Natural Gas Price Impact on Gas Turbine Economics

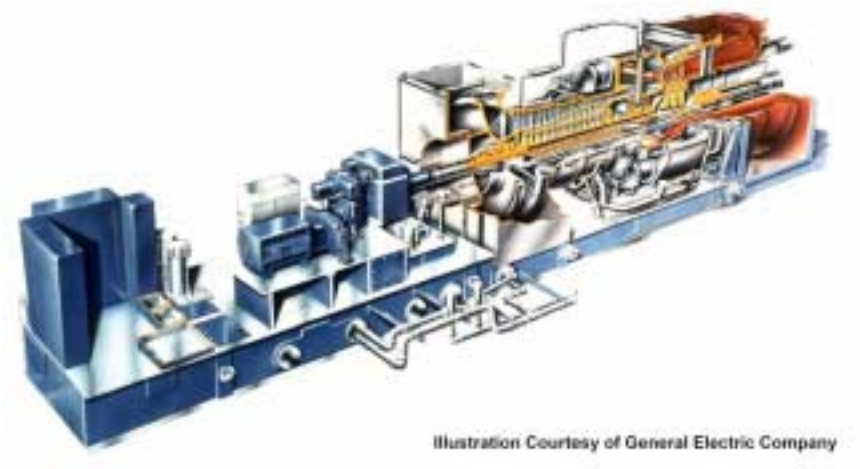


Illustration Courtesy of General Electric Company

Economics of Gas Turbines in the PJM Region

Strategic Center for Natural Gas

An SCNG Policy Study

- **GEMSET is an Evaluation and Planning Division tool for assessing the economic merits of fossil generation equipment in today's power market**

- **The SCNG worked with the Evaluation and Planning Division to apply GEMSET modeling to the problem**
- **Participants were:**

NETL
- Julianne Klara
- Patricia A. Rawls

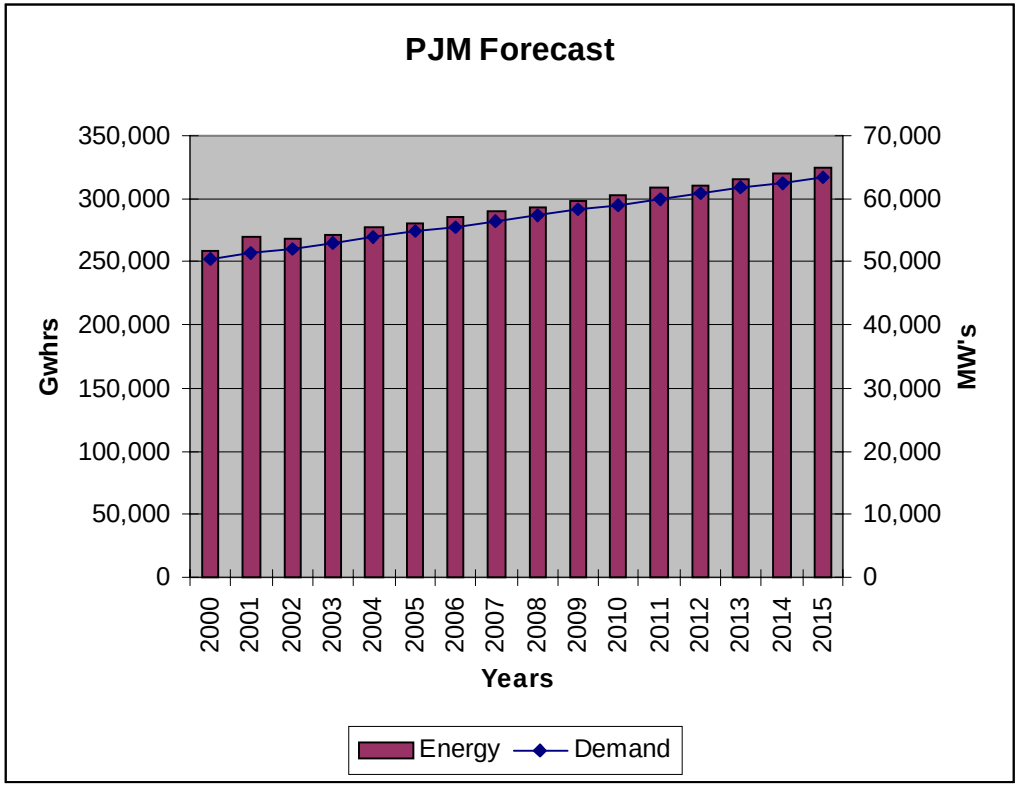
PARSONS
- Richard E. Weinstein, P.E.
- Albert A. Herman, Jr.

Study Methodology

- Estimate Production Costs for Existing Generating Units within PJM
- Estimate Fuel Prices (Oil, Gas and Coal)
- Characterize PJM's Hour-by-Hour Electric Price and Fleet Make-Up
- Relate Demand and Production Costs to Threshold Bid Price
- Estimate Effects of Competition

PJM FORECAST

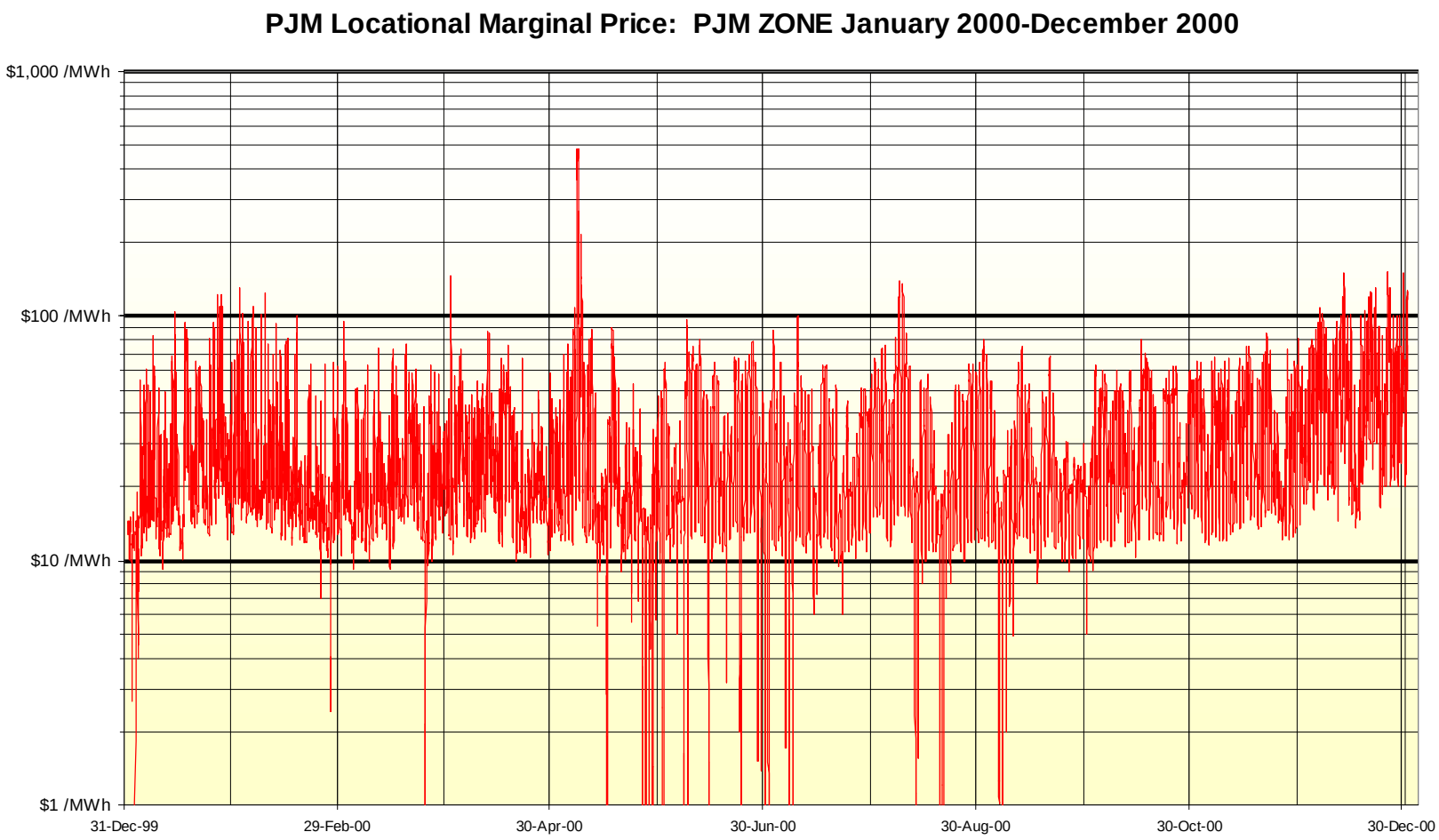
- Limited growth expected over next 15 years (less than 2%)
- Demand & Energy about the same growth
- Over 15 years only 13,000 MW's projected in growth
- Over 40,000 MW's of projects in queue



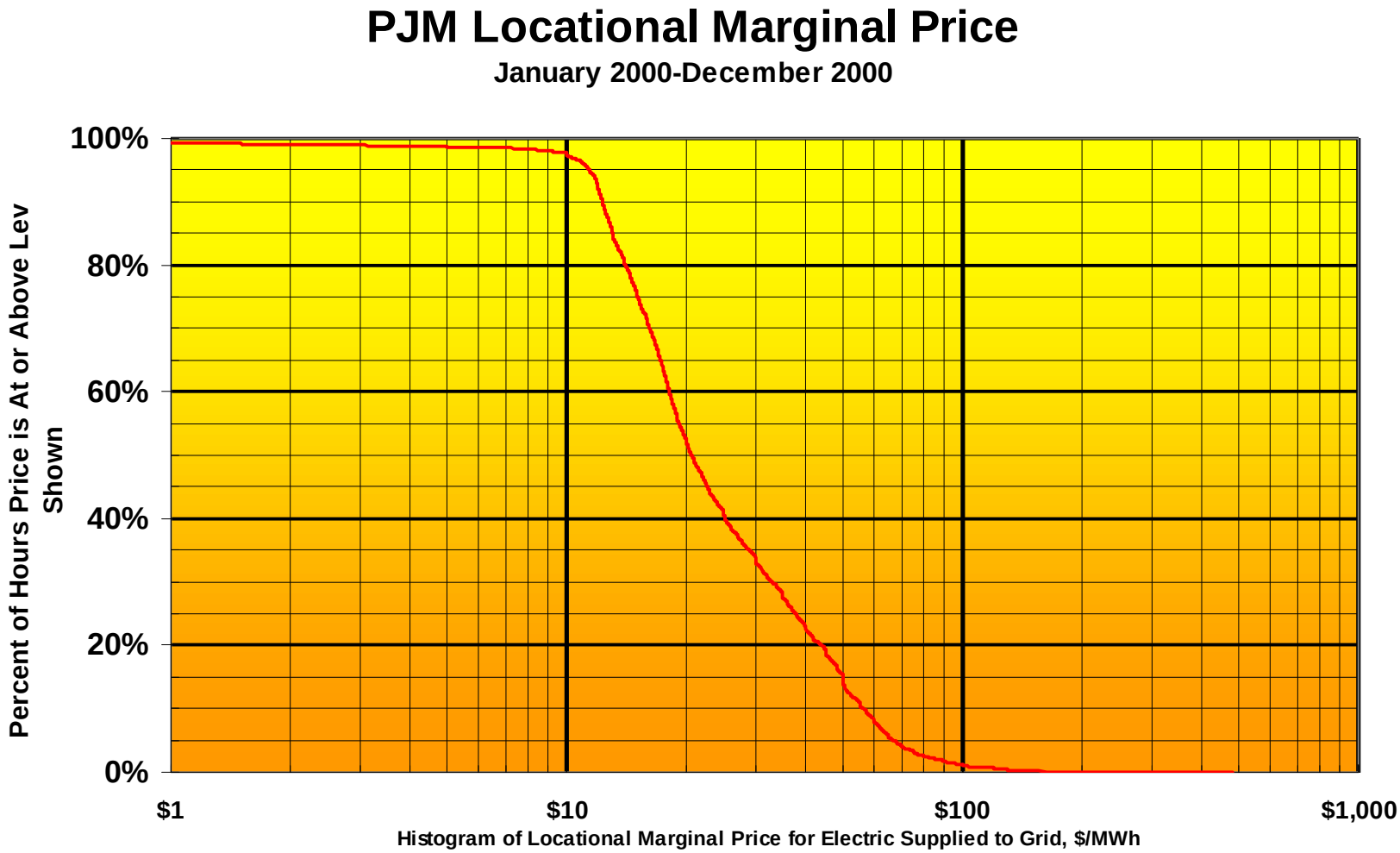
Review of Pricing in PJM as it relates to GEMSET

- January 1, 2000 through December 31, 2000 (hour by hour)
- Histogram of day ahead prices
- PJM Price versus Demand correlation in Production Costs
- Expected Average Price

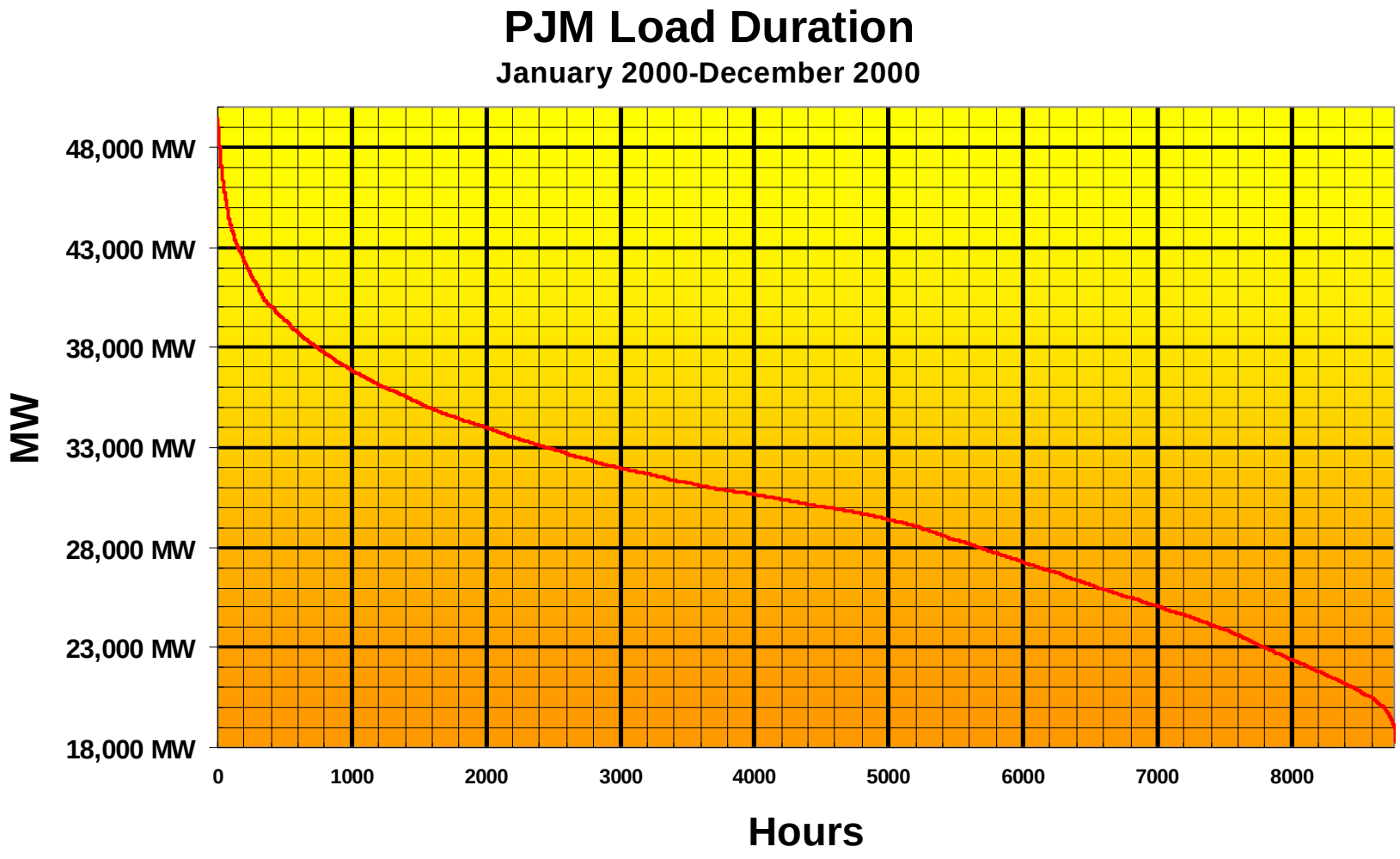
PJM Day-Ahead Price



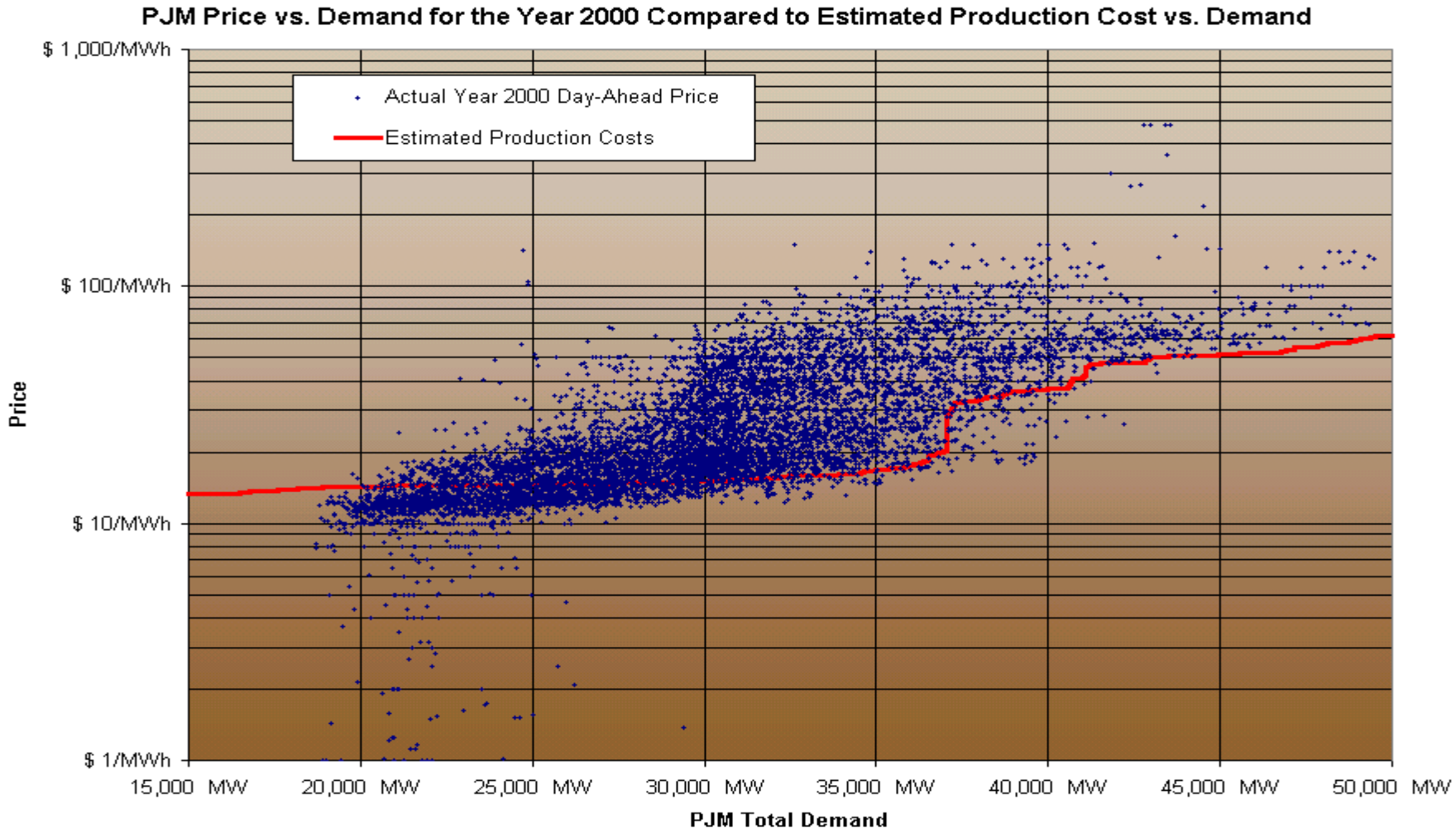
PJM Price Duration Histogram



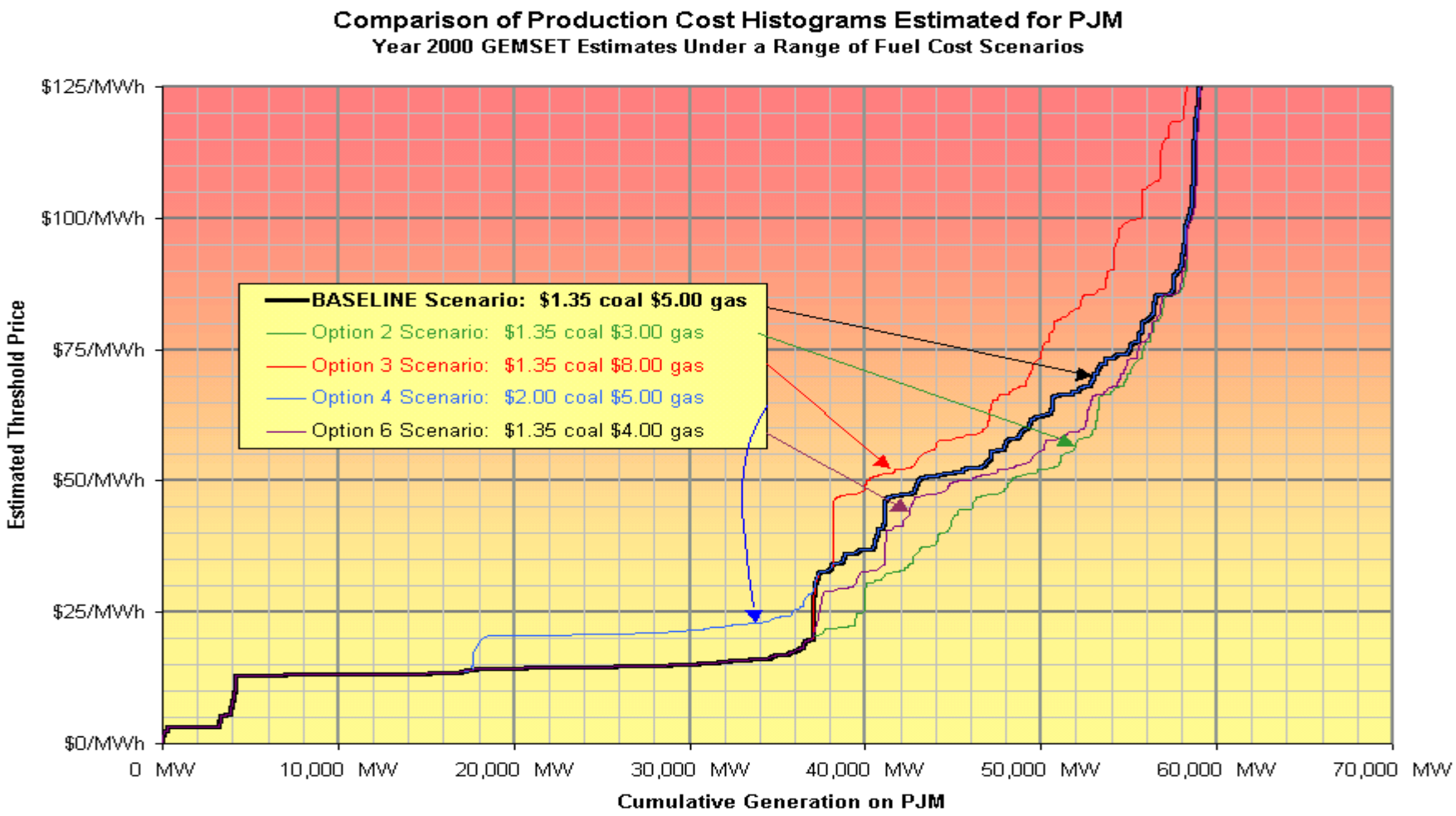
Load Duration Histogram



PJM Price vs. Demand Correlation



Production Cost Estimates



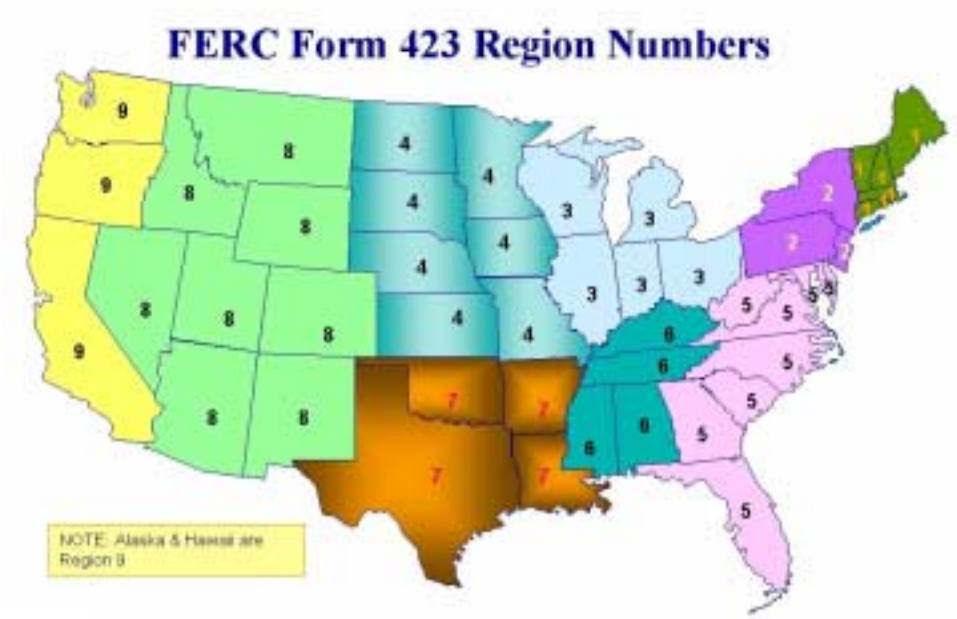
Estimating Fuel Price

- **Fuel costs are a key element influencing regional electric prices.**

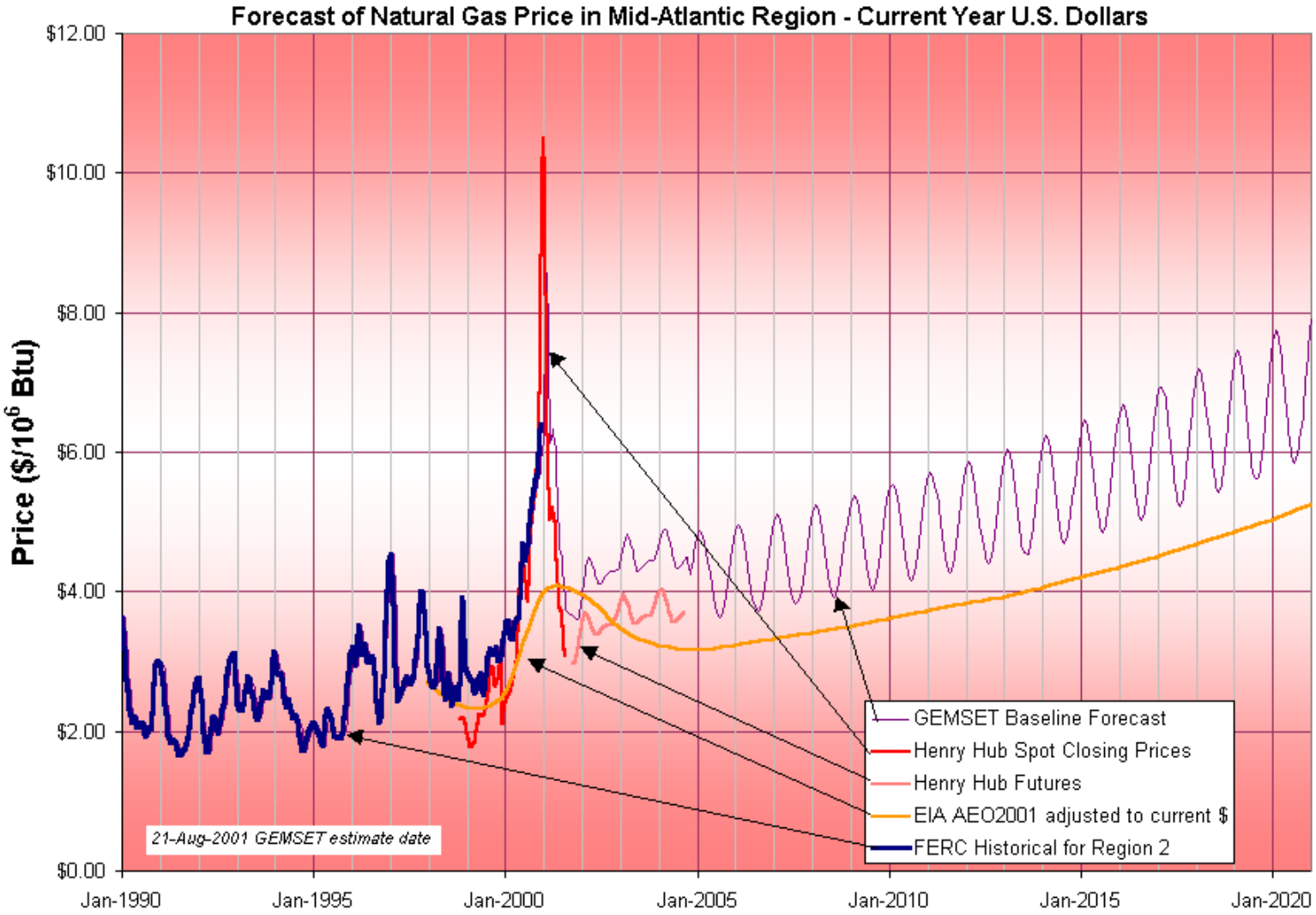
- **GEMSET used a mix of historical, spot market, futures market and forecast data to establish its energy cost baseline.**
  - Historical delivered prices to power companies from FERC
  - Spot Market and natural gas futures price projections from NYMEX
  - Long-term projections from EIA

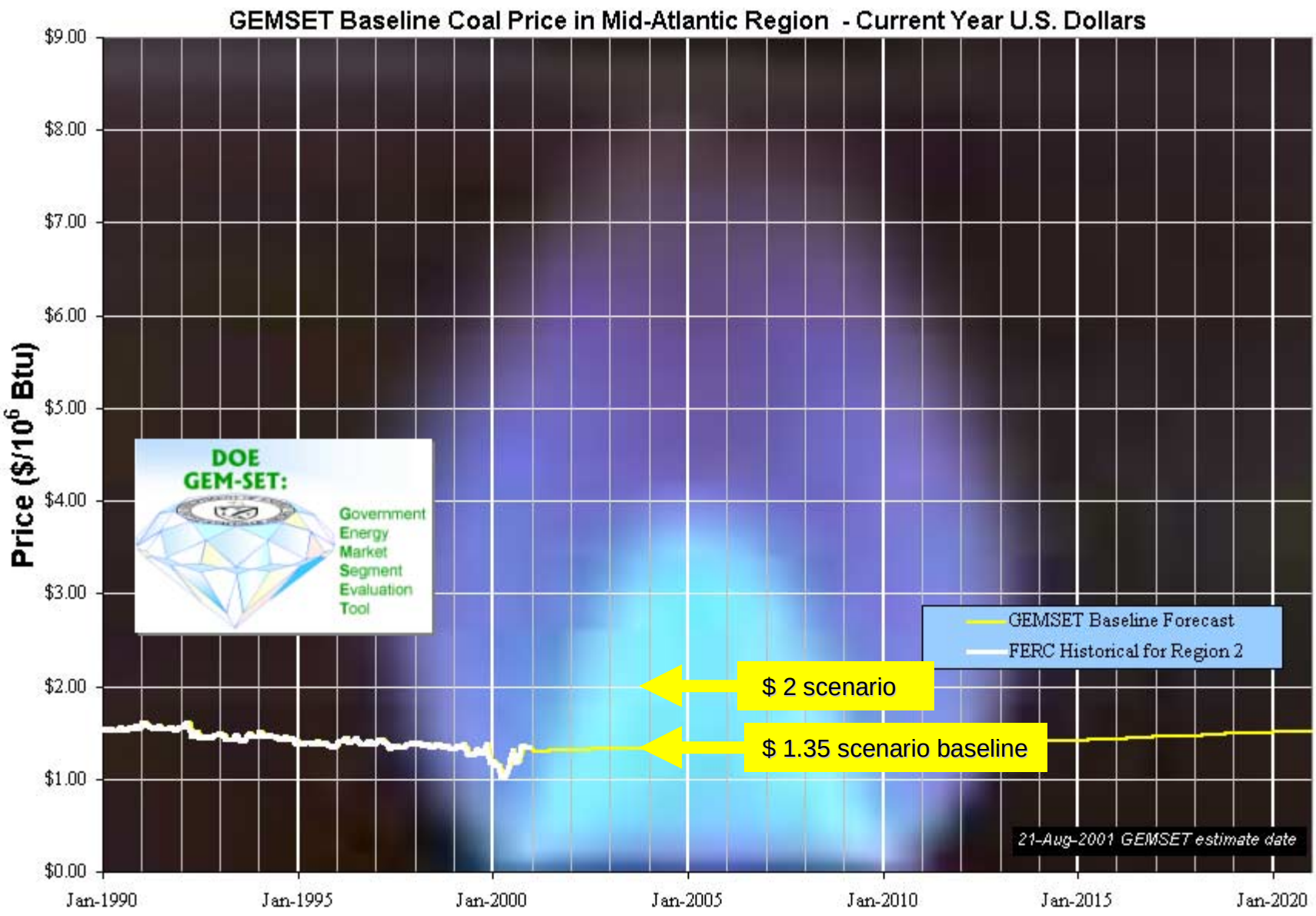
GEMSET Fuel Price Forecast

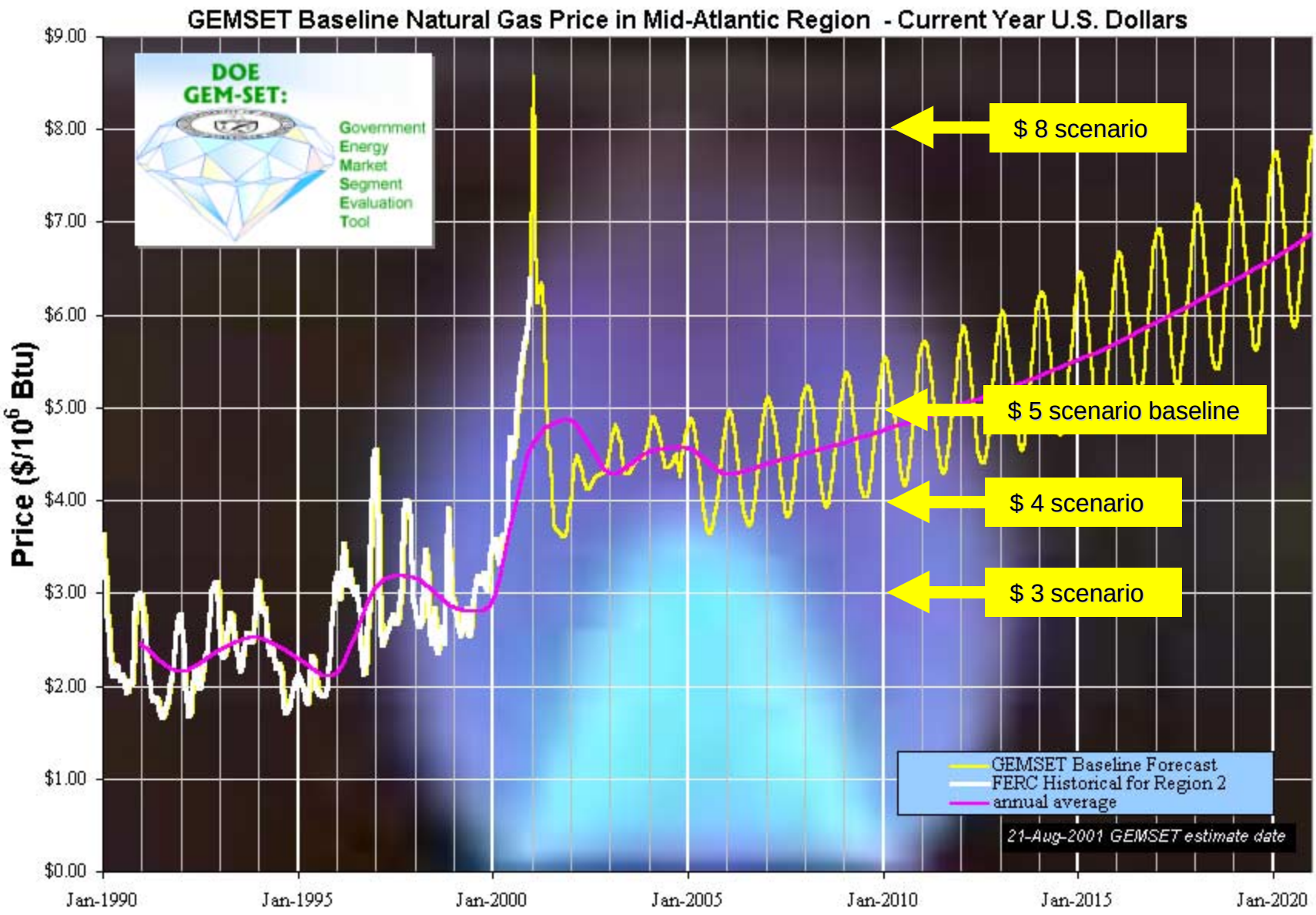
FERC Region 2
Mid-Atlantic



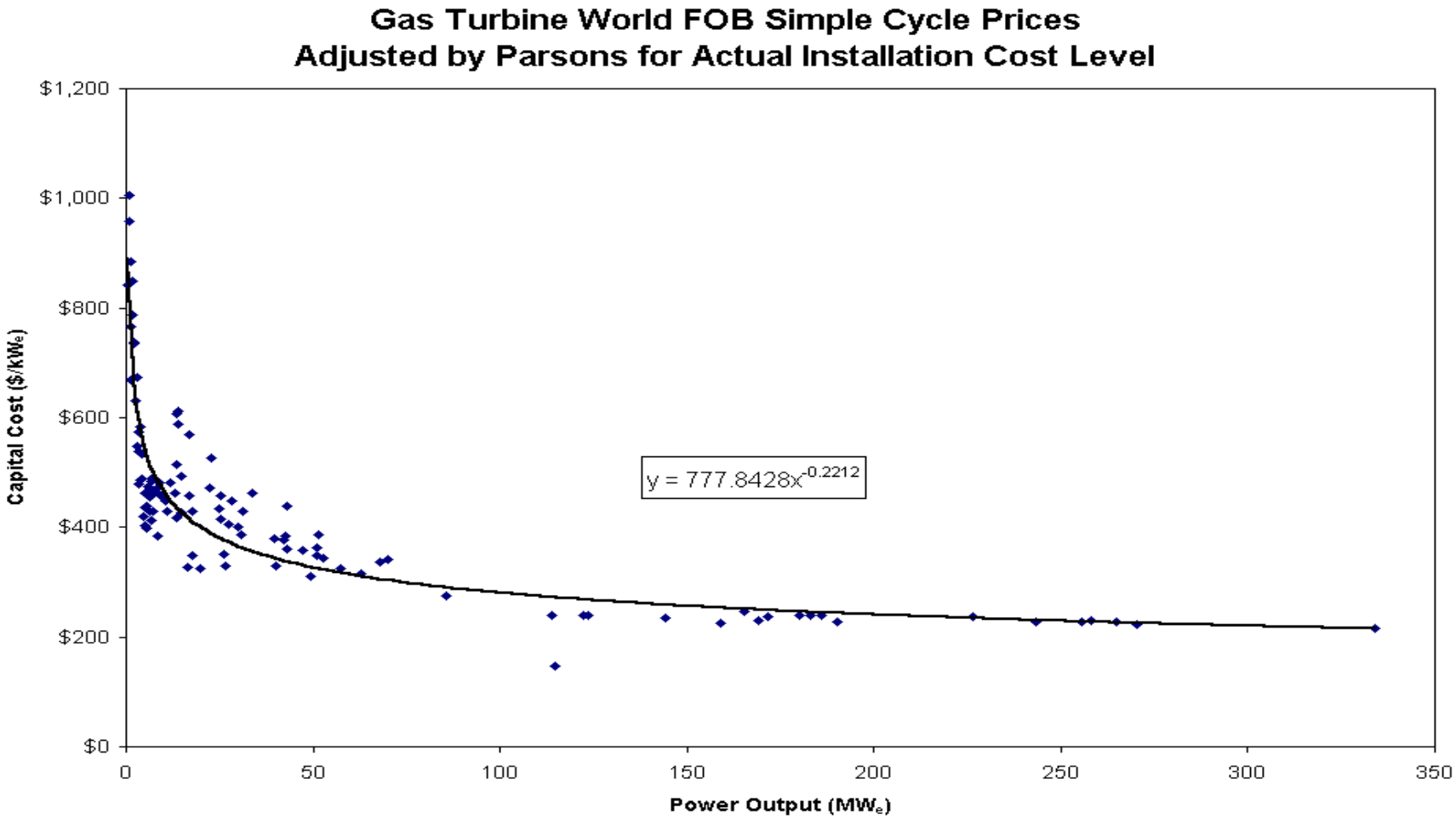
Example: Natural Gas in FERC Region 2



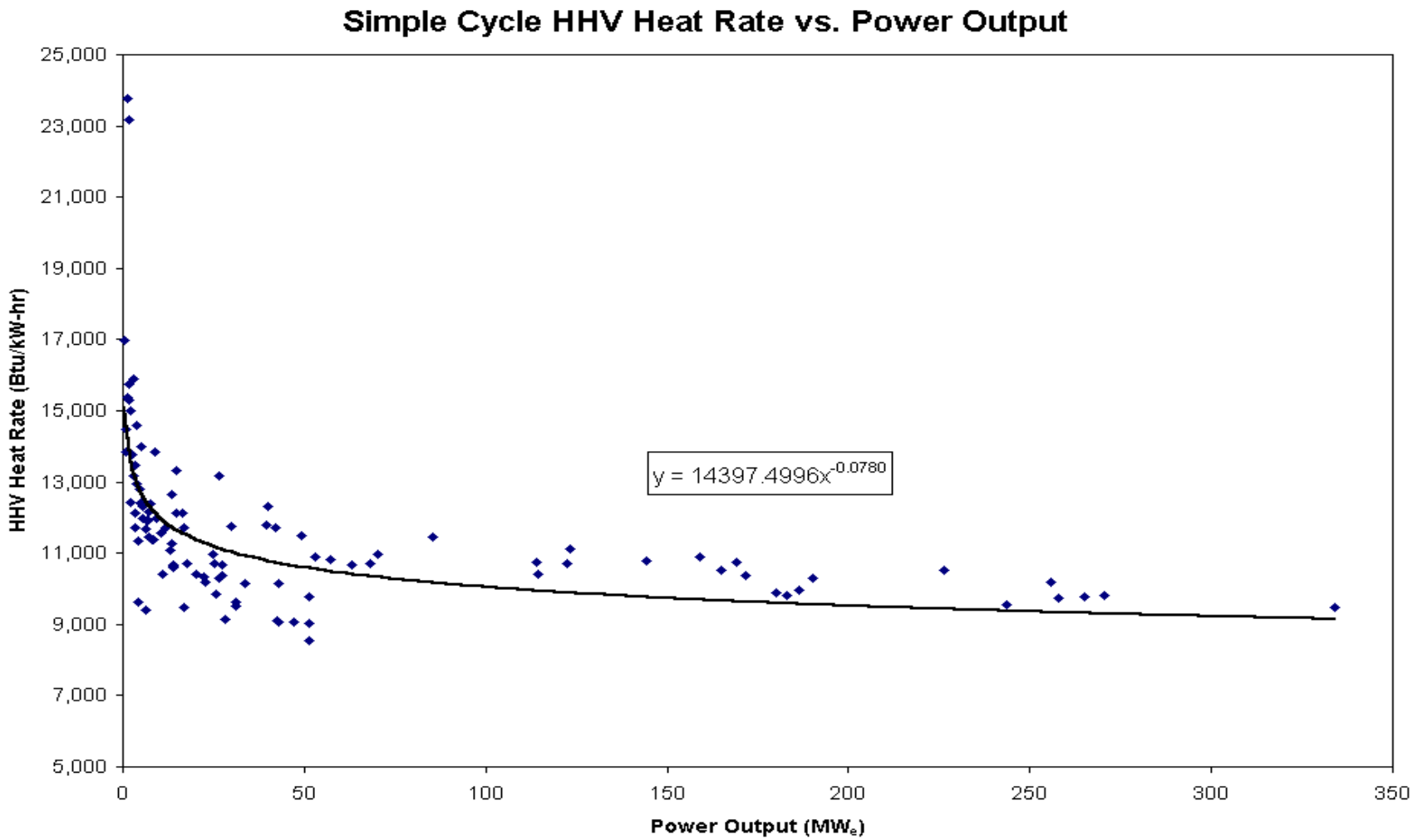

GEMSET Baseline Coal Price in Mid-Atlantic Region - Current Year U.S. Dollars
Price ($/10^6 Btu)
$9.00
$8.00
$7.00
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
Jan-1990
Jan-1995
Jan-2000
Jan-2005
Jan-2010
Jan-2015
Jan-2020
DOE
GEM-SET:
Government
Energy
Market
Segment
Evaluation
Tool
GEMSET Baseline Forecast
FERC Historical for Region 2
$ 2 scenario
$ 1.35 scenario baseline
21-Aug-2001 GEMSET estimate date


GEMSET Baseline Natural Gas Price in Mid-Atlantic Region - Current Year U.S. Dollars
DOE
GEM-SET:
Government
Energy
Market
Segment
Evaluation
Tool
$ 8 scenario
$ 5 scenario baseline
$ 4 scenario
$ 3 scenario
GEMSET Baseline Forecast
FERC Historical for Region 2
annual average
21-Aug-2001 GEMSET estimate date
Price ($/10^6 Btu)
$9.00
$8.00
$7.00
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
Jan-1990
Jan-1995
Jan-2000
Jan-2005
Jan-2010
Jan-2015
Jan-2020

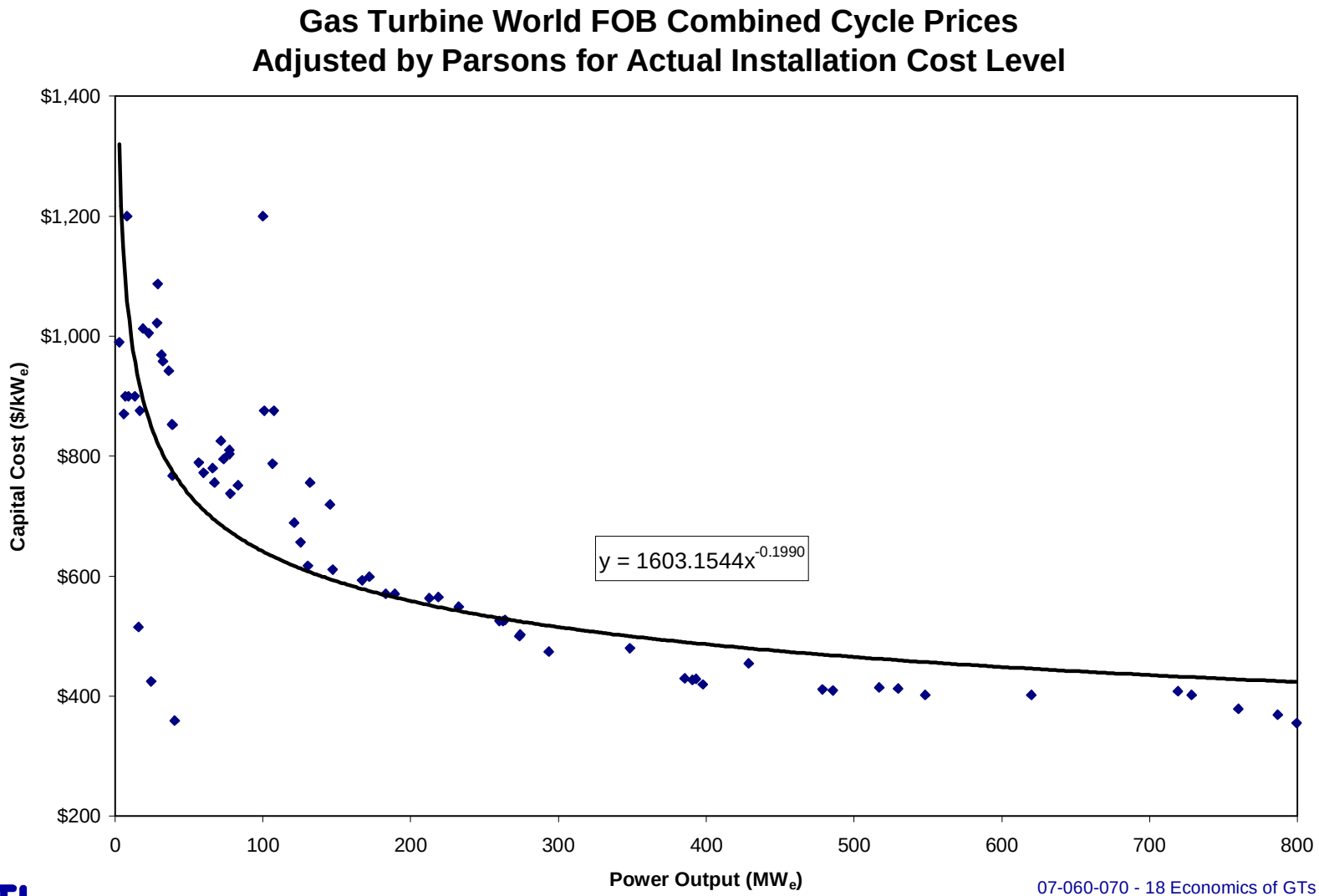
Simple Cycle Capital Projections



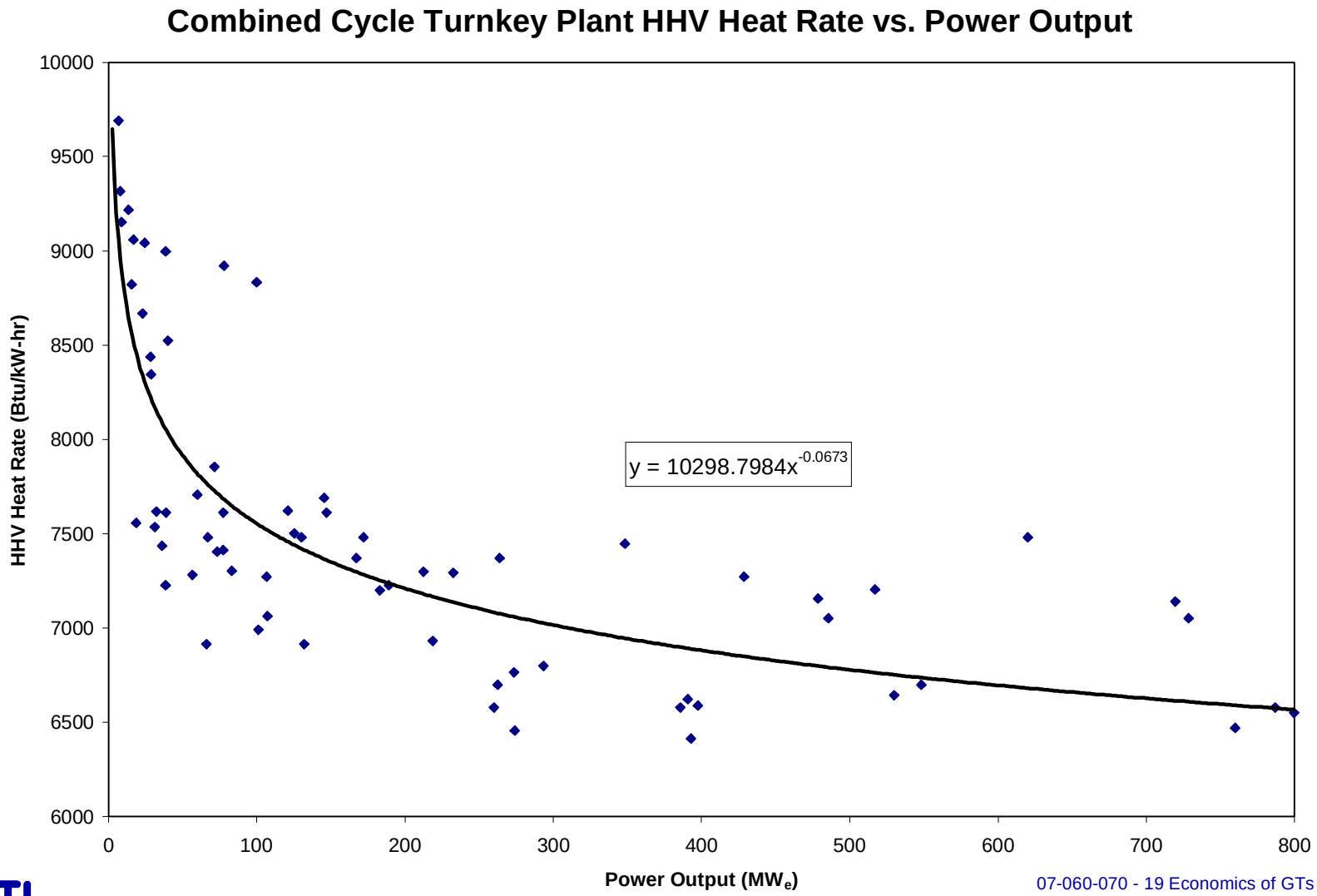
Heat Rate vs. Power Output



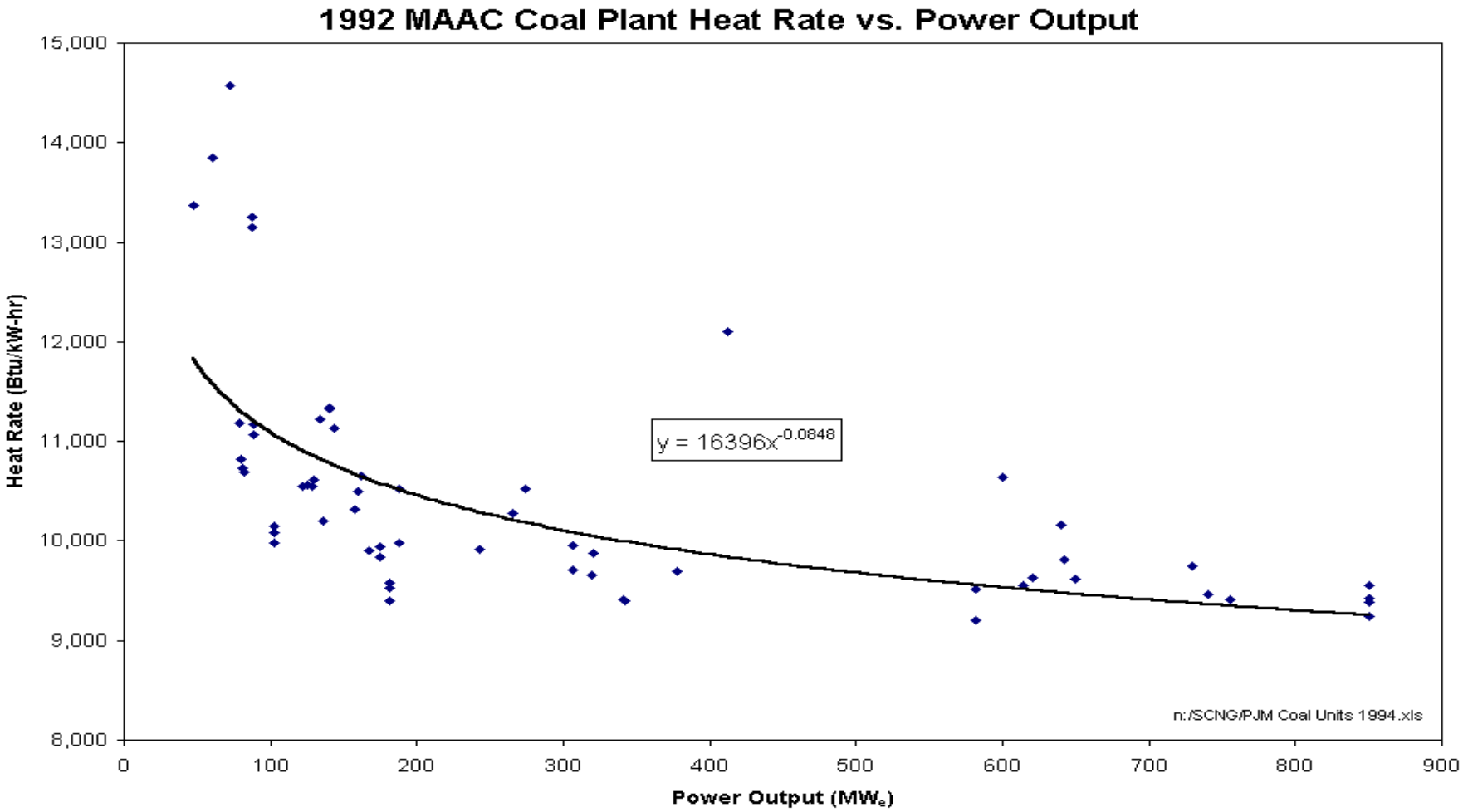
Combined Cycle Capital Projections



Heat Rate vs. Power Output



Heat Rate vs. Power Output



Operation & Maintenance Expenses

Fixed O&M and Consumable Assumptions Used to Characterize Threshold bid prices for the PJM Fleet

Type of Unit	Fixed O&M
Coal and Solid Fuels *for coal, wood, culm, etc.*	*$ 26.80 / kW*
Simple Cycle Gas Turbine *for gas and petroleum fuels*	*$ 11.20 / kW*
Gas Turbine Combined Cycle *for gas and petroleum fuels*	*$ 16.00 / kW*

for all types of units:

Fuel Type of Unit	Consumables
Bituminous glob	$ 2.50 / MWh
Coal	$ 1.70 / MWh
Culm	$ 2.50 / MWh
Petroleum Fuels	$ 0.40 / MWh
Landfill Gas	$ 0.30 / MWh
Municipal Solid Waste	$ 2.50 / MWh
Natural Gas	$ 4.00 / MWh
Petroleum Coke	$ 2.50 / MWh
Nuclear	$ 2.77 / MWh †
Wood and Wood Waste	$ 2.50 / MWh
Hydroelectric	$ 3.26 / MWh
Waste Process Gas	$ 2.50 / MWh

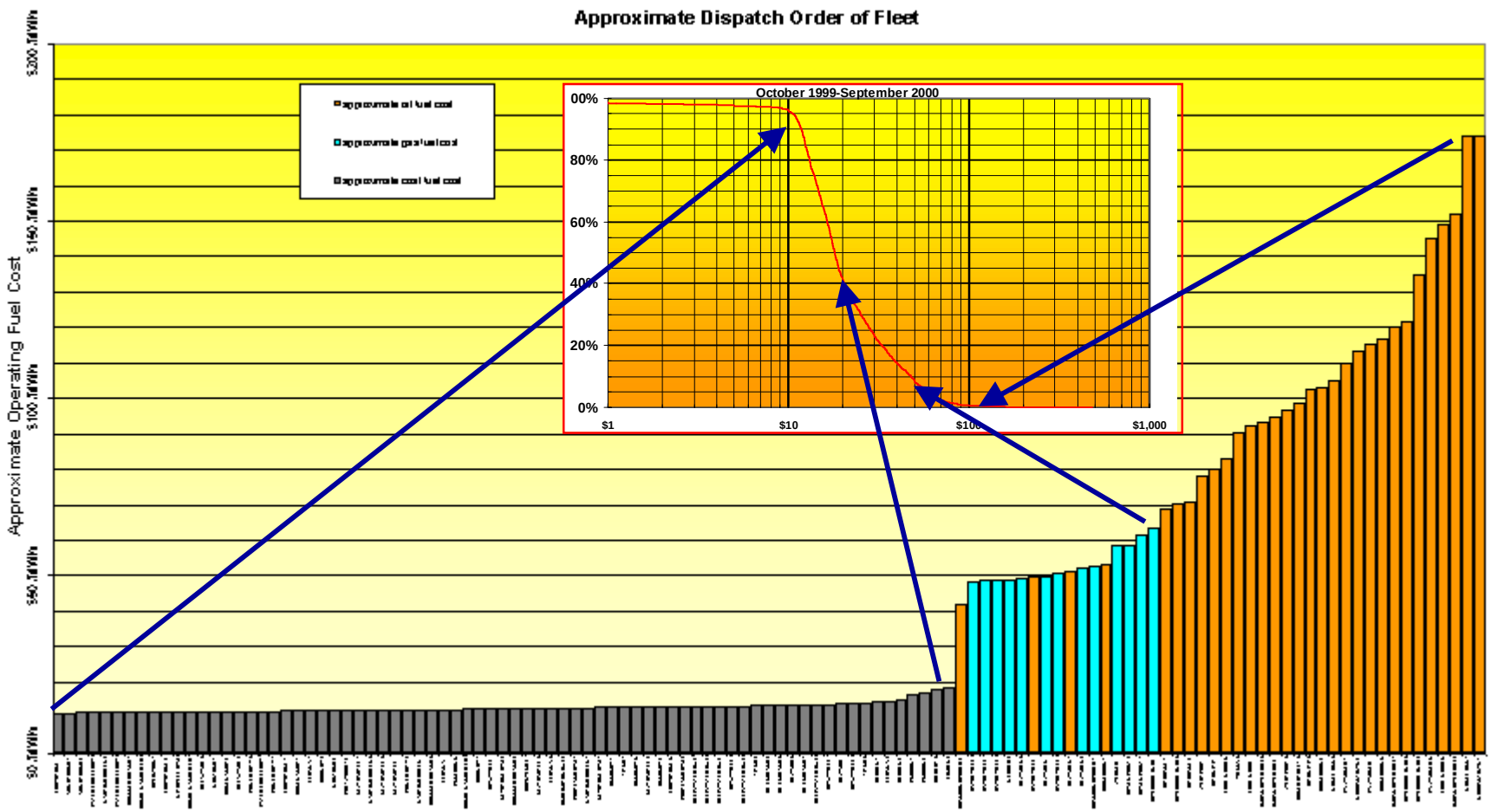
† nuclear fuel O&M related to fuel handling and processing included with fuel price

Annual Capital Component

Fixed Charge Rate Applied

Rate of Return on Equity	*Simple Cycle*	*Combined Cycle*	*Coal*
0%	0.1115	0.1115	0.1029
15%	0.1419	0.1419	0.1534
25%	0.1637	0.1637	0.1913

Build Region from Existing Fleet



Units Arranged in Threshold Bid Price Order

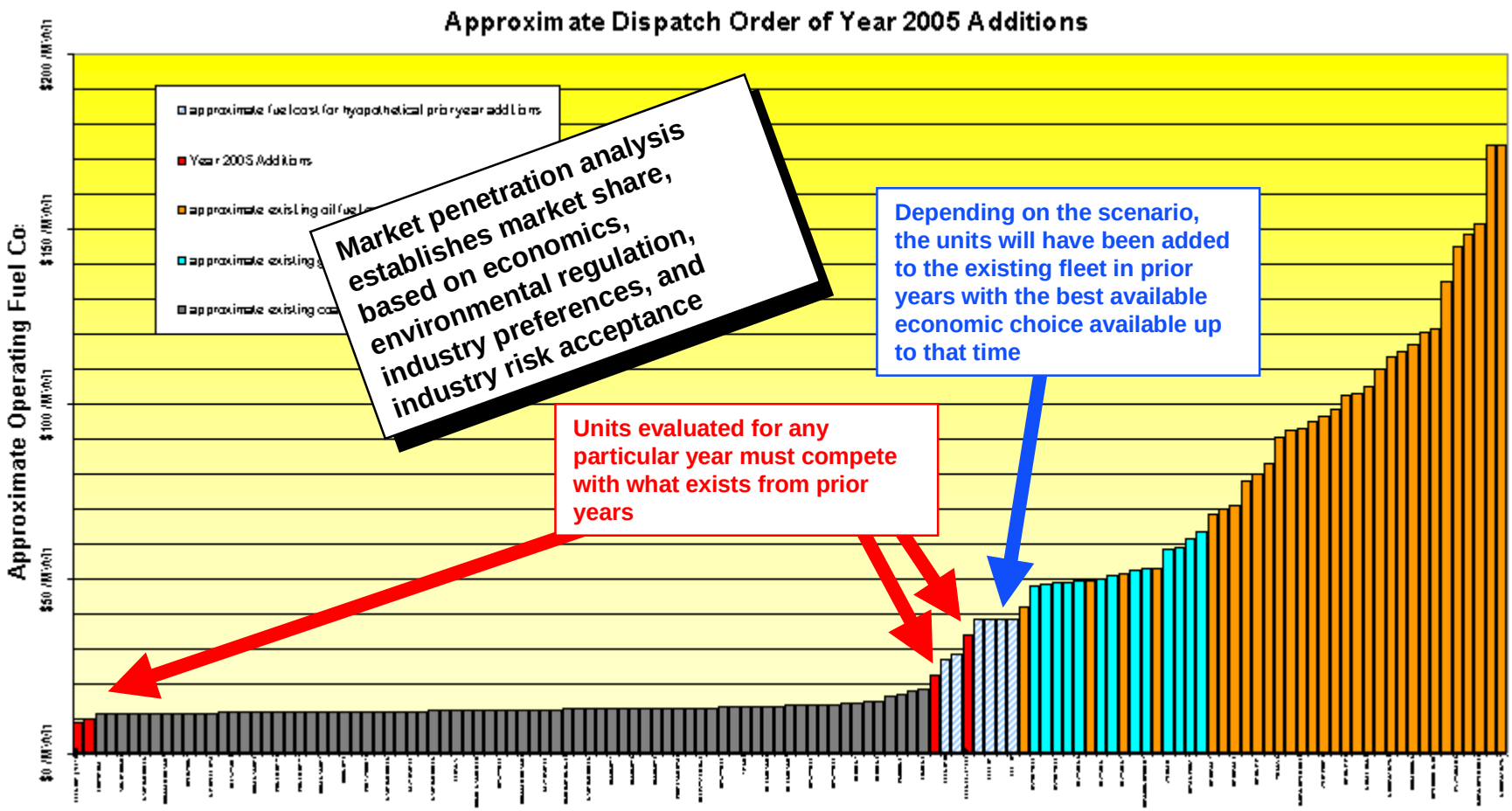
The Economics of Gas Turbines in the PJM Region

Exhibit 6-1. GEMSET Baseline Threshold Bid Price Ranking Order of Existing Units in the PJM Fleet (*continued*)

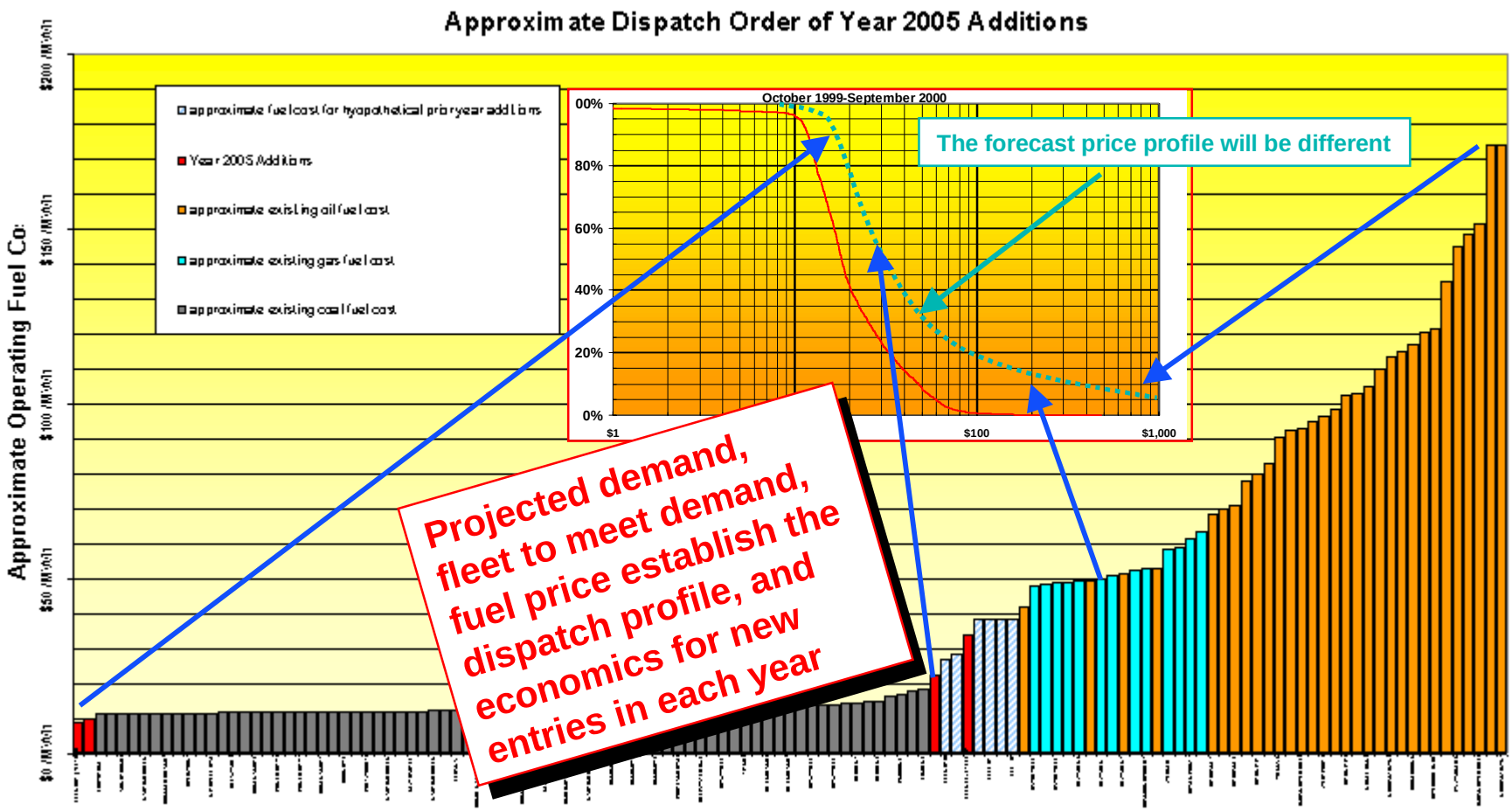
Baseline $1.35/10⁶ Btu coal – $5.00/10⁶ Btu gas

Utility	Plant Name	Unit Type	Fuel	Summer kW	Cumulative MW
Dover City Of	General Foods	ST	COL	15,100	36,525
Pennsylvania Power & Light Co.	Montour	ST	COAL	15,000	36,540
Potomac Electric Power Co.	Potomac River	ST	COAL	102,000	36,642
Potomac Electric Power Co.	Potomac River	ST	COAL	102,000	36,744
Pennsylvania Power & Light Co.	Holtwood	ST	COAL	-	36,744
UGI Corp.	Hunlock Power Sta	ST	COAL	48,000	36,792
Sithe Power Marketing, L. P.	Warren	ST	COAL	41,000	36,833
Sithe Power Marketing, L. P.	Warren	ST	COAL	41,000	36,874
Atlantic Electric / Conectiv	Mobil NUG	ST	COL	10,700	36,885
Atlantic Electric / Conectiv	Mobil NUG	ST	COL	10,700	36,896
Sithe Power Marketing, L. P.	Seward	ST	COAL	136,000	37,032
Public Service Electric & Gas Co.	Bergen	CT	GAS	445,000	37,478
Pennsylvania Power & Light Co.	Martins Creek	IC	FO2	2,500	37,480
Pennsylvania Power & Light Co.	Martins Creek	IC	FO2	2,500	37,483
Public Service Electric & Gas Co.	Bergen	CW	GAS	230,000	37,713
Public Service Electric & Gas Co.	Burlington	GT	NG	184,000	37,825
Public Service Electric & Gas Co.	Eagle Point	CC	GAS	195,000	38,145
Potomac Electric Power Co.	Essex	GT	NG	168,000	38,338
Potomac Electric Power Co.	Dickerson	GT	NG	139,000	38,506
Public Service Electric & Gas Co.	Dickerson	GT	NG	139,000	38,673
Public Service Electric & Gas Co.	Kearny	GT	NG	134,000	38,832
Public Service Electric & Gas Co.	Kearny	GT	NG	134,000	38,991
	Camden	CC	GAS	149,000	39,140

Build Region from Existing Fleet



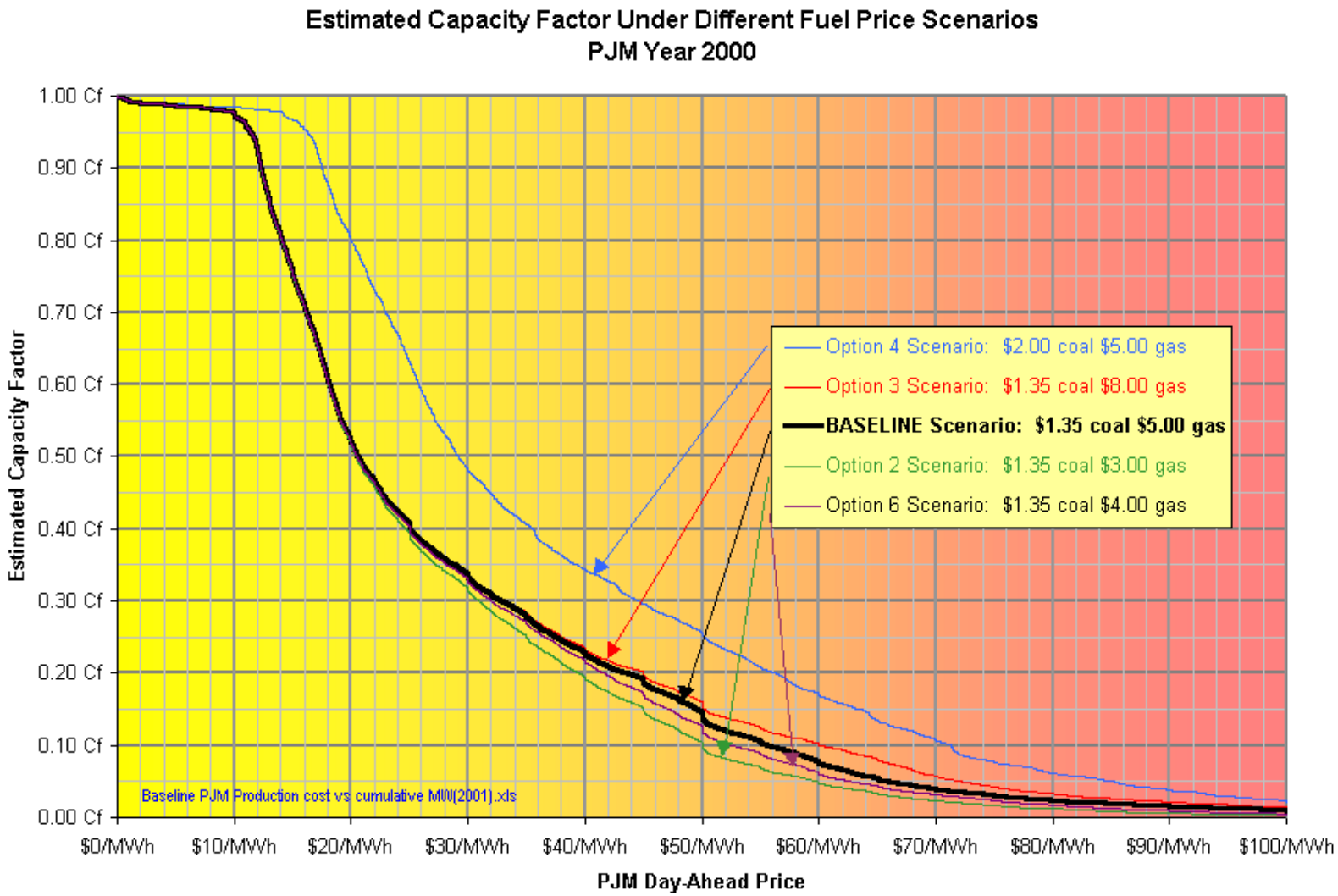
Forecast Prices and Dispatch for the New Scenario



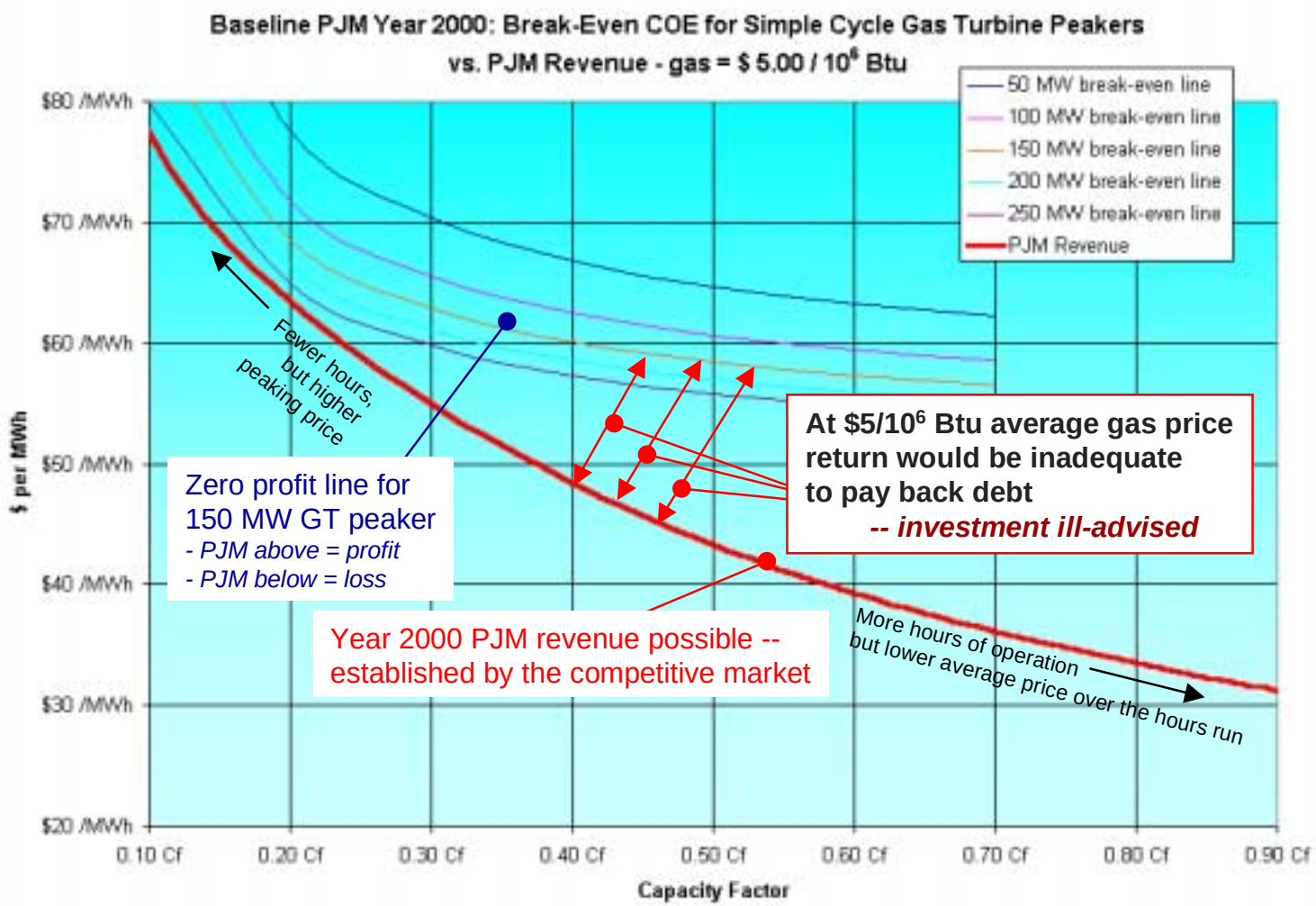
Relating Demand and Production Costs to Threshold Bid Price

- An un-manipulated market is a random walk
- Gamesmanship establishes bid price, but all owners are constrained by their production costs
- No model can predict the hour-by-hour variation
- Expectation is that the amount of volatility and variability of bid prices to estimated production costs will over a year be about the same
- An "inferred competition ratio" for each hour maps a bid strategy that in aggregate models bidding under the various scenarios

Estimated CF vs. Threshold Bid Price for Each Scenario



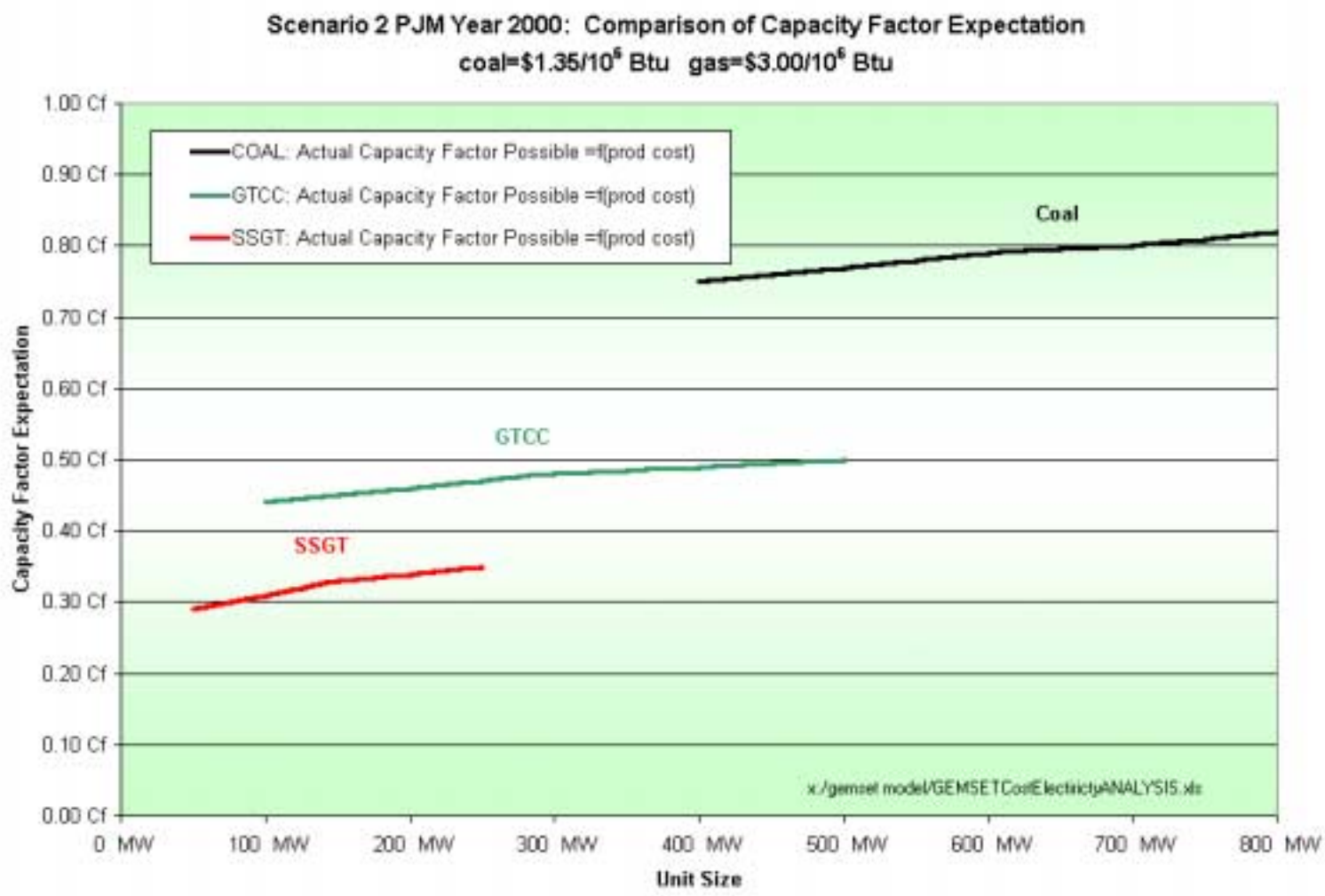
HIGHER RISK -- Owner's Return Depends on Uncertain Market Conditions



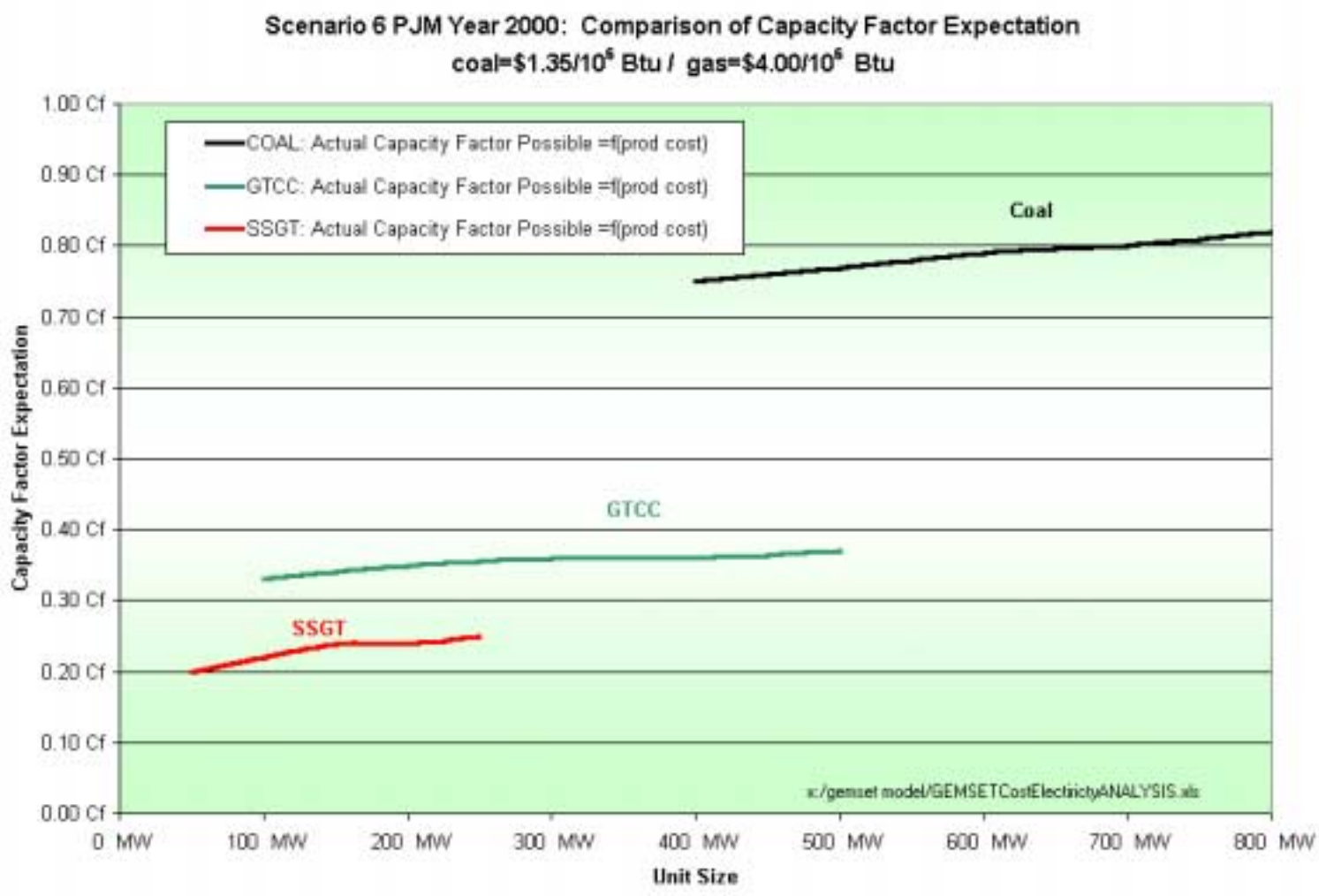
SUMMARY
PRICE SENSITIVITYANALYSIS

Estimate -- Year 2000 PJM
Fuel Price Sweep

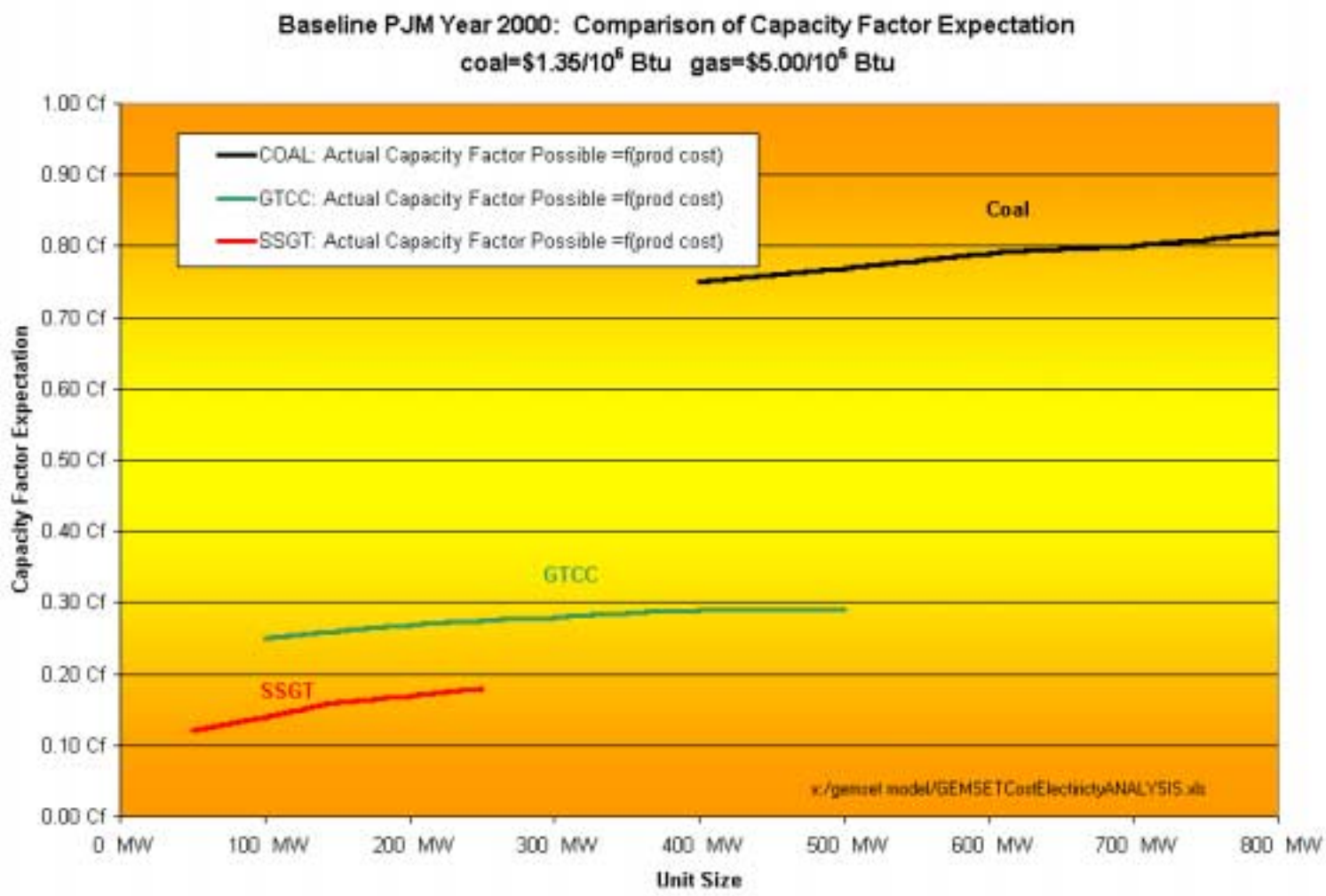
Capacity Factor: $ 3 / 10^6 Btu Natural Gas



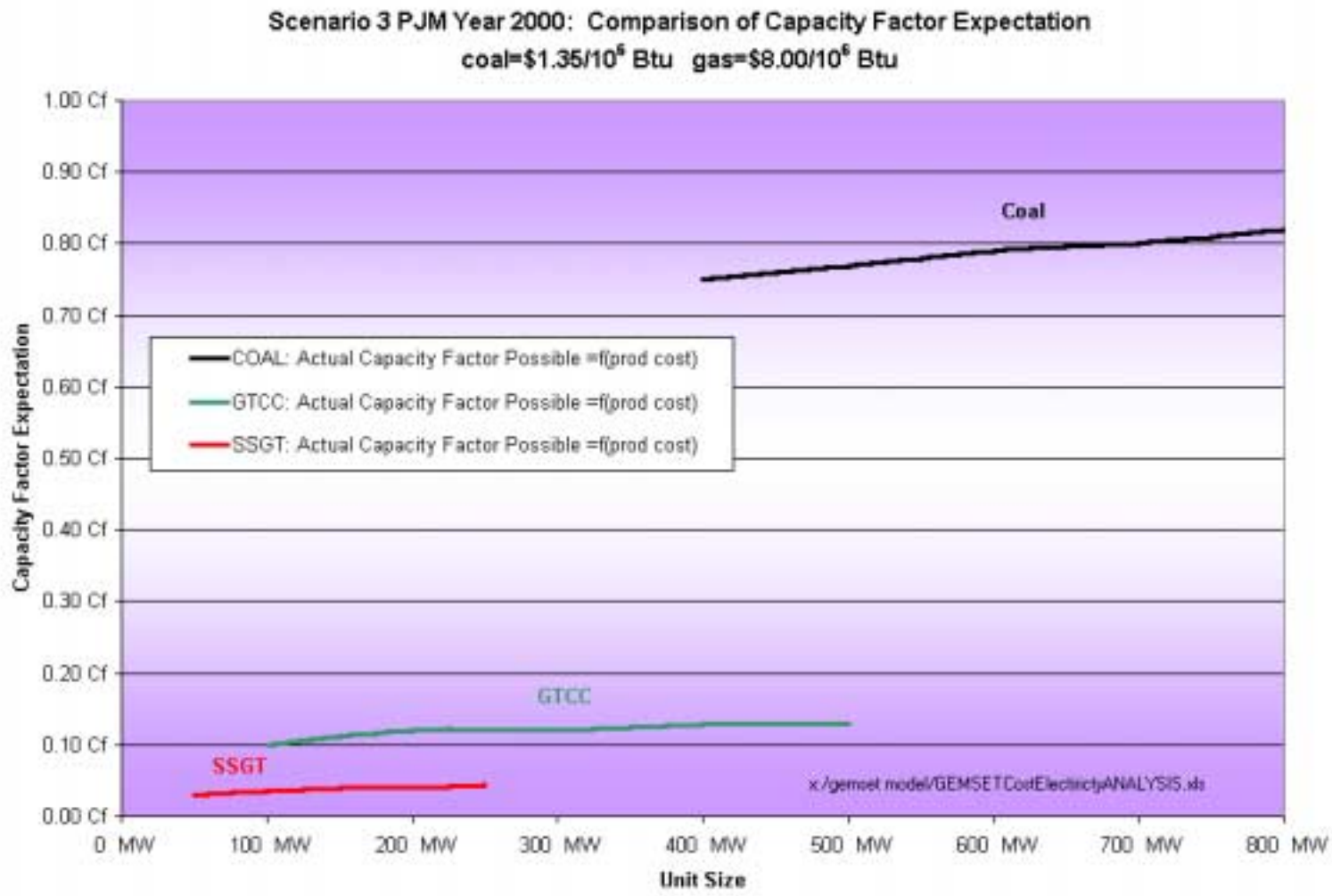
Capacity Factor: $ 4 / 10^6 Btu Natural Gas



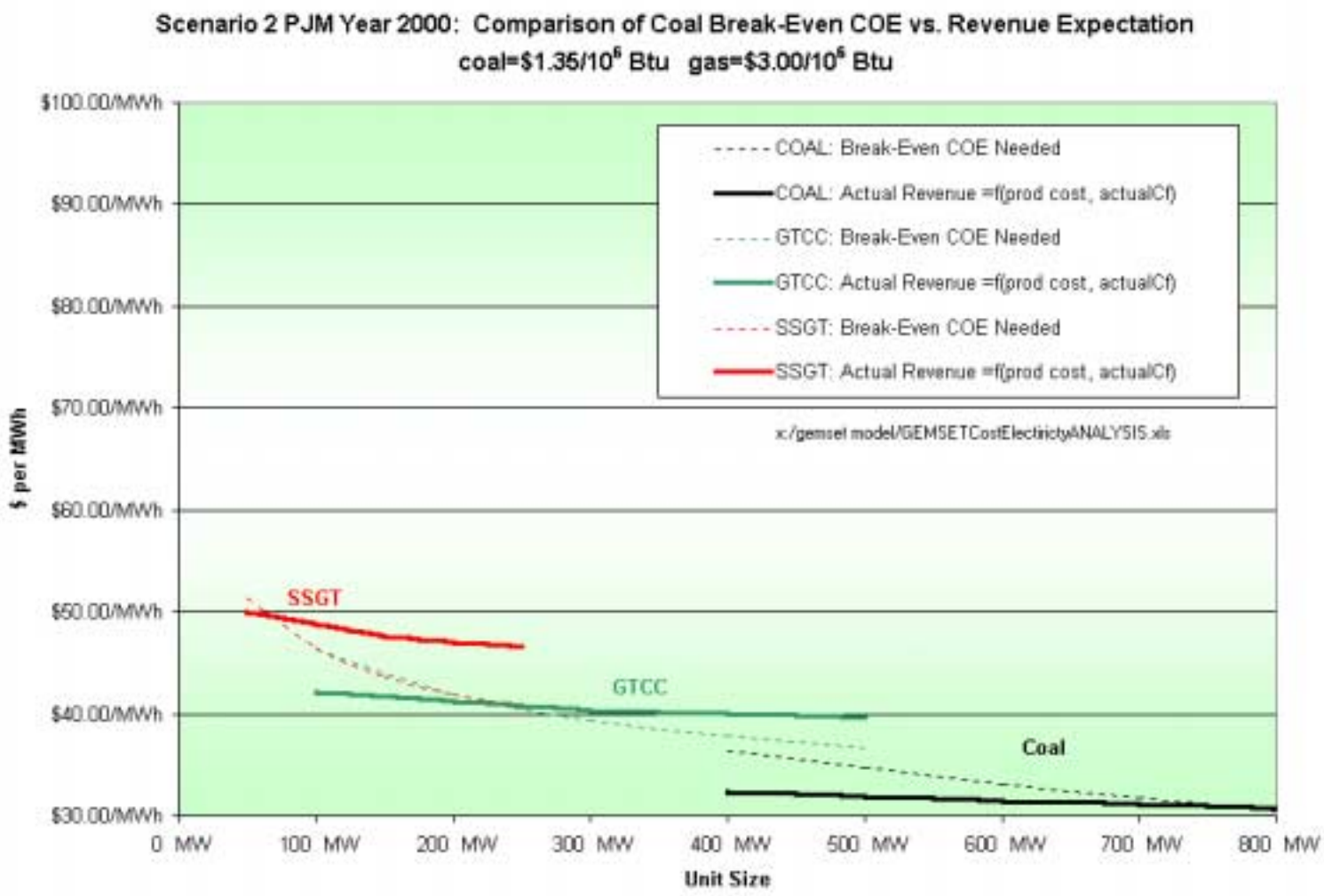
Capacity Factor: $ 5 / 10^6 Btu Natural Gas



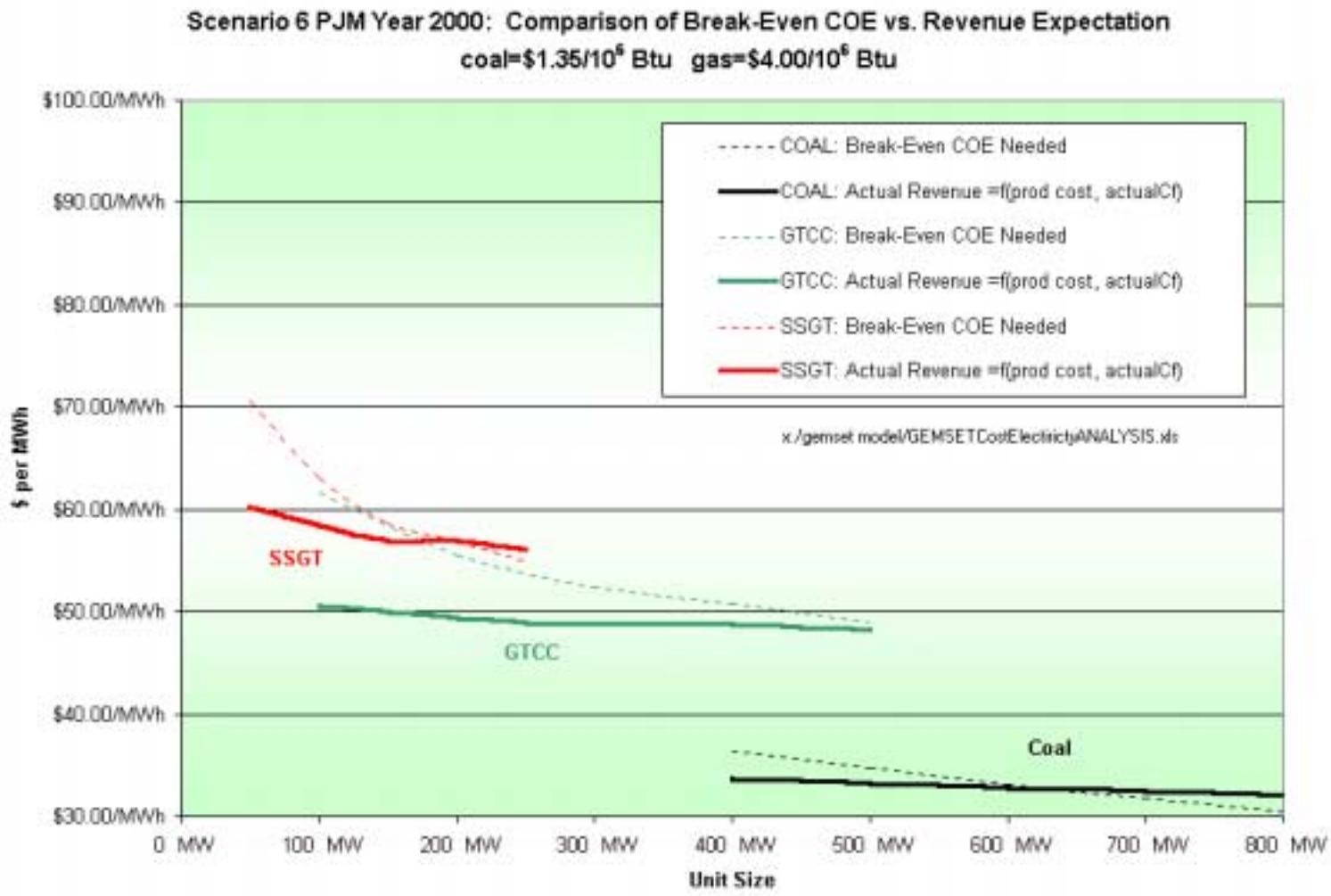
Capacity Factor: $ 8 / 10^6 Btu Natural Gas



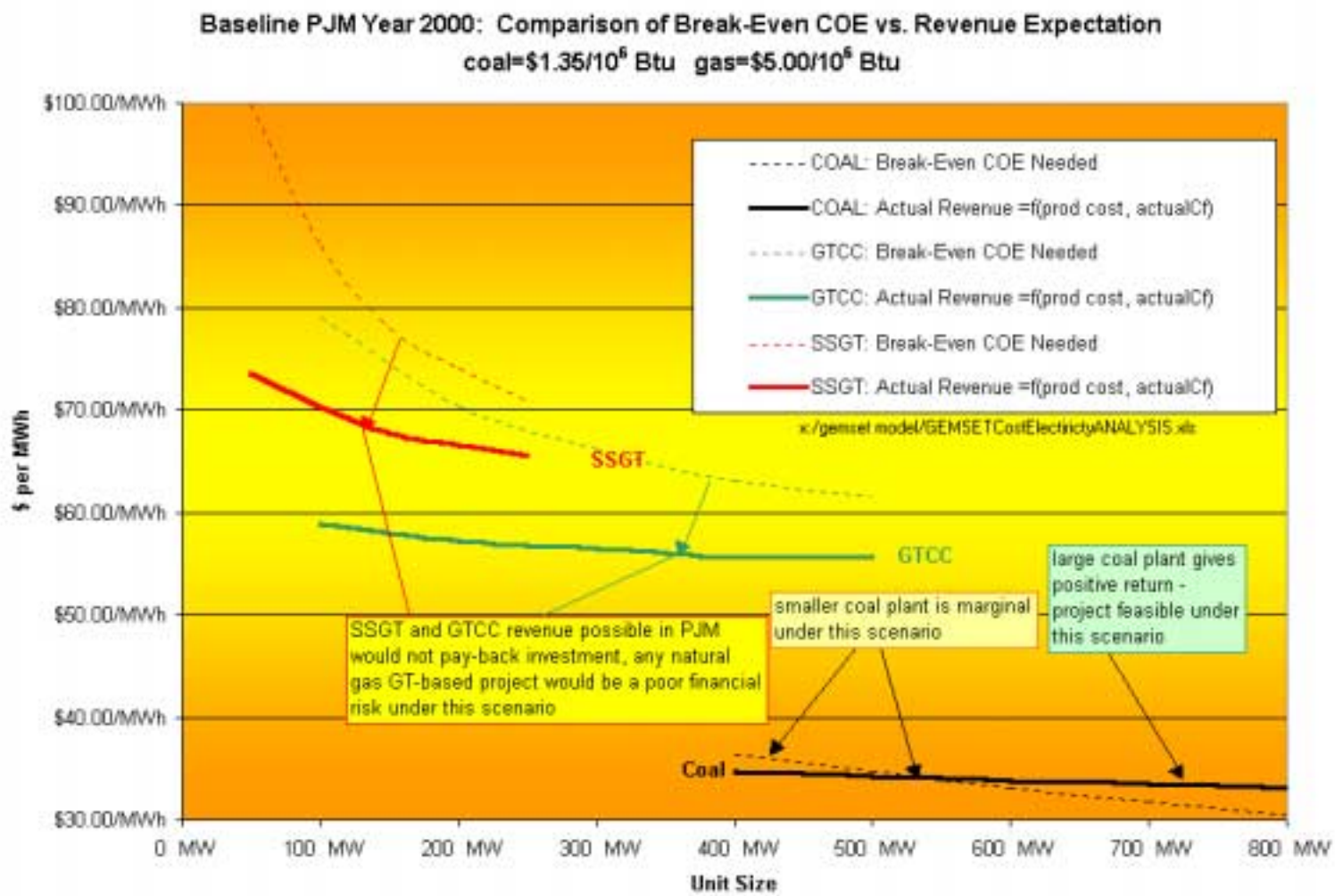
Economics: $ 3 / 10^6 Btu Natural Gas



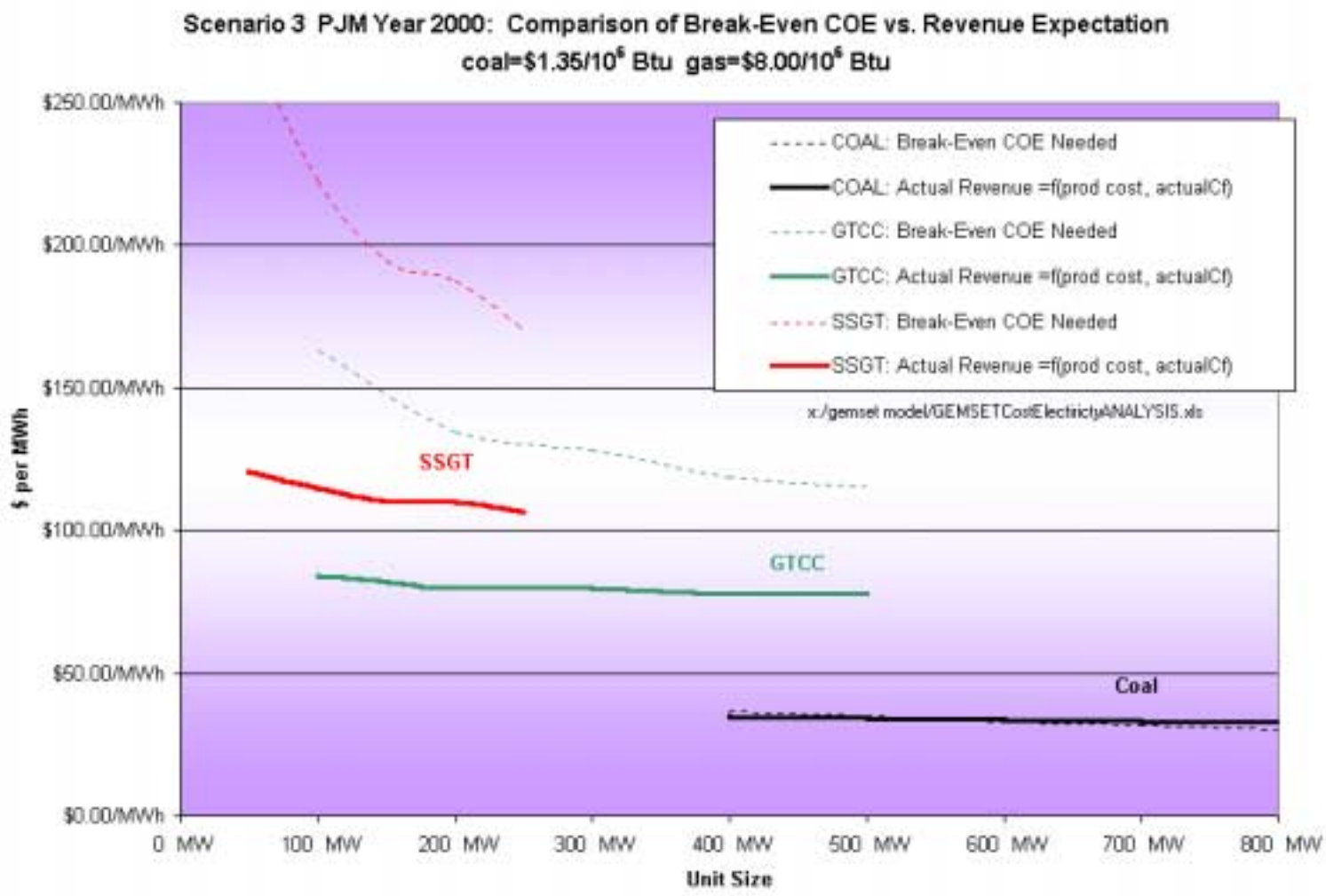
Economics: $ 4 / 10^6 Btu Natural Gas



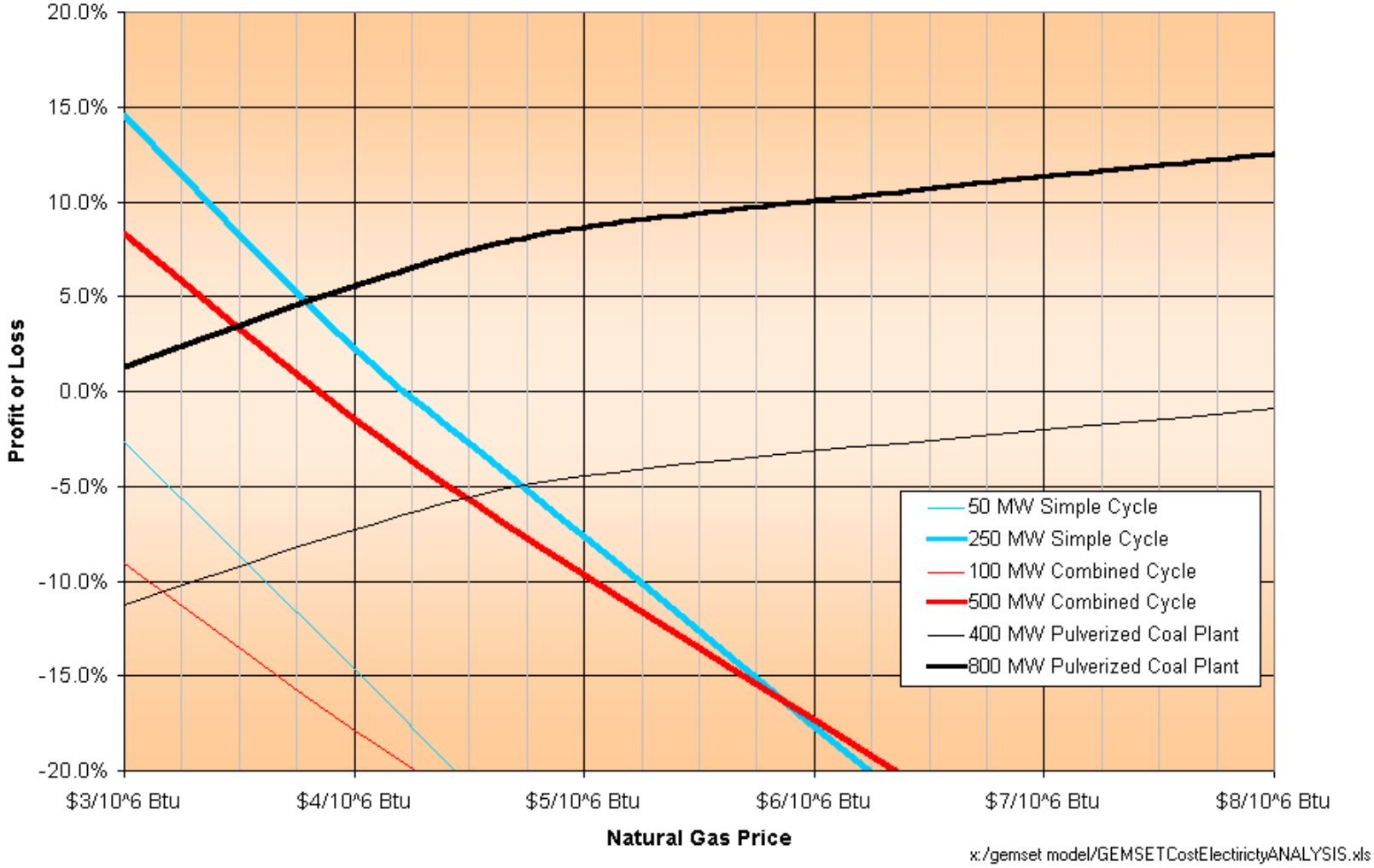
Economics: $ 5 / 10^6 Btu Natural Gas



Economics: $ 8 / 10^6 Btu Natural Gas



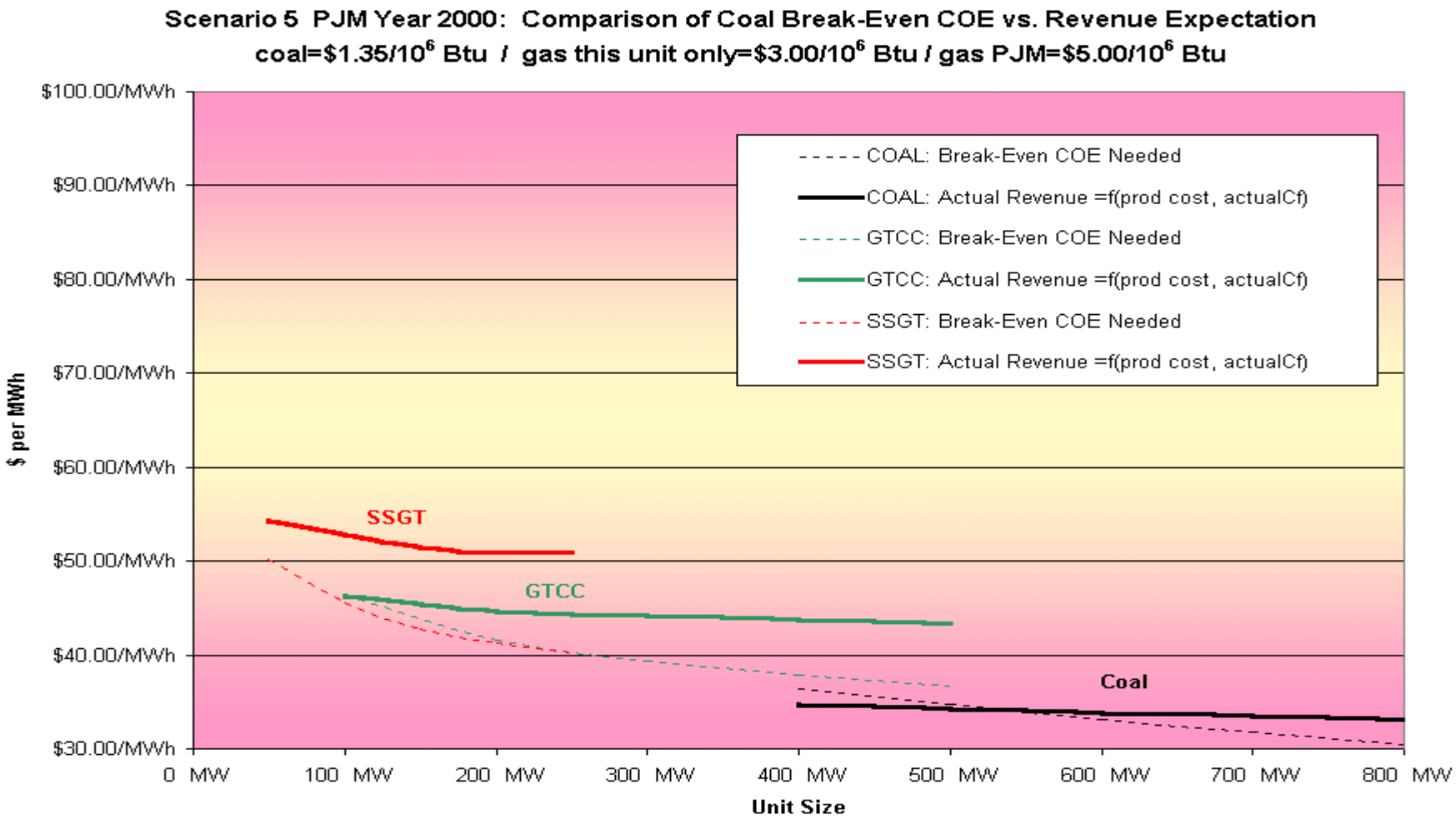
Profit Before Taxes



Estimate -- Year 2000 PJM

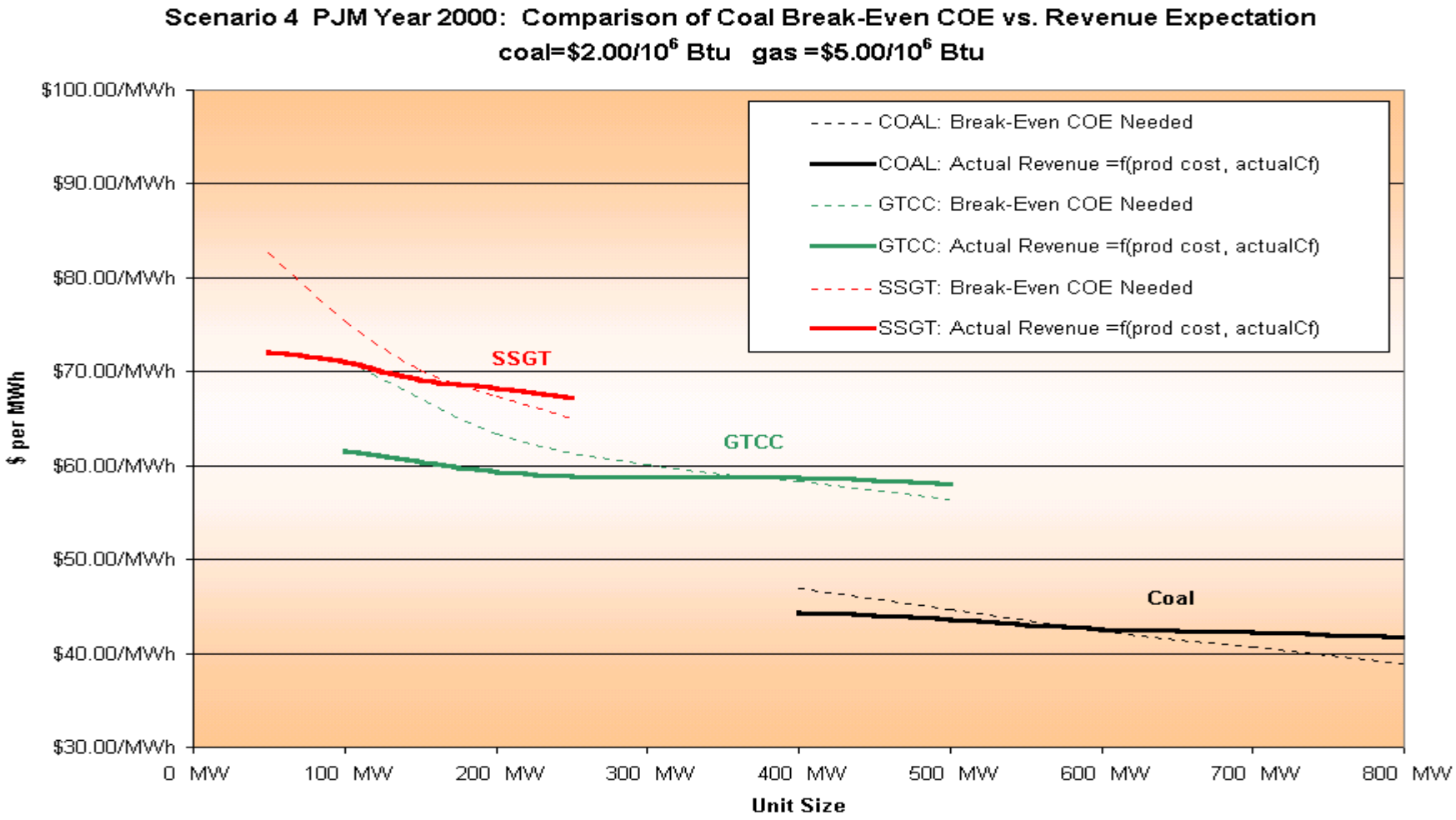
Local Unit Has Low Gas Price Advantage Compared to Other Gas Units

Economics: $ 3 / 10^6 Btu Natural Gas for Local Unit



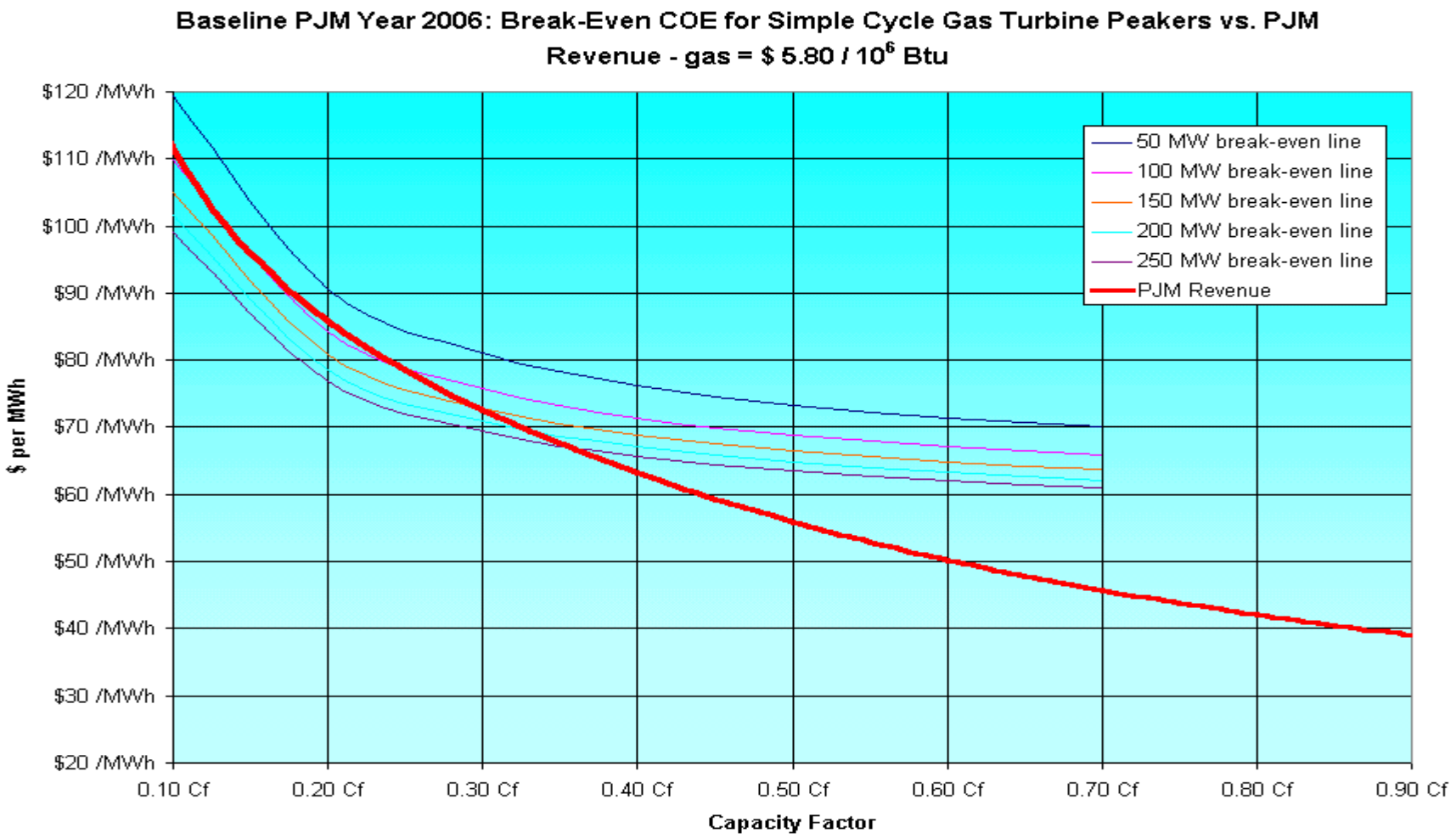
Estimate -- Year 2000 PJM
Coal Price Rises to $ 2.00 / 10^6 Btu

Economics: $ 2/10^6 Btu Coal, $ 5/10^6 Natural Gas

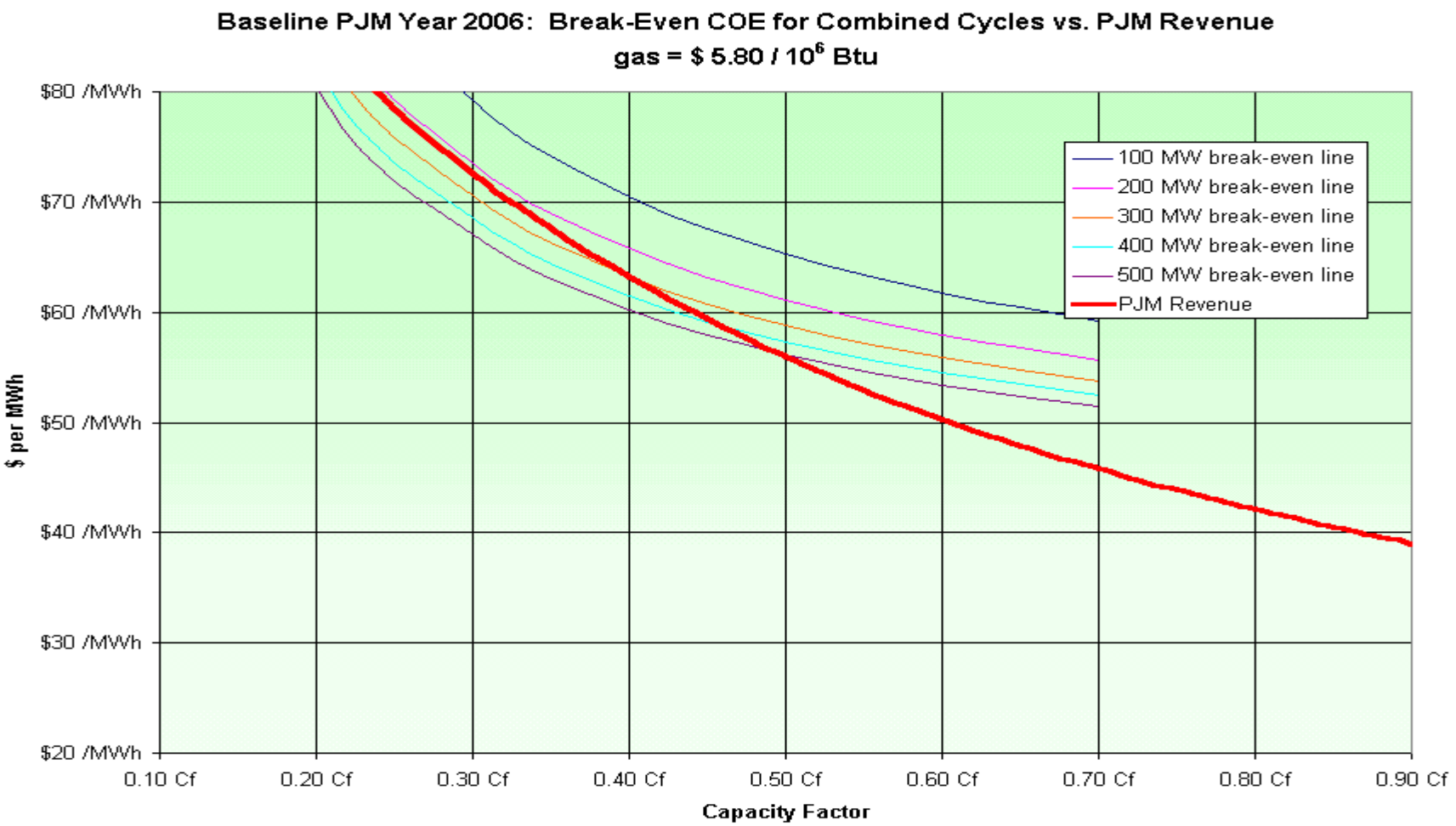


Estimate -- Year 2006 PJM

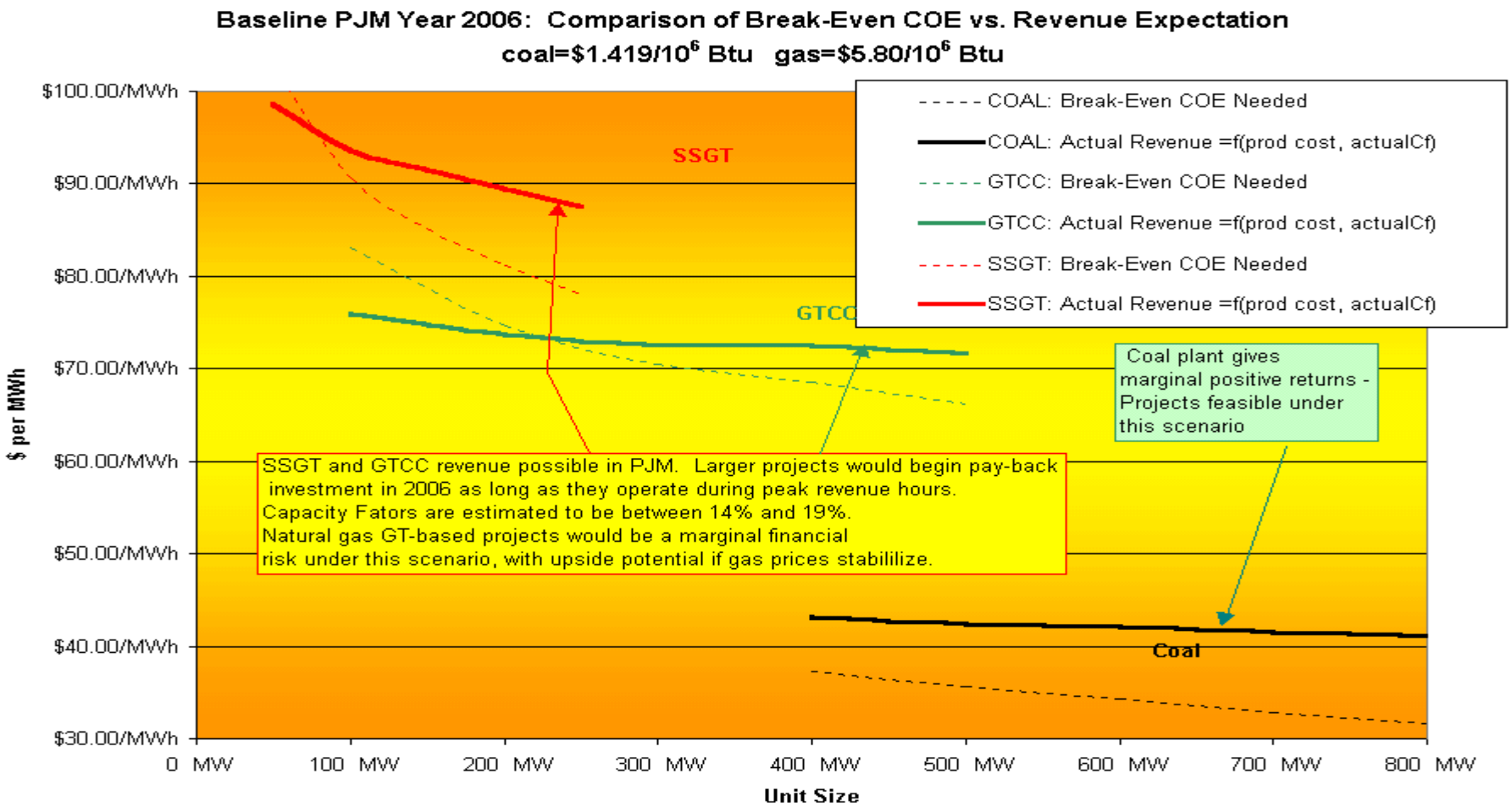
Economics: 2006 Simple Cycle COE



Economics: 2006 Combined Cycle COE



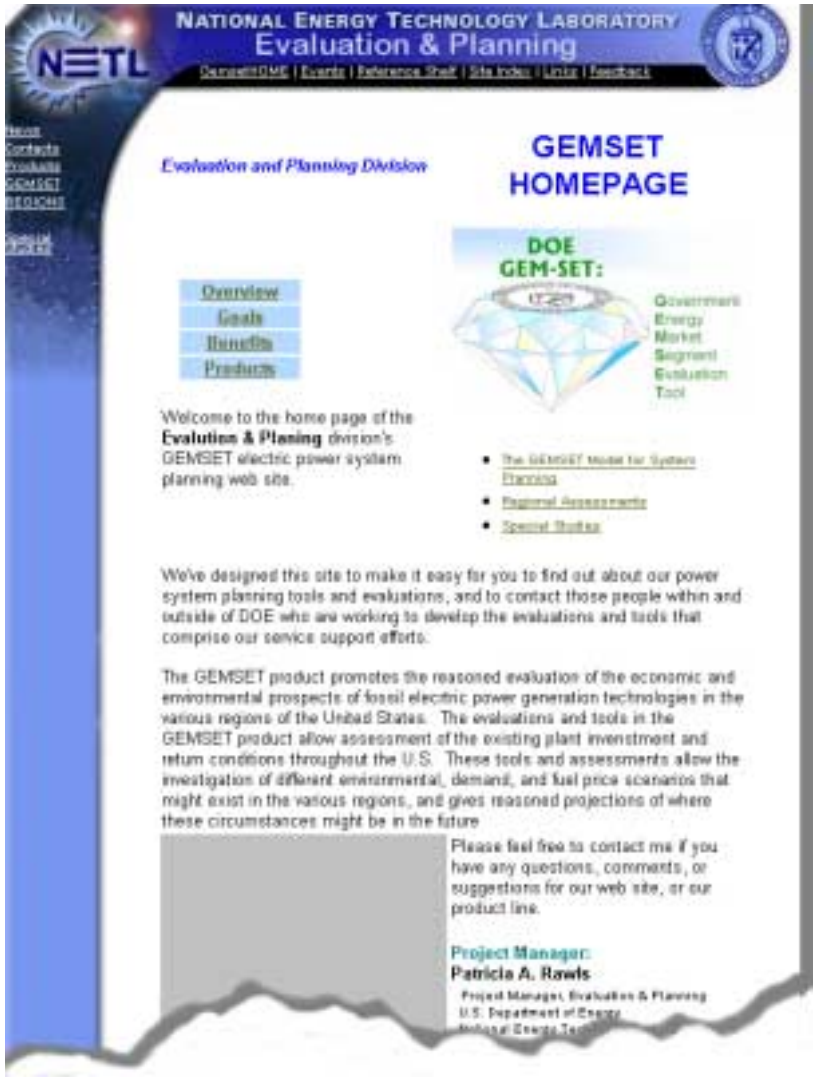
Economics: 2006 Baseline Estimates



Conclusions

- **At gas prices below $4.00/million Btu in PJM, new gas turbine and combined cycle electric projects are profitable**
- **Higher than expected fuel costs can result in financial failure for an existing plant or cancellation of planned new plants**
  - inadequate generation to meet demand growth
  - electric power shortages and skyrocketing electric price to consumers during peak demand periods

GEMSET Web Site



- **Prototype Internet web site under development**
- **This is preliminary, not all links complete, subject to significant change**
- **Prototype site available at:**

  (all lowercase)

  http://www2.epix.net/~parsons

- **Select "GEMSET"**
- **Final version will be on the DOE web when development is completed**