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The Evolution of Capacity Markets in the USA

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OUTLINE

- **A Fork on the Road to Deregulation**
  - Speculation by generators (price spikes) is almost inevitable
  - 1. Accept price spikes in an energy-only market (LRMC pricing)
  - 2. Suppress speculative behavior (SRMC pricing)
  - AND use a Capacity Market to cover the "Missing Money"
- **Meeting Reliability Standards in New York State**
  - Locational capacity requirements for New York State
  - Average price duration curves and long-run average costs
  - Augmented capacity market (New York's "demand" curve)
- **Summary Evaluation of Generation Adequacy**
  - Forward Capacity Market in New England
  - Implications when the mix of generating capacity is not least-cost
  - Conclusions

Investment Incentives and Investment Decisions

- **Typical Regulated Market**
  - LMP is based on the true operating costs
  - Generators are paid for actual costs incurred
  - Capital costs are based on book values
  - Investment decisions are made by a planning process
- **Typical Deregulated Market**
  - LMP is based on generators' offers to sell
  - LMP determines the payments to generators
  - Transmission is still regulated and usually partially planned
  - Decentralized decisions used for investment in generation
  - Replacement cost of capital replaces the book value
  - Generators' income is much more fungible

PART 1

A Fork on the Road to Deregulation:

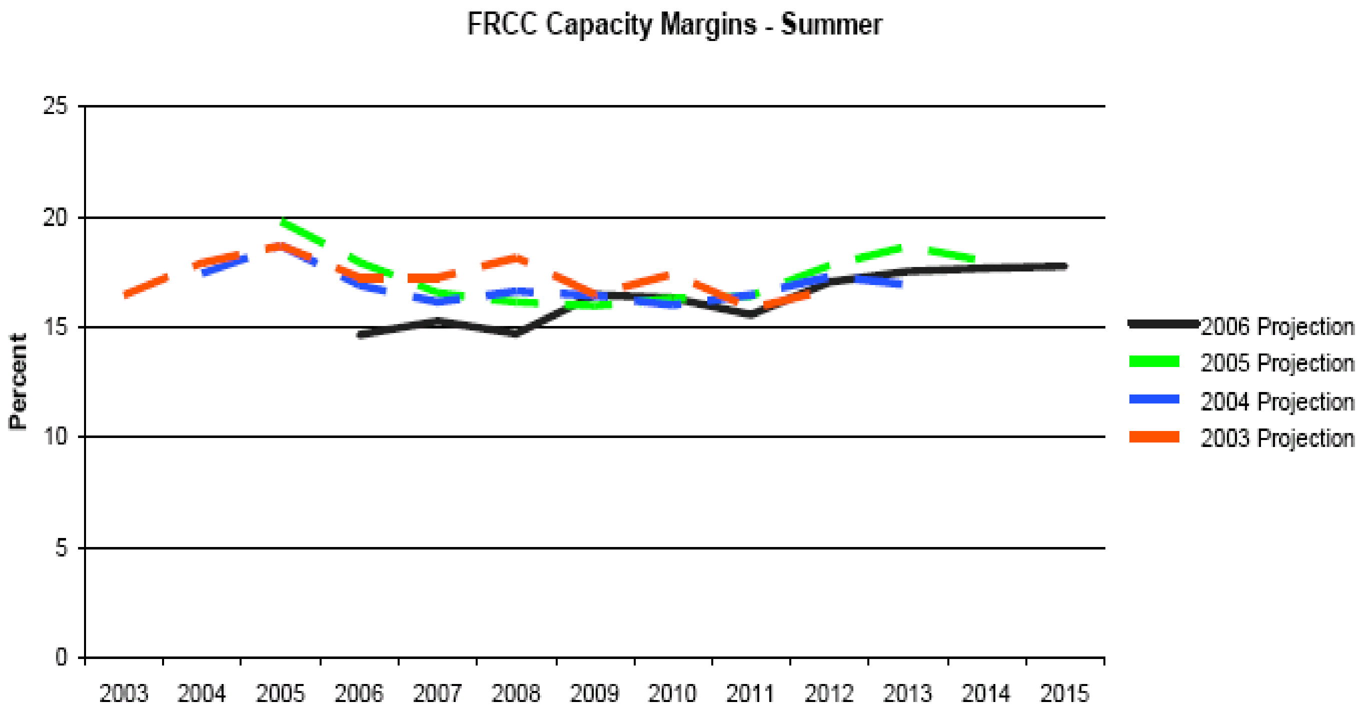
Energy-Only Wholesale Market

or

Wholesale Market + Capacity Market

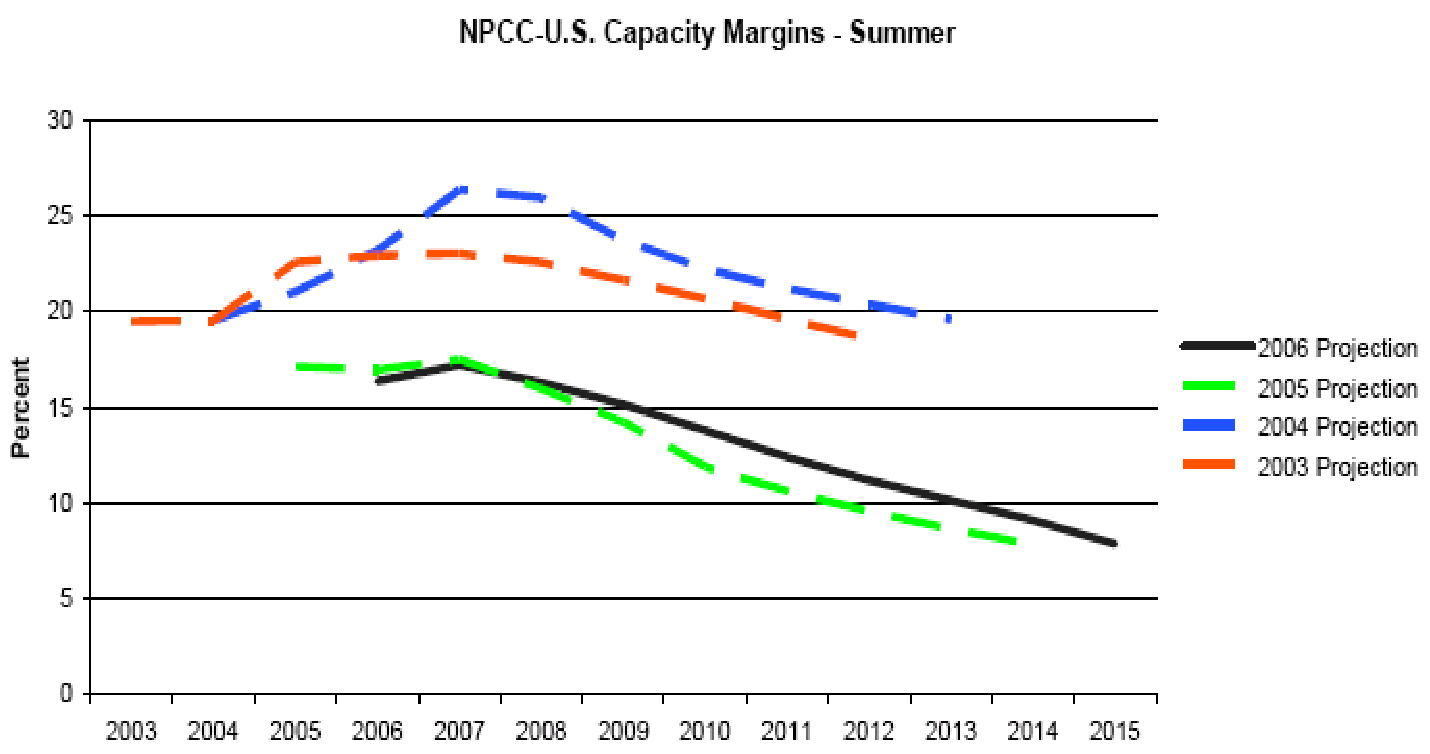
Reserve Margins for Generating Capacity in a Typical Regulated Region

Florida



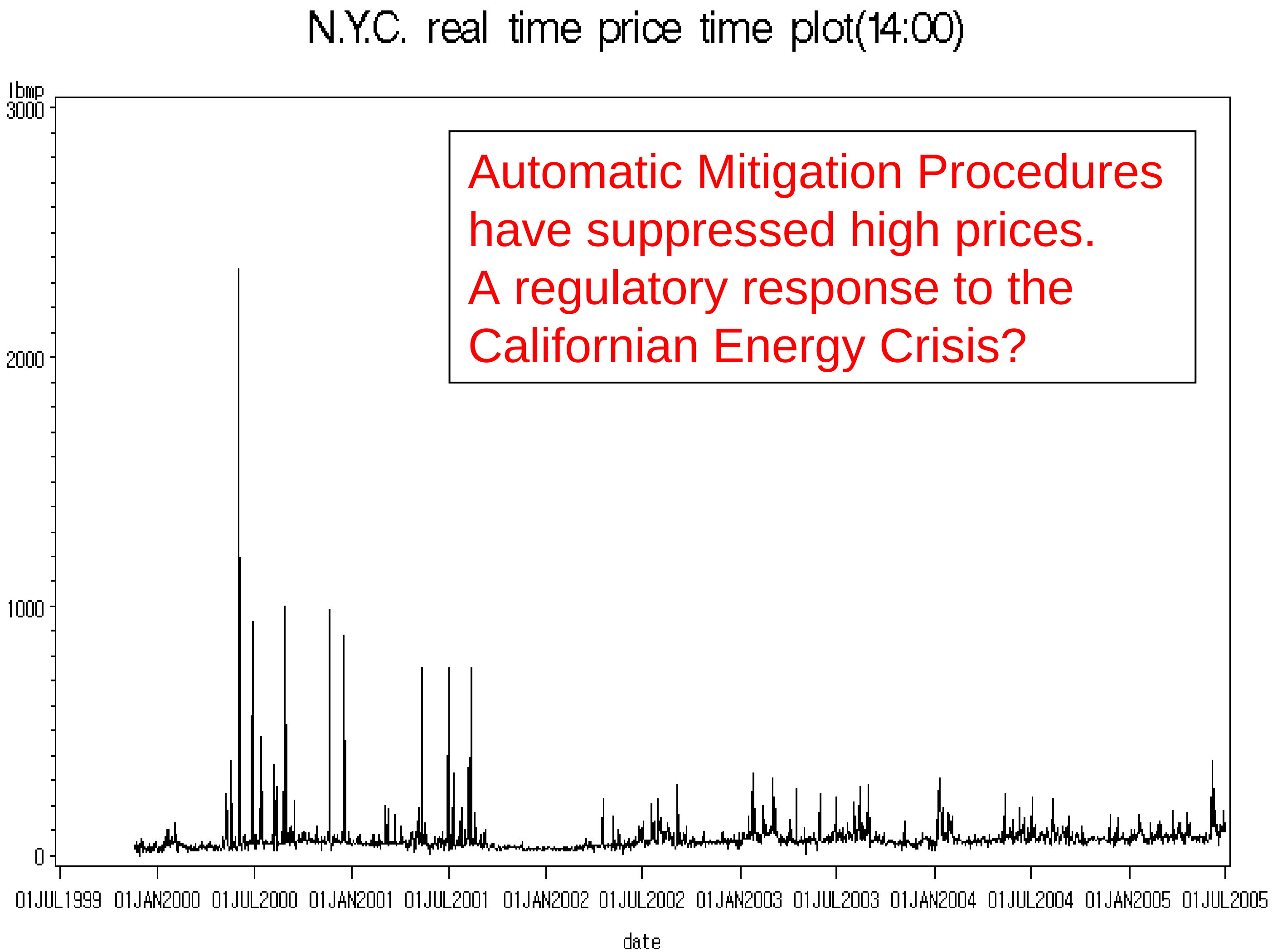
Reserve Margins for Generating Capacity in a Typical Deregulated Region

New York and New England



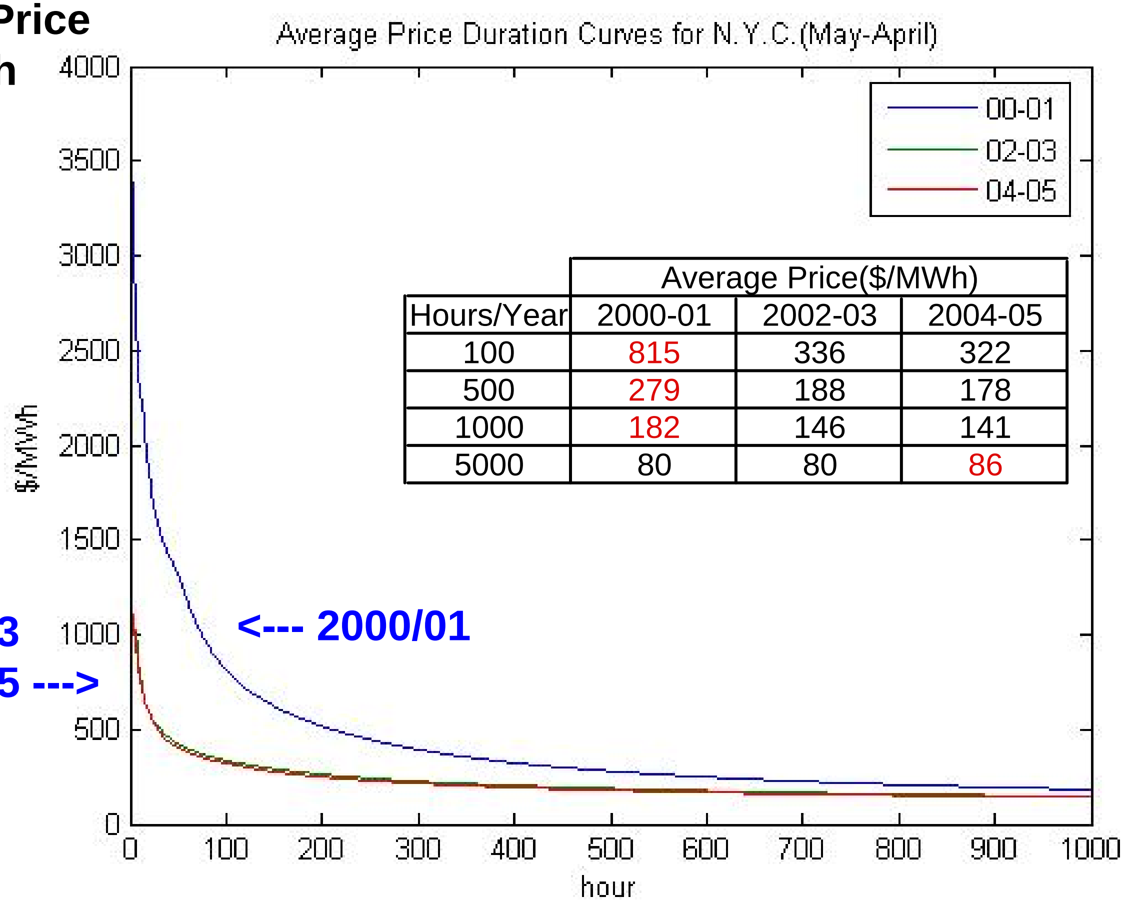
Daily Spot Prices in New York City
(1/7/99 - 1/7/05 at 2PM, $/MWh)

Price $/MWh



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)

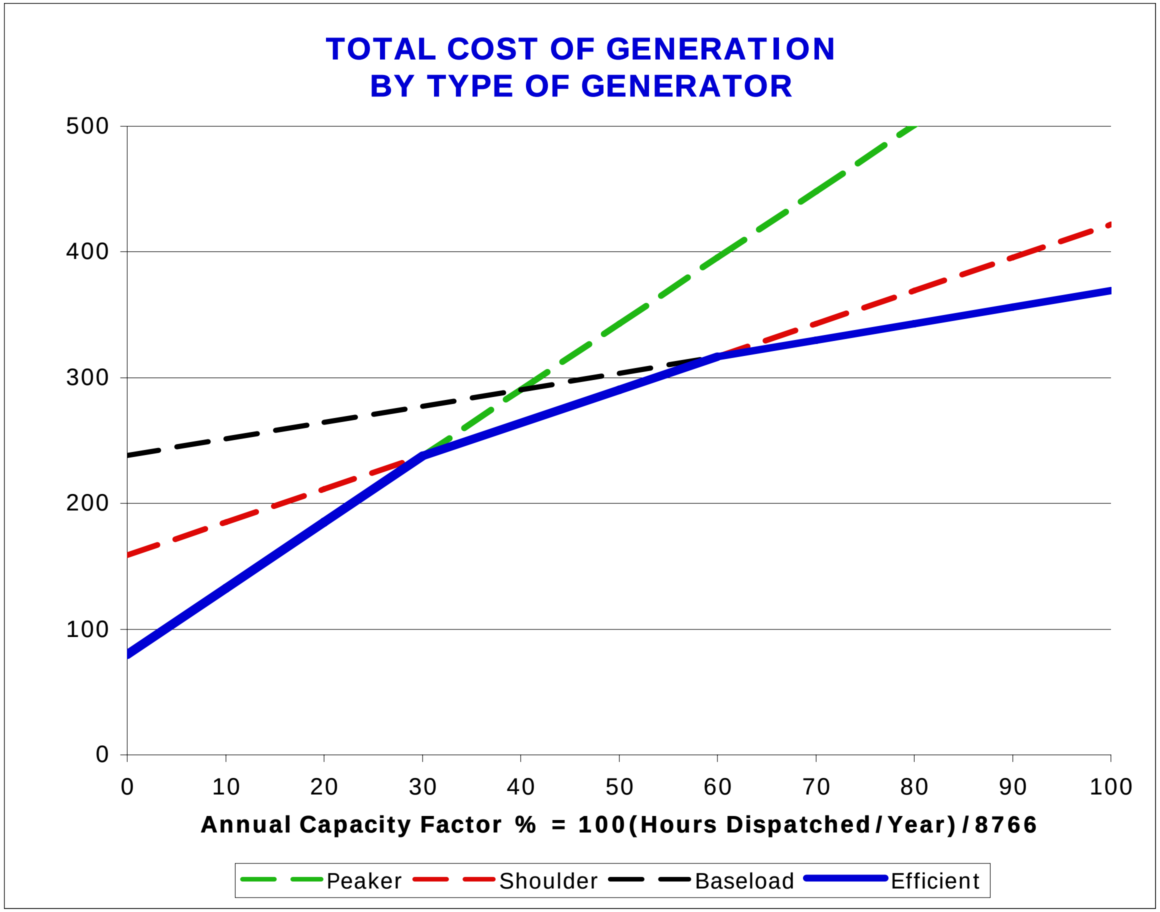
The Financial Incentives for Peaking Capacity have Disappeared in New York City

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	**860**	815	336	323
200	460	**517**	262	249
500	220	**279**	188	178
1200	126	**164**	136	132
2000	100	**124**	113	113
3000	87	**101**	97	100
5000	76	80	80	**86**
6000	73	74	74	**81**

Av. Price > Long Run Average Cost (LRAC) is **RED**

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

Total Cost of Generation/Year by Type of Generator



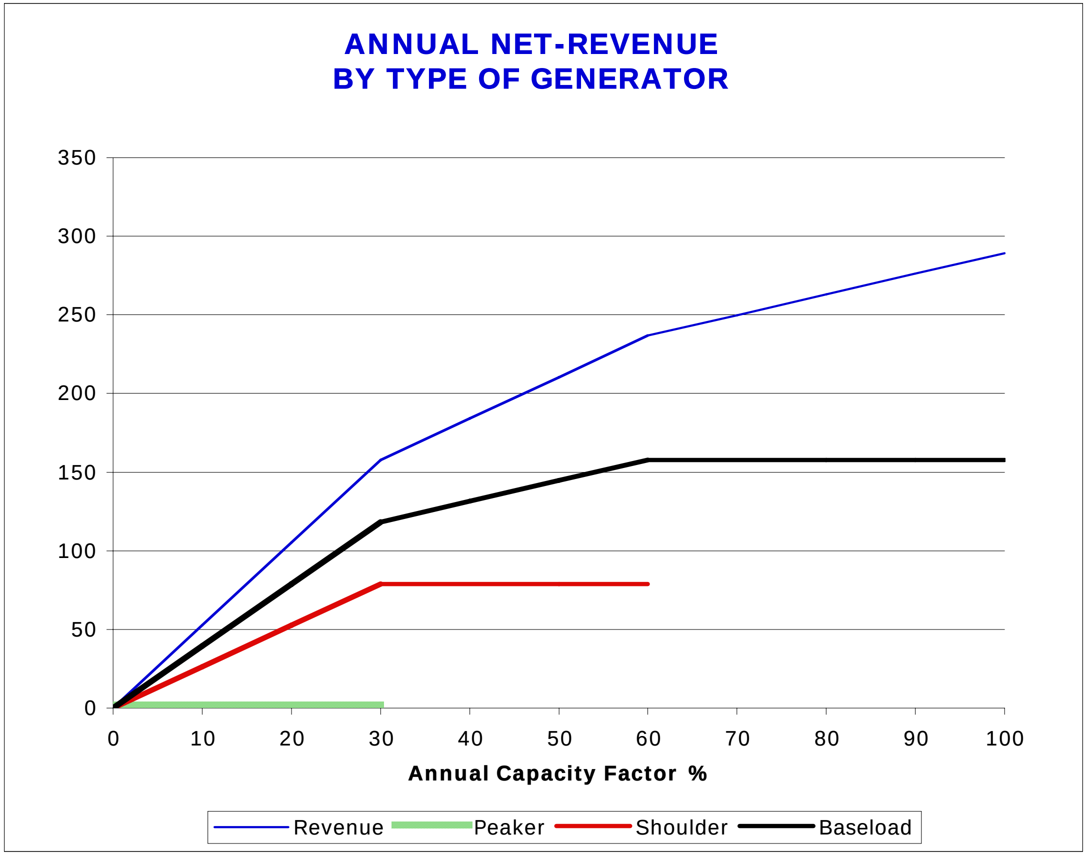
Specified Costs

	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 Marginal Cost Pricing = Marginal Operating Cost



Specified Costs

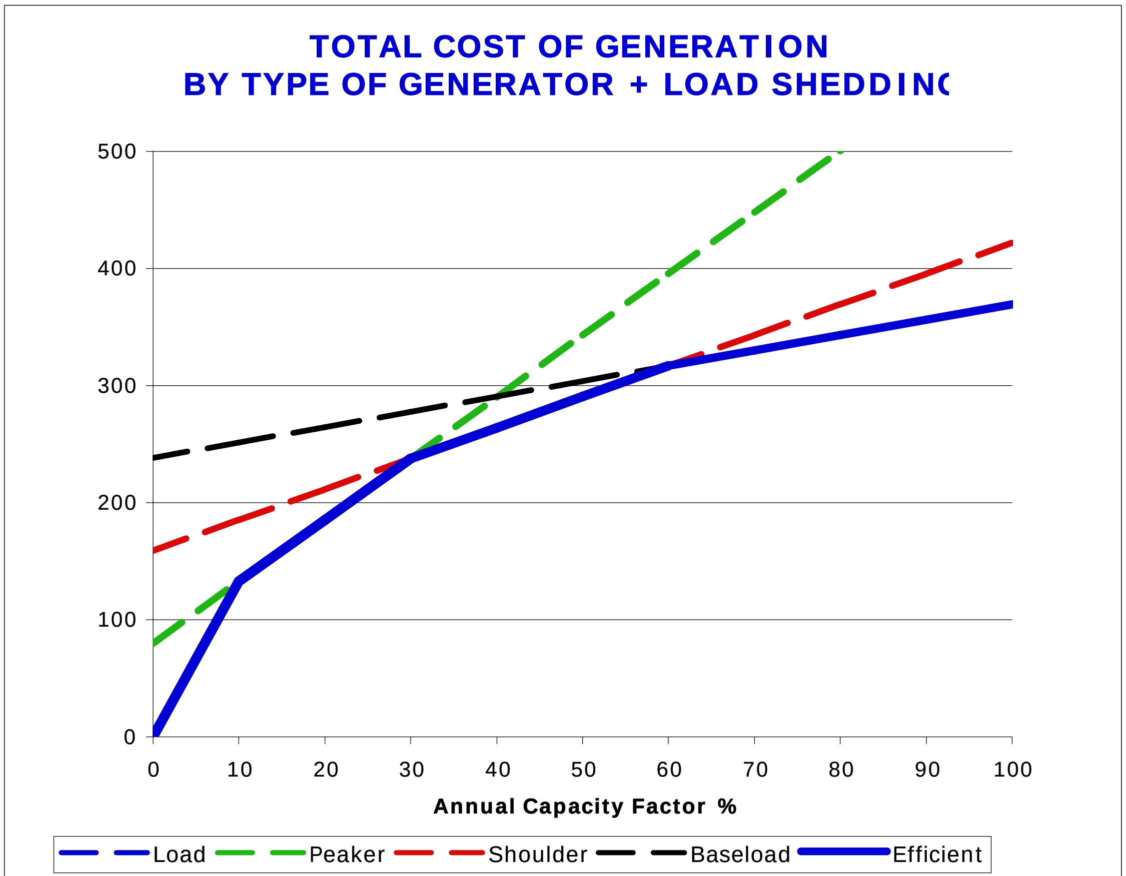
	Variable ($/MWh)	Capital (k$/MW/Year)
Peak	60	80
Shoulder	30	159
Baseload	15	238

Missing Money Needed to Cover the Capital Costs

(k$/MW/Year)

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

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



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)

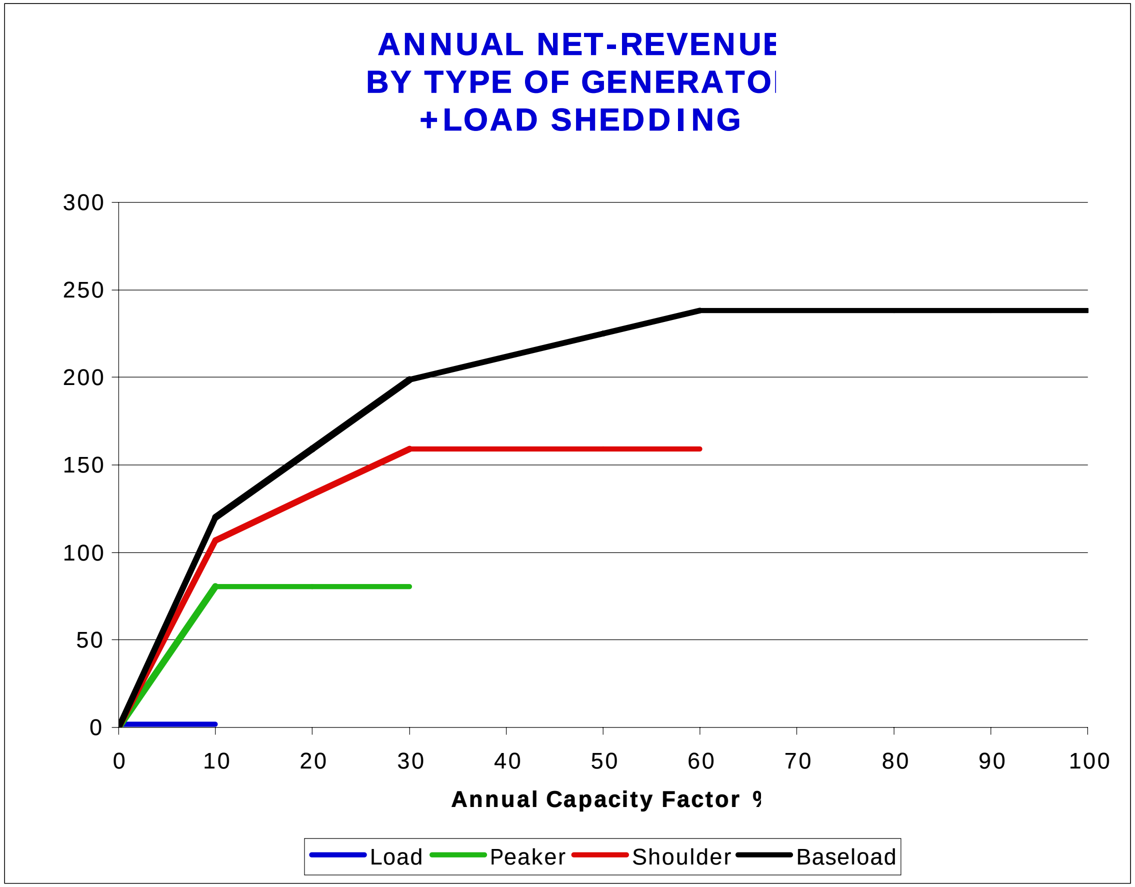
$152/MWh

NERC Reliability Standard

(2.4 Hours/Year)

$33,393/MWh

Annual Net-Revenue
Using Short-Run Competitive Prices
+ Load Shedding (Scarcity Pricing)



Specified Costs

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

Missing Money Needed to Cover the Capital Costs
(k$/MW/Year)

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

Problem Solved!

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

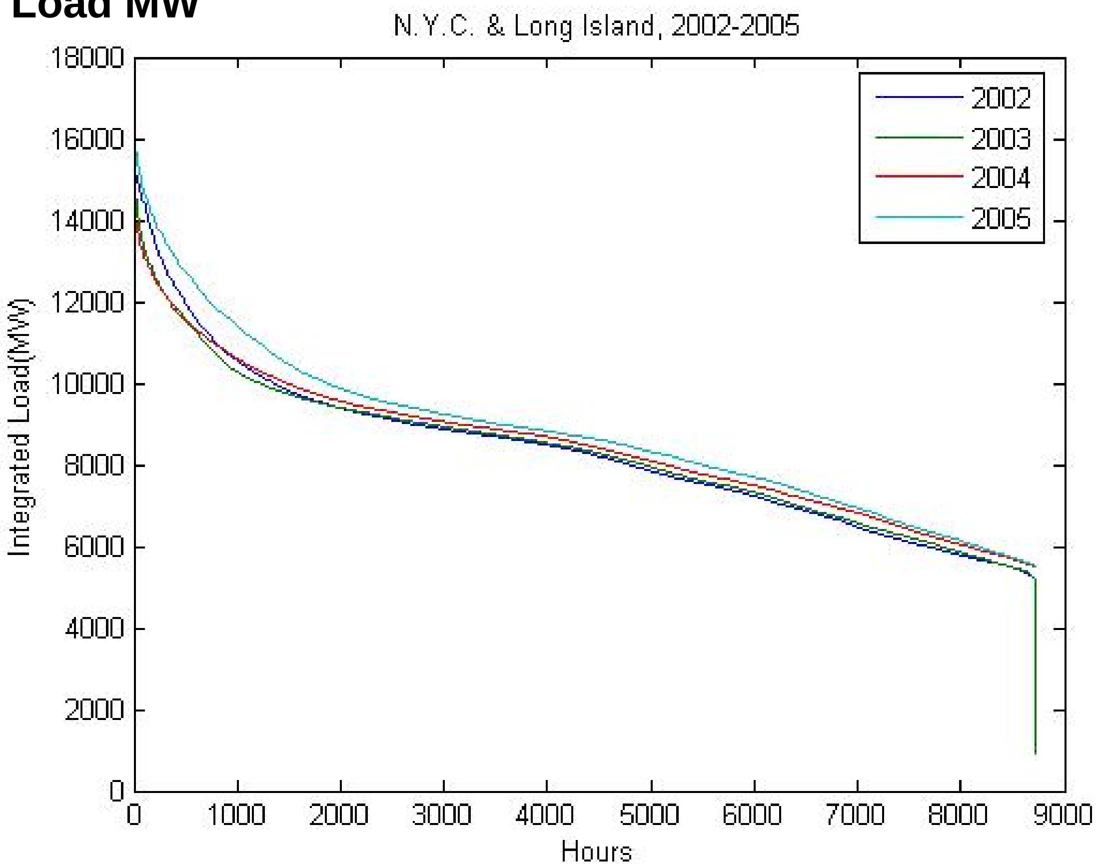
Load MW

Reserves --->

Peak --->

Shoulder --->

Baseload --->



Hours/Year

The Regulatory Choice at the Fork on the Road to Deregulation

- **Energy-Only Market**
  - Allow some price spikes to occur
  - Scarcity pricing or speculative behavior?
  - Monitor the relationship between AVERAGE ANNUAL prices and LONG RUN Marginal Costs (LRMC)
- **Wholesale Market + Capacity Market**
  - Monitor the relationship between MARGINAL HOURLY prices and the SHORT RUN Marginal Costs (SRMC)
  - Implement Automatic Mitigation Procedures
  - Use a Capacity Market to cover the “Missing Money”
  - Assume that all generating units should be paid the SAME AMOUNT in the Capacity Market

The Choice Made in Different Deregulated Markets

- **Energy-Only Market**
  - Texas (new)
  - Alberta
  - Australia
- **Wholesale Market + Capacity Market**
  - New York State (LICAP Market)
  - New England (new FCM)
  - PJM (new RPM)
  - Midwest (like PJM?)
  - California (still to be determined)
- **Objective for this presentation**
  - **Focus on Generation Adequacy in New York City**

PART 2

Meeting Reliability Standards in New York State

Current Reliability Standards

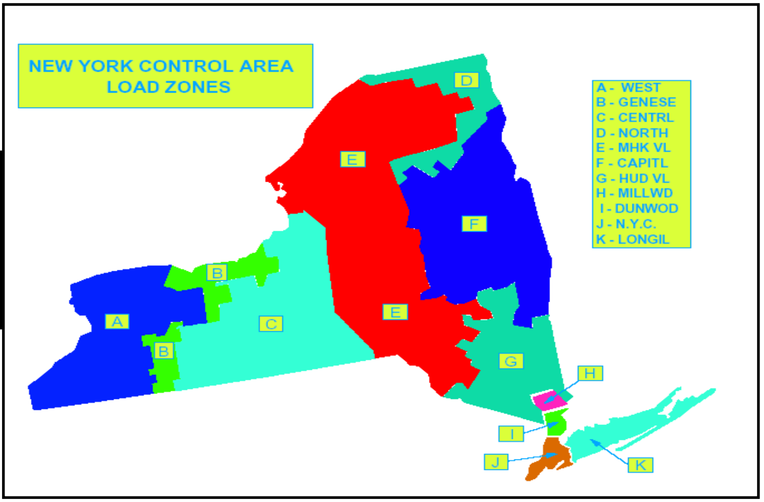
Capacity requirements set by state regulators for the New York Control Area (NYCA)

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



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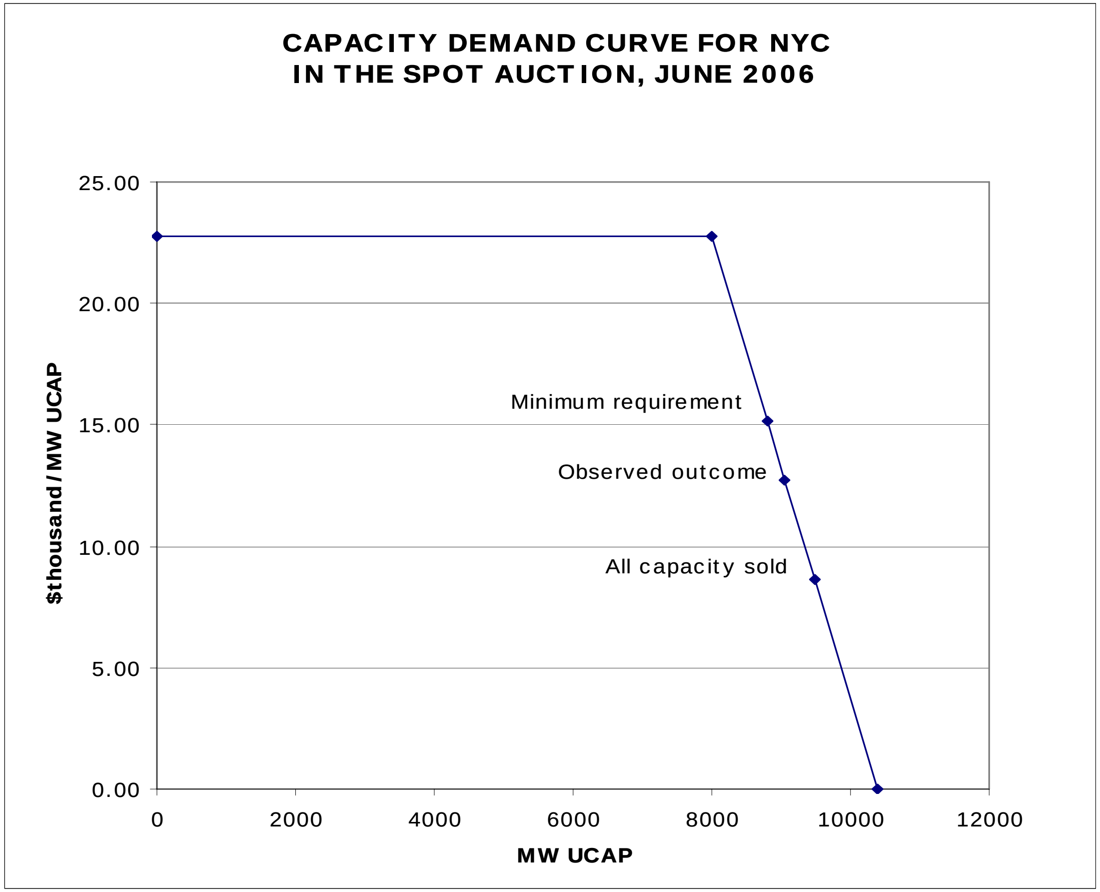
How the LICAP Market Should Work

- **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 when needed
- **Structure of the LICAP Market**
  - 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

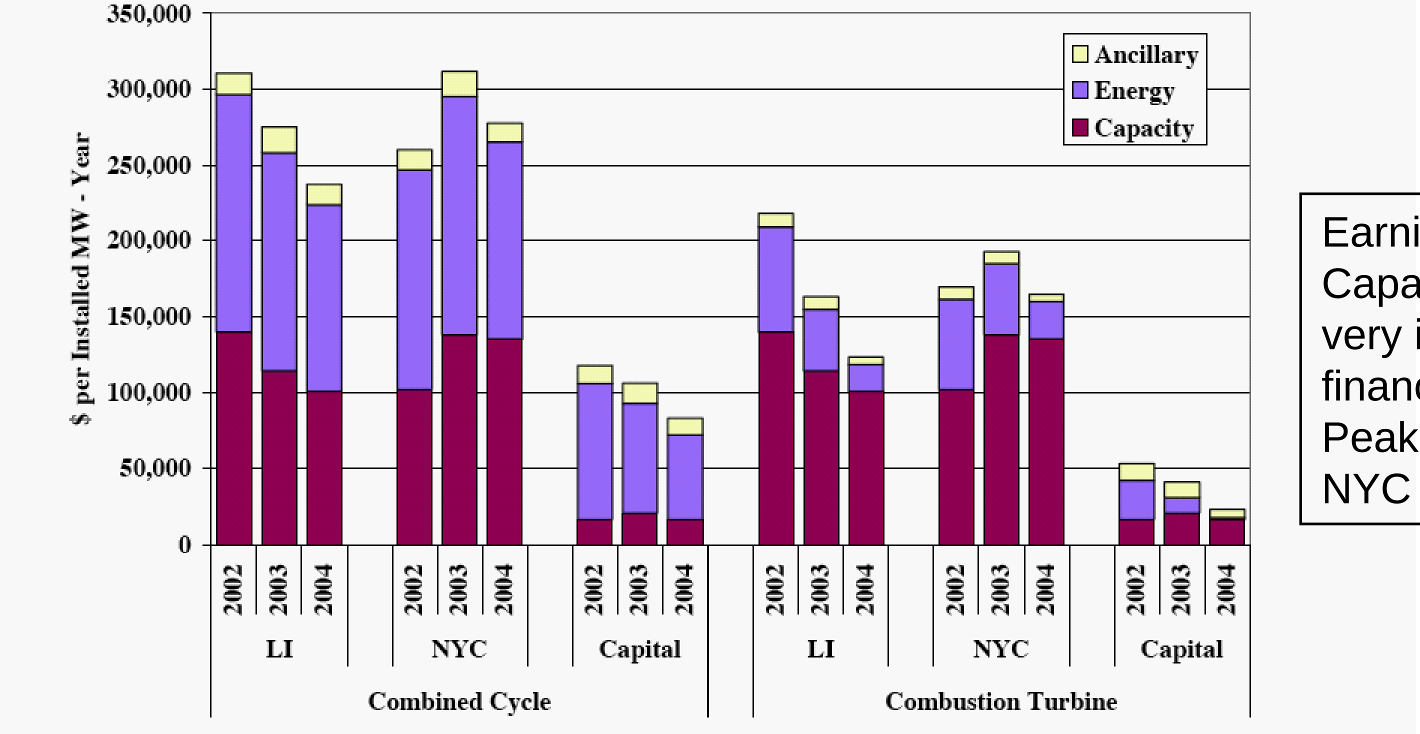
The Demand Curve for Capacity Specified by Regulators for NYC



The annual payment to generators in NYC is over $1billion/year, but this is still not enough to bring in new merchant capacity.

The observed price is set by a regulated price cap on the annual payments made to incumbent generators - market power is exploited effectively

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

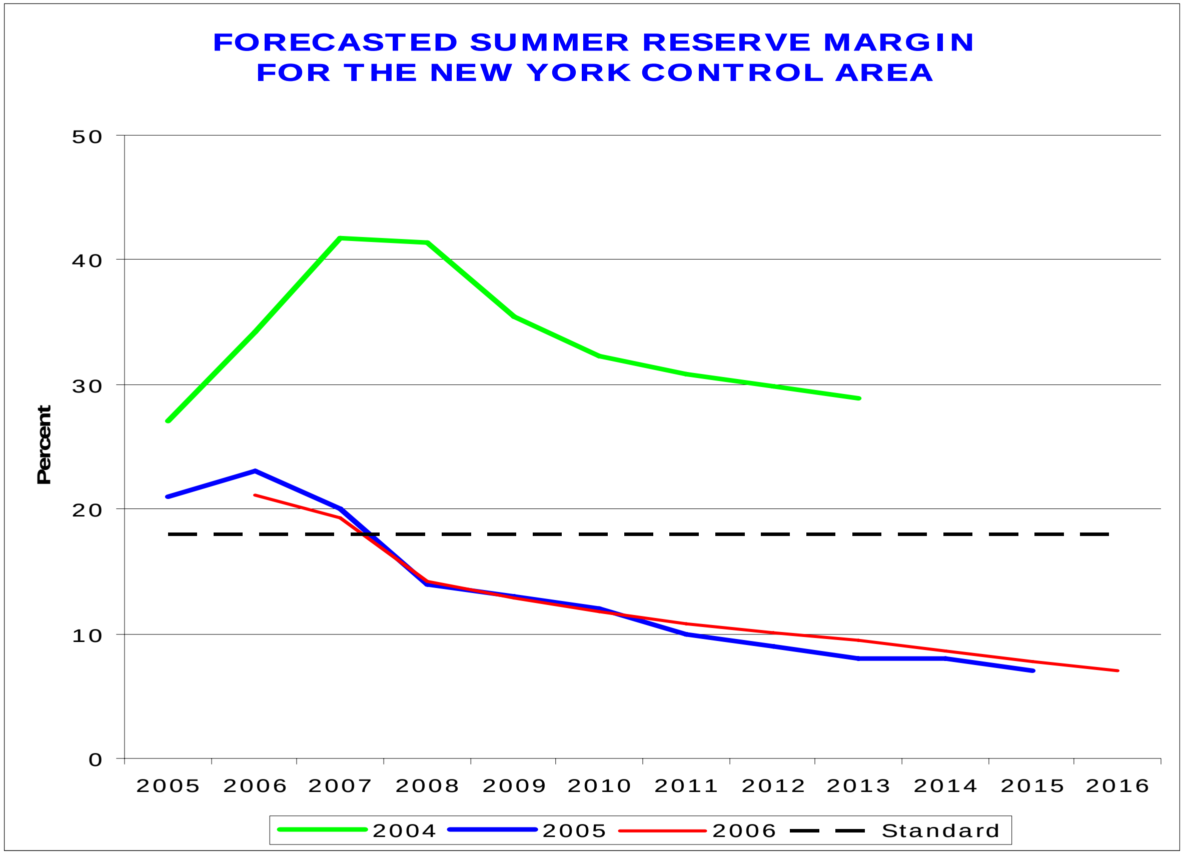


Earnings from the Capacity Market are very important for the financial viability of Peaking Units in NYC and LI.

"Capital" is the upper Hudson valley

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

Generation Adequacy in Reality
Projected Reserve Margins for New York



NYISO standard ---
A reserve margin of 18% is needed to meet the proposed NERC reliability standard (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 Overall Performance of the LICAP Market in New York

- Generation Adequacy is a minimal requirement for maintaining the reliability of supply because blackouts are very expensive. Since the electric supply system is unforgiving, policies for maintaining Generation Adequacy must be sufficient.
- An Energy-Only Market works because allowing price spikes results in an average price duration curve that approximates the long-run average costs of different types of generating capacity. However, it is financially risky for generators and investment and it is NOT sufficient.
- Giving more >$1 billion/year to generators in New York City through the LICAP market is expensive, NOT necessary and definitely NOT sufficient. Current payments increase the market value of installed generating units but have not resulted in new investment. Profits are fungible.
- Projected shortfalls of capacity in New York City will be met by last-minute schemes (e.g.delay retirements and count transmission links to PJM). Decisions are made too late to be economically efficient.
- To maintain Generation and Transmission Adequacy effectively, it is essential to plan ahead and provide enough time for the completion of new construction projects.

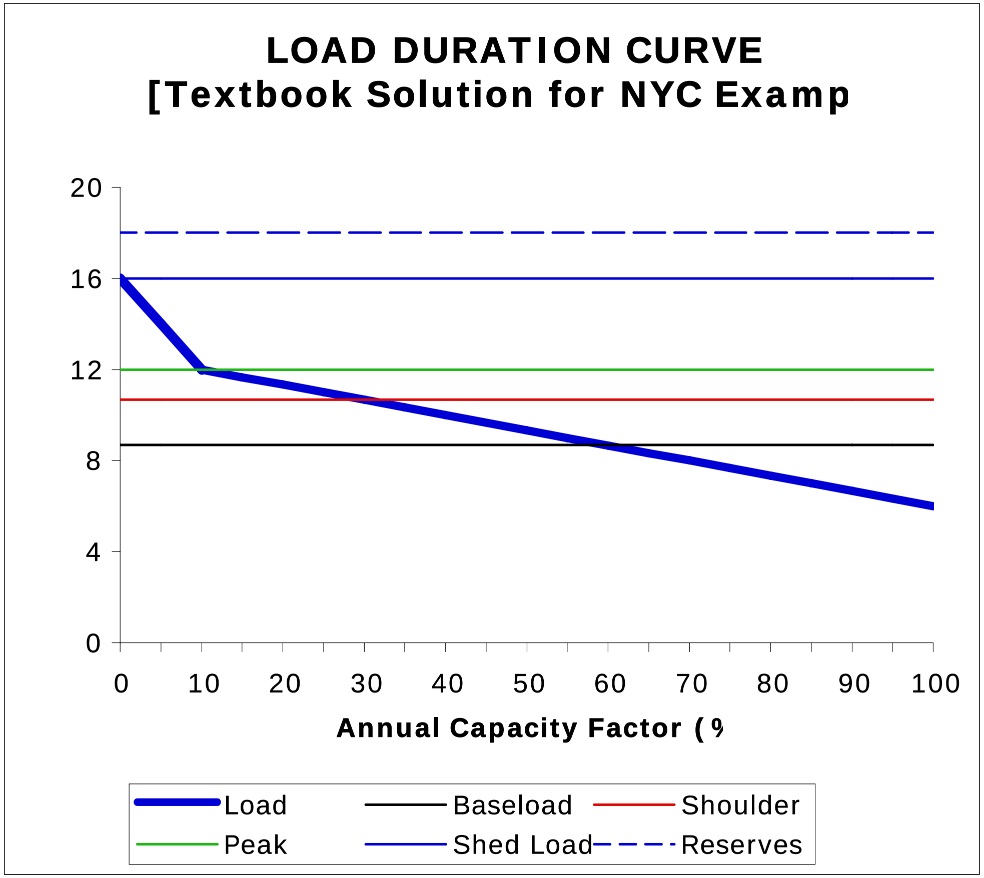
PART 3

Summary Evaluation of Generation Adequacy and the Forward Capacity Market Proposed by ISO-NE

Proposed Improvements in the ISO-NE Forward Capacity Market (FCM)

- Purchase Generation Capacity THREE Years Ahead
  - This allows NEW ENTRANTS and incumbent firms to participate in the FCM and build new (peaking) capacity if their offer prices are accepted in the auction. In addition, the market price can be locked-in for up to FIVE years for any new capacity.
- The Ability of Incumbent Firms to Exploit the Auction is Restricted by the ISO
  - The ISO requires all installed capacity to enter the auction, authorizes all exceptions (e.g. having a contract to export firm capacity), and enforces a low cap on the offer prices submitted for installed capacity (new capacity can submit higher offers).
- ISO Announces How Much Capacity to Purchase in Advance
  - A DESCENDING CLOCK Auction is used to purchase a specified amount of capacity. Hence, all potential sources of capacity are in the auction initially, and it is possible for the ISO to cancel the auction if insufficient capacity is offered to make the auction reasonably "competitive".
- Specify Capacity Requirements for sub-regions (ZONES)
  - This enables the ISO to specify more stringent capacity requirements for congested regions, such as Boston and SW Connecticut. The market-clearing prices of capacity may be higher in these congested zones.
- Use "Excess" Earnings in the Spot Market to Reduce FCM Earnings
  - Earnings in the FCM are treated as a "Make-Whole" Payment to supplement earnings in the spot market for real energy. Earnings in the spot market above a specified cap (e.g. $150/MWh) reduce payments for capacity in the FCM.

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

Effects of Doubling the Cost of Natural Gas on the Profits of Generators

LOW COSTS: Mix of Generating Capacity is Least-Cost
HIGH COSTS: Mix of Generating Capacity is **Unchanged**

Annual Profit for Installed Capacity

Type of Generation	LOW COSTS Profit ($/kW/Year)	HIGH COSTS Profit ($/kW/Year)
Peaking	-80	-80
Shoulder	-80	+159
Baseload	-80	+238

The standard economic rationale for paying all generating units the same price in a capacity market is

NO LONGER VALID with HIGH COSTS

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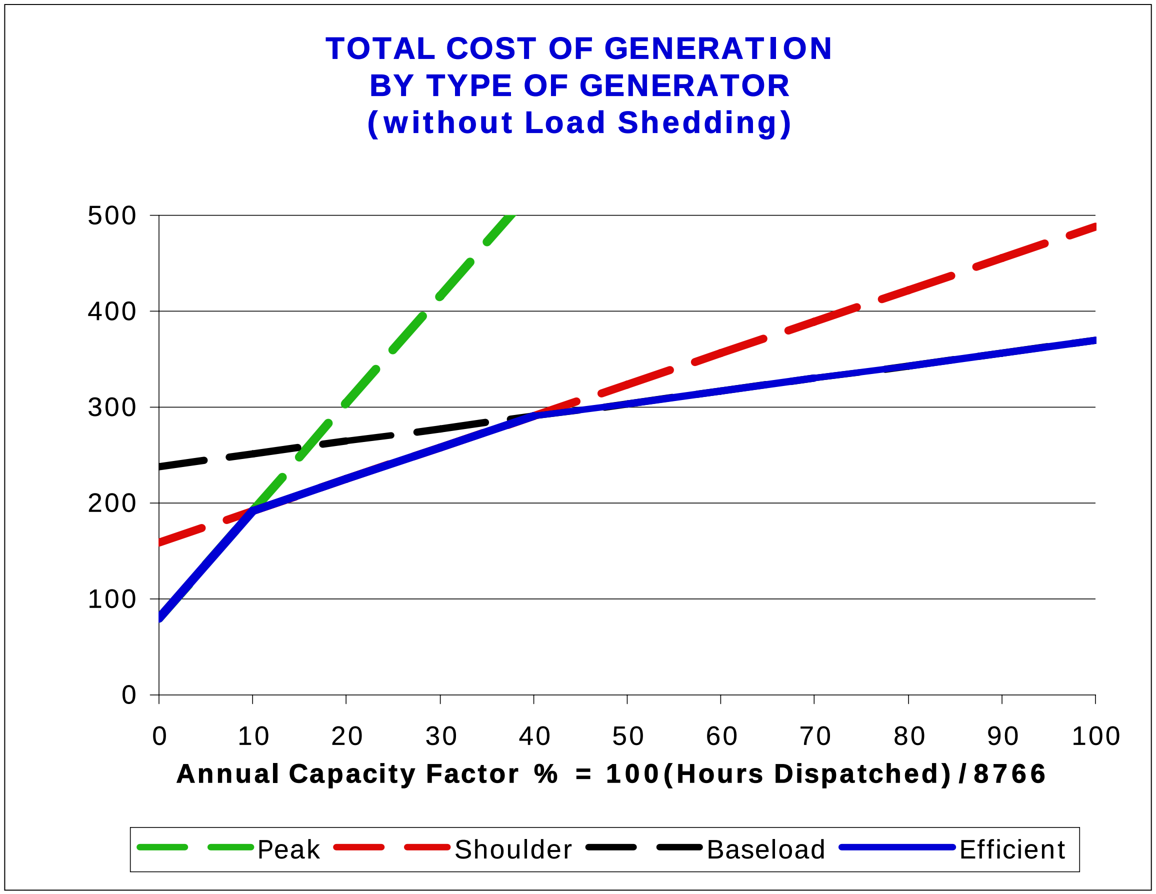
Total Cost of Generation/Year by Type of Generator

[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

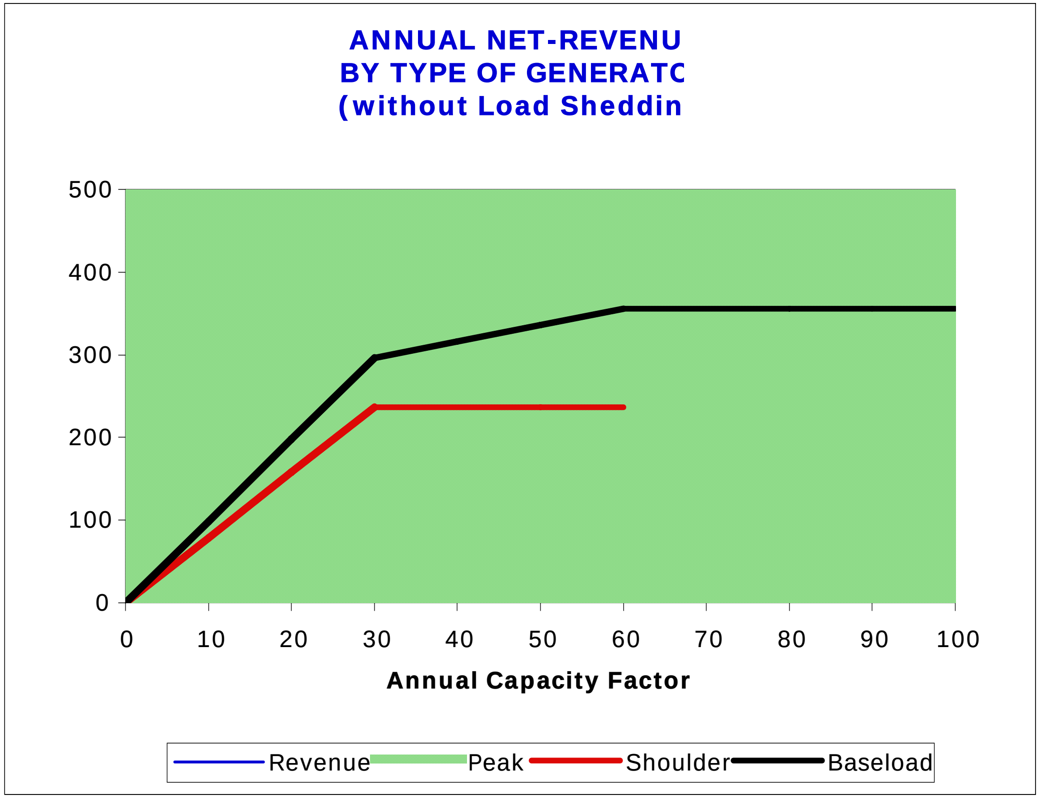
Capacity Factors for Least-Cost Choices

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

* Optimum values before higher fuel costs

Annual Net-Revenue Using Short-Run Competitive Prices

[Inefficient Legacy Mix of Generators]



Specified Costs

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

Annual Profit for the Legacy Mix of Capacity (k$/MW/Year)

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

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

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 for Deregulated Regions with Capacity Markets

- **Maintaining the Reliability of Supply**
  - Generation and Transmission Adequacy are essential regulatory responsibilities because blackouts are very costly for customers
  - Merchant projects can contribute, but some form of planning ahead is essential to maintain reliability effectively
  - Many generating units needed for reliability have low capacity factors and low annual earnings --- a genuine financial problem
- **Conclusions about Capacity Markets**
  - Designed by regulators for markets using SRMC pricing to provide the "missing money" for generators
  - Purchasing capacity ahead of time is a step in the right direction because it is consistent with planning and purchases are backed by the ISO
  - One price (policy instrument) does NOT meet all of the needs for New Capacity, Peaking Units, and Baseload Capacity
  - Earnings are more fungible in deregulated markets. The real problem in NYC is "Missing Investment" not "Missing Money"
  - It is still too early to determine if the new forms of capacity market proposed for New England and PJM will be economically efficient