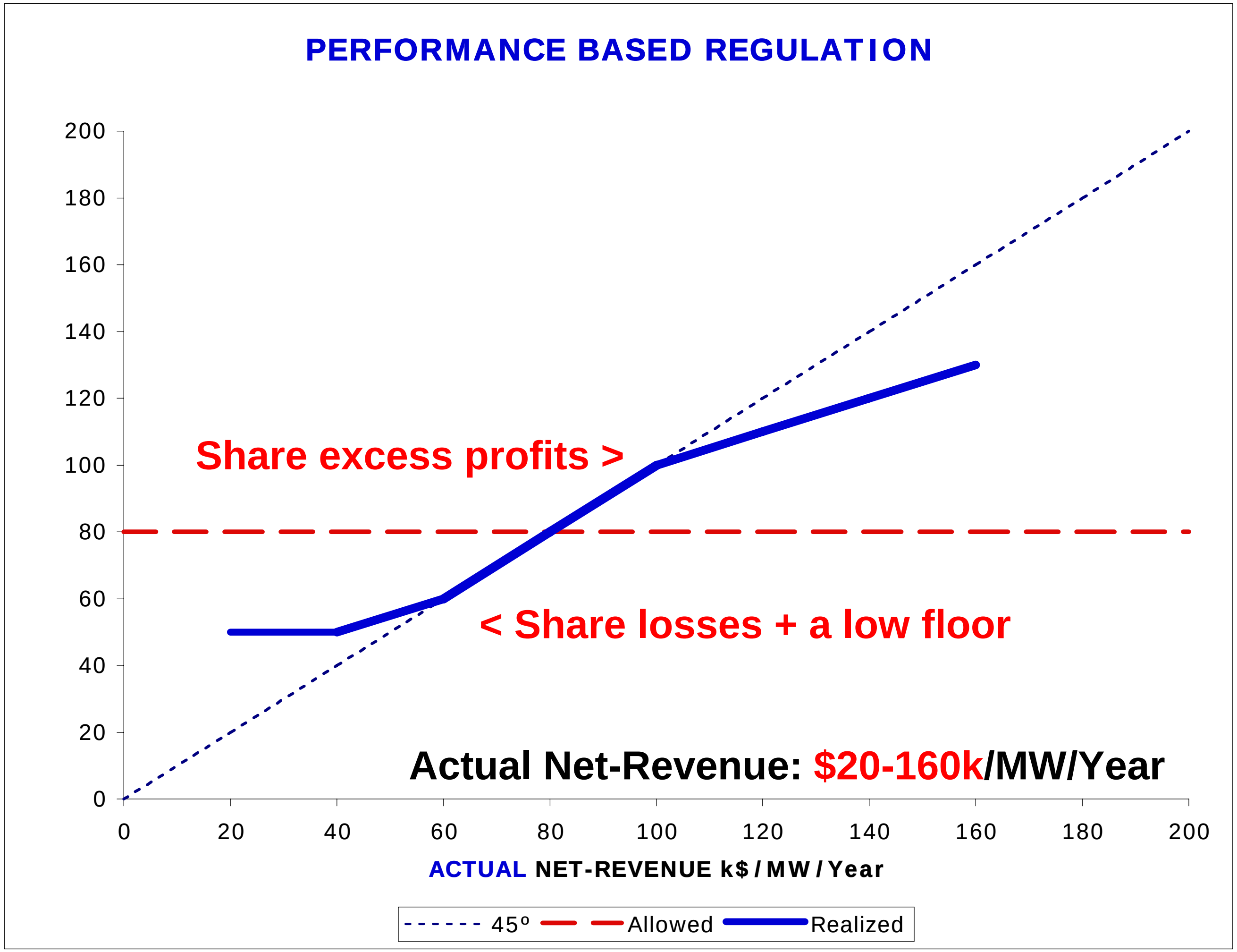
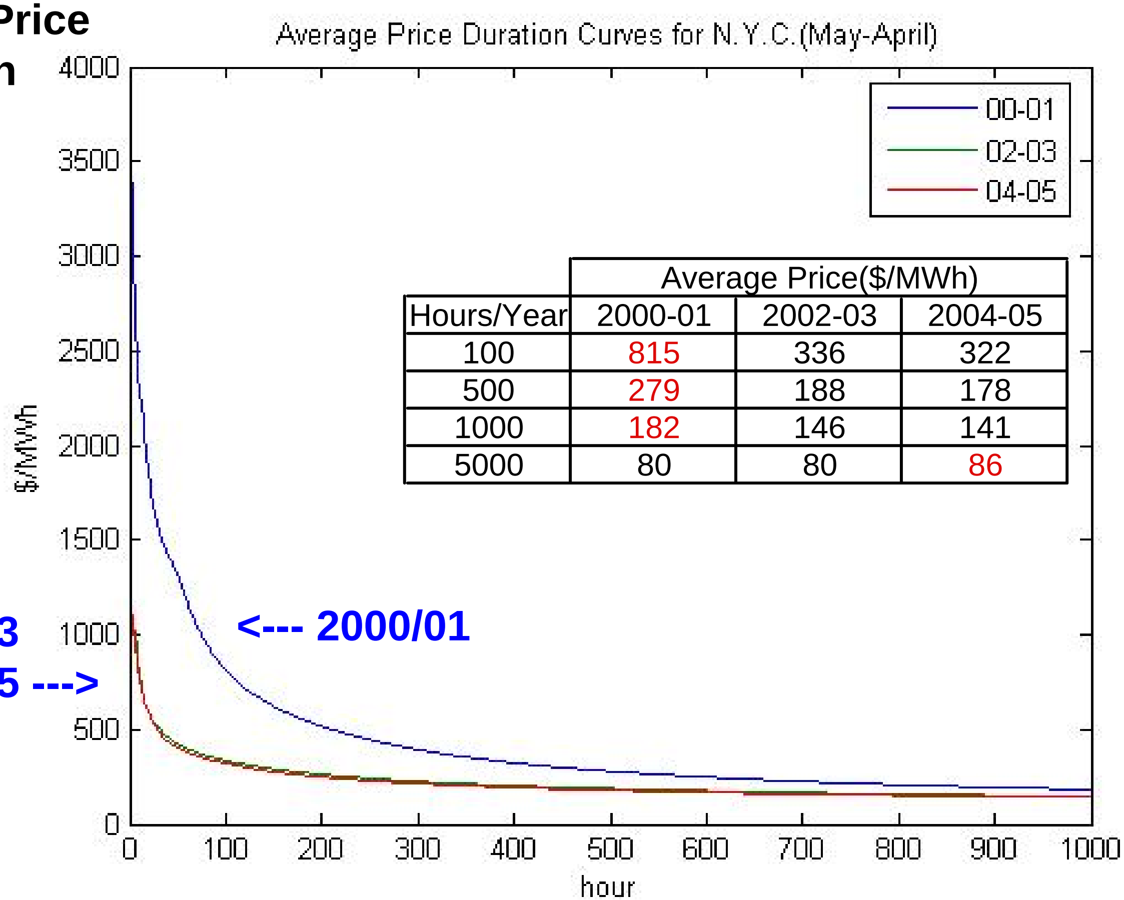
Annual Earnings of a Generator
5. Performance Based Regulation



Average Price Duration Curves for New York City

Average Price
$/MWh



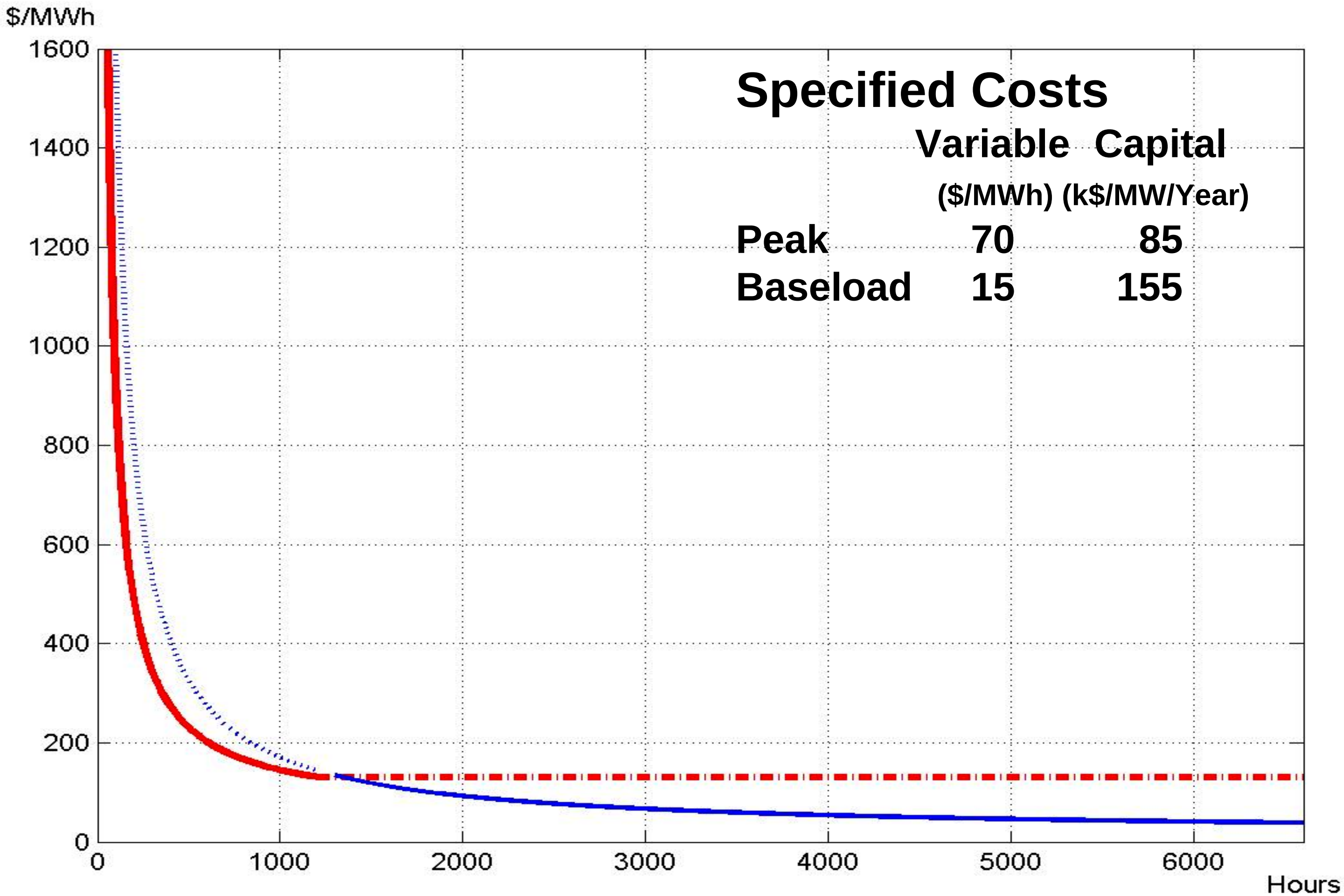
	Average Price($/MWh)		
Hours/Year	2000-01	2002-03	2004-05
100	815	336	322
500	279	188	178
1000	182	146	141
5000	80	80	86

<--- 2000/01

2002/03
2004/05 --->

Hours/Year
(1000 Hours = 11.4% Capacity Factor)

Average Long-Run Cost (LRAC) of Generating Capacity $/MWh



PSERC

The Financial Incentives for Peaking Capacity have Disappeared in the NYC Spot Market

Number of hours/year of operation	Minimum LRAC ($/MWh)	Av. Price 2000/01 ($/MWh)	Av. Price 2002/03 ($/MWh)	Av. Price 2004/05 ($/MWh)
100	**920**	815	336	323
200	495	**517**	262	249
500	240	**279**	188	178
1200	140	**164**	136	132
2000	92	**124**	113	113
3000	67	**101**	97	100
5000	46	80	80	**86**
6000	40	74	74	**81**

Av. Price > LRAC is **RED**

Max. value for each row is **BOLD**

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How an ICAP Market Should Work

- **Implicit Assumptions**
  - Generation Adequacy is an effective proxy for maintaining NERC/FERC standards of Operating Reliability
  - Locational requirements for generation capacity in NYC and LI are an effective proxy for the limitations of the transmission network, and specifying these requirements is the primary responsibility of regulators
  - Requiring Load Serving Entities (LSE) to hold contracts for generation capacity to meet forecasted peak load plus a required reserve is an effective way to decentralize decisions about maintaining generation adequacy (similar to a Cap-and-Trade policy for controlling emissions from power plants)
  - Ensuring that payments for generation capacity cover the annualized capital cost of peaking capacity when new generation capacity is needed provides a sufficient incentive for investors to build new power plants
- **Structure of the Capacity Auctions**
  - The price of Installed Capacity is determined in a voluntary two-sided auction for a six-month strip followed by auctions for individual months
  - The final monthly auction requires all LSEs to submit all existing capacity contracts and to purchase additional capacity, if necessary, using a demand curve specified by regulators

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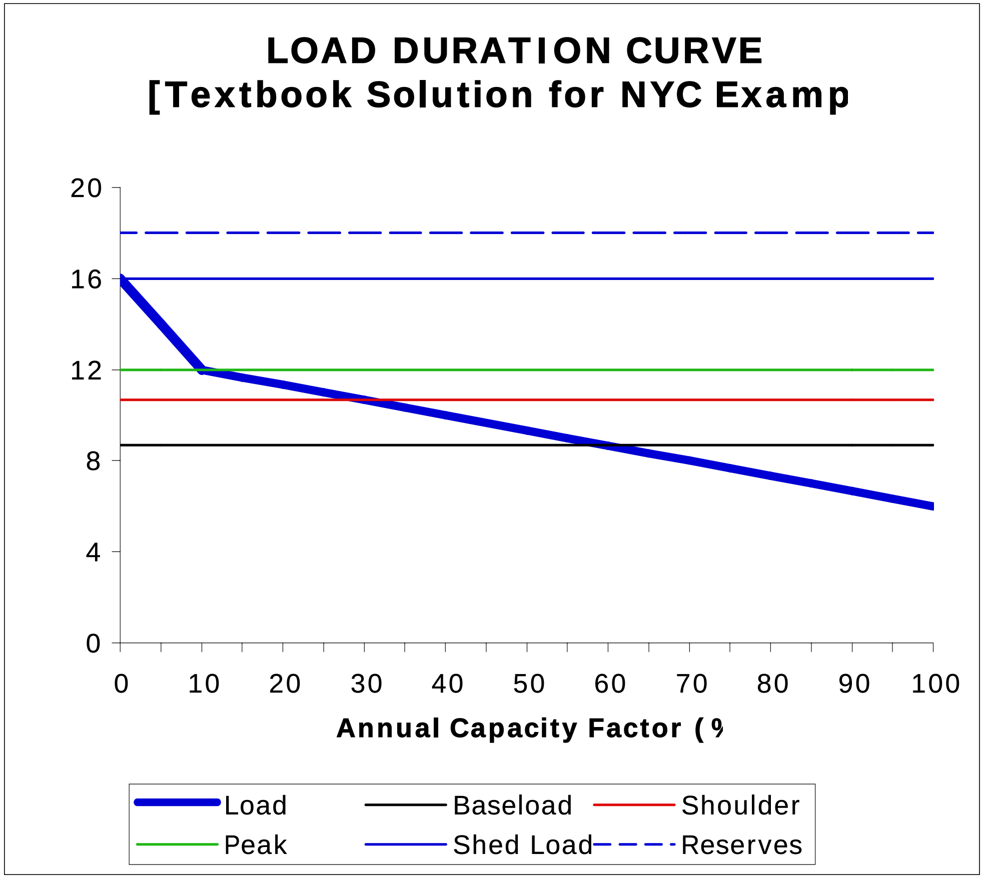
Least Cost Mix of Installed Generation Capacity



Installed Capacity (GW)

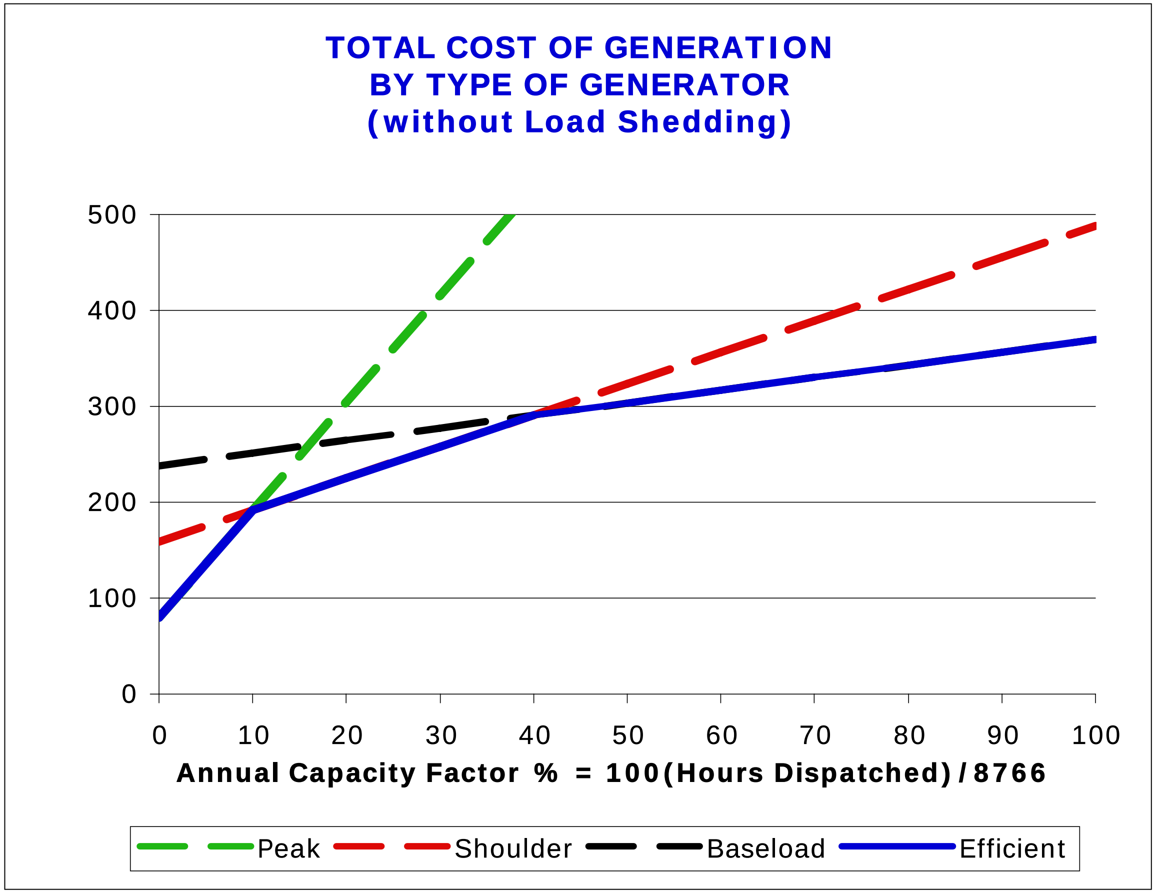
Baseload (C.F. >60%)	8.7
Shoulder (C.F. 30-60%)	2.0
Peak (C.F. 10-30%)	1.3
Shed Load (C.F. 0-10%)	4.0
Reserves (C.F. 0-0.03%)	2.0
TOTAL	18.0

Real Problems for NYC

1. Insufficient Load Shedding
2. Limits on Baseload Capacity
3. A lot of Peak Capacity with low Capacity Factors and insufficient net-revenues
4. High prices for Natural Gas

Total Cost of Generation/Year by Type of Generator

[Higher Fuel Costs for Peak and Shoulder Capacity]



Specified Costs

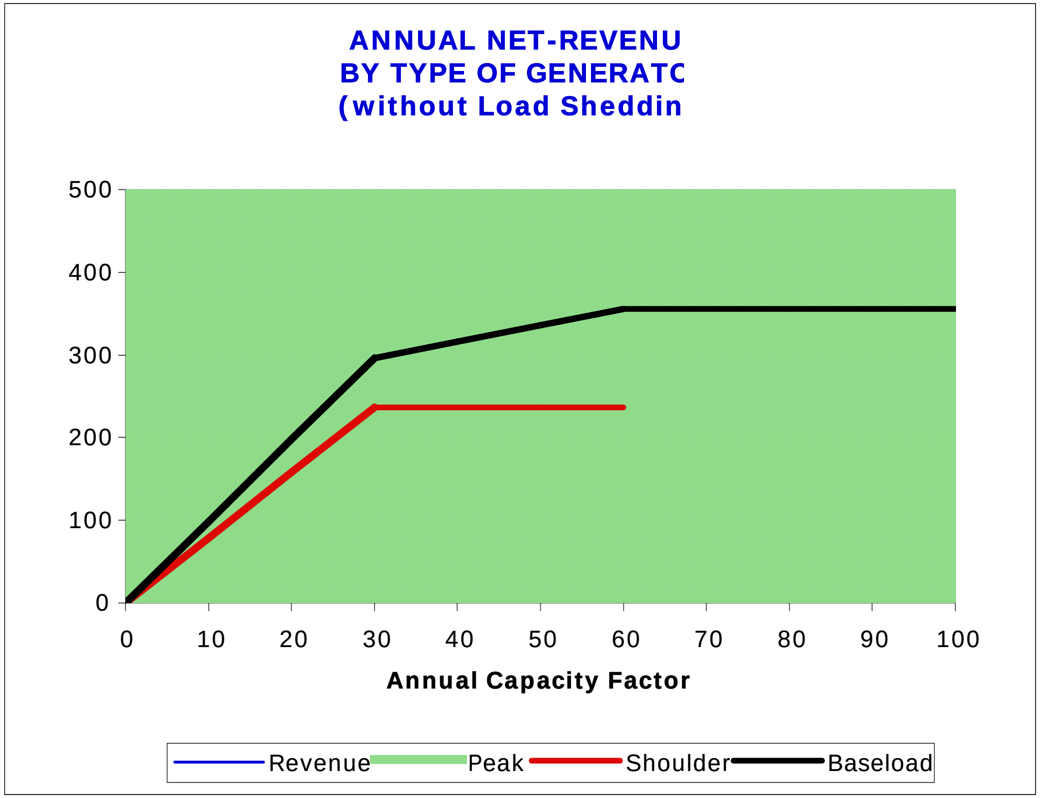
	Variable ($/MWh)	Capital (k$/MW/Year)
Peak	128 (60*)	80
Shoulder	38 (30*)	159
Baseload	15	238

Capacity Factors for Least-Cost Choices

Peak	< 10% (30%*)
Shoulder	10-40%
Baseload	> 40% (60%*)

* Optimum values before higher fuel costs

Annual Net-Revenue Using Short-Run Competitive Prices
[Inefficient Mix of Legacy Generators]



Specified Costs

	Variable ($/MWh)	Capital (k$/MW/Year)
Peak	128	80
Shoulder	38	159
Baseload	15	238

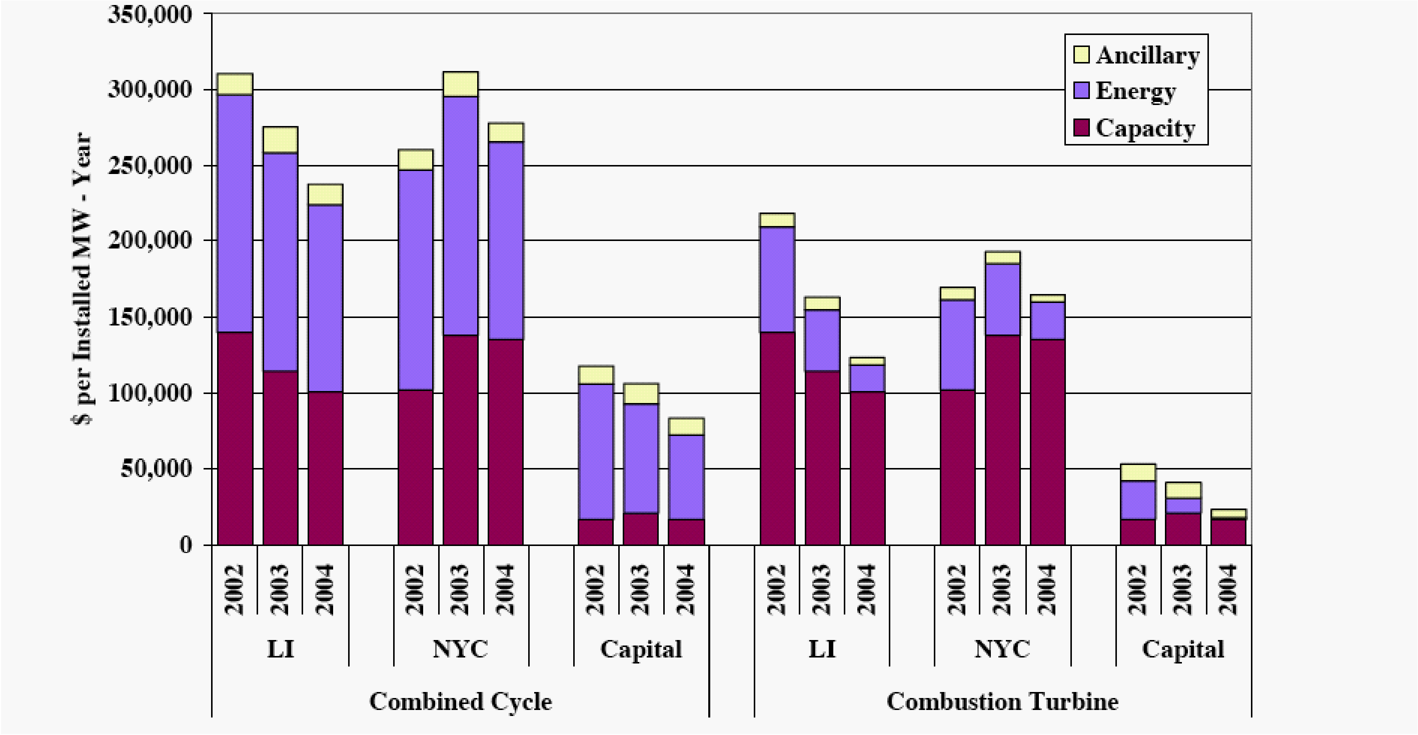
Additional Revenue Needed to Cover the Capital Costs

(k$/MW/Year)

Peak	80
Shoulder	-78 = 159 - 237
Baseload	-117 = 238 - 355

The lack of net-revenue is no longer an issue for Shoulder and Baseload, but it is still the big problem for Peak capacity.

Estimated Annual Net-Revenue of Combined Cycle and Combustion Turbines in Different Locations for 2004



"Capital" is the upper Hudson valley
Source: Figure 16 on p. 23 of the "NYISO 2004 State of the Market Report" <www.nyiso.com>

Alternative Ways of Maintaining Generation Adequacy: Summary

	Allow Price Spikes	Capacity Auction	Power Purchase Agreements
Real-Time Operations	ISO	ISO	ISO
Regulatory Objective	Long-run Efficiency	Short-run Efficiency	Short-run Efficiency
Volatility of Spot Prices	High	Low	Low
Fairness for Generators	Fair	Fair	Discriminate
Additional Cost to Customers	Low?	High	Low
Regulatory Responsibility	Fully Decentralized	Set Reserve Margins	Margins + Contracts
Length of Commitment	None	1-3 Years	Multi-Year
Sufficient for Adequacy?	No?	No	Yes

Conclusions

- Generation Adequacy is a minimal requirement for maintaining the reliability of supply because blackouts are very expensive.
- The electric supply system is unforgiving, and policies for maintaining Generation Adequacy must be sufficient.
- The Australian market works because allowing price spikes results in an average price duration curve that approximates the long-run average costs of different types of capacity. However, it is risky for operations and investment and is NOT sufficient.
- Giving more $ to all generators in New York through an ICAP market is expensive, NOT necessary and definitely NOT sufficient.
- Current shortfalls of capacity in New York State will probably be met in mysterious ways through *ad hoc* Power Purchase Agreements (PPA). In other words, the customers in the state will have to pay twice.
- There is a better way even if the Australian solution is ruled out but it will have to be discriminatory. PPAs will be necessary, and regulators should develop explicit rules for identifying eligible capacity (i.e. needed for reliability). Eligible generators should be given a choice between relying on market outcomes or getting some form of Performance Based Return.