

Regional Power Market Briefing

**DOE
GEM-SET:**



Government
Energy
Market
Segment
Evaluation
Tool

Tools to Assess the U.S. Market *Workshop-3*

9:00 am - 11:00 am
Tuesday February 12, 2002
NETL Pittsburgh PA Campus

Patricia A. Rawls, NETL
Richard E. Weinstein, P.E., Parsons



Agenda

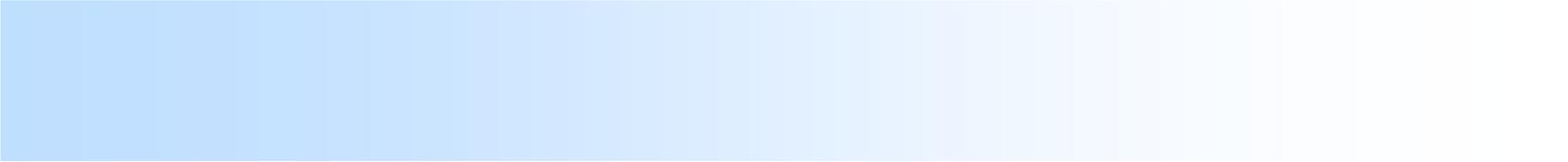
- Welcome
- Session 1: The GEMSET Model -- Overview, Status, and Plan
- Session 2: Highlights of the Characterizations
- Session 3: Fuel Characterizations, and Economic & Financial Modules
- Session 4: How GEMSET Forecasts the Future
- Session 5: GEMSET- The next 6 months
- Session 6: *Roundtable Discussion*
What Are the Important Problems GEMSET Can Help YOU Solve?
- Closing Remarks

GEMSET ASSESSMENT

This meeting is a status review of project results so far, and a roadmap of where we are heading.

We want your inputs to make sure GEMSET works well for you.

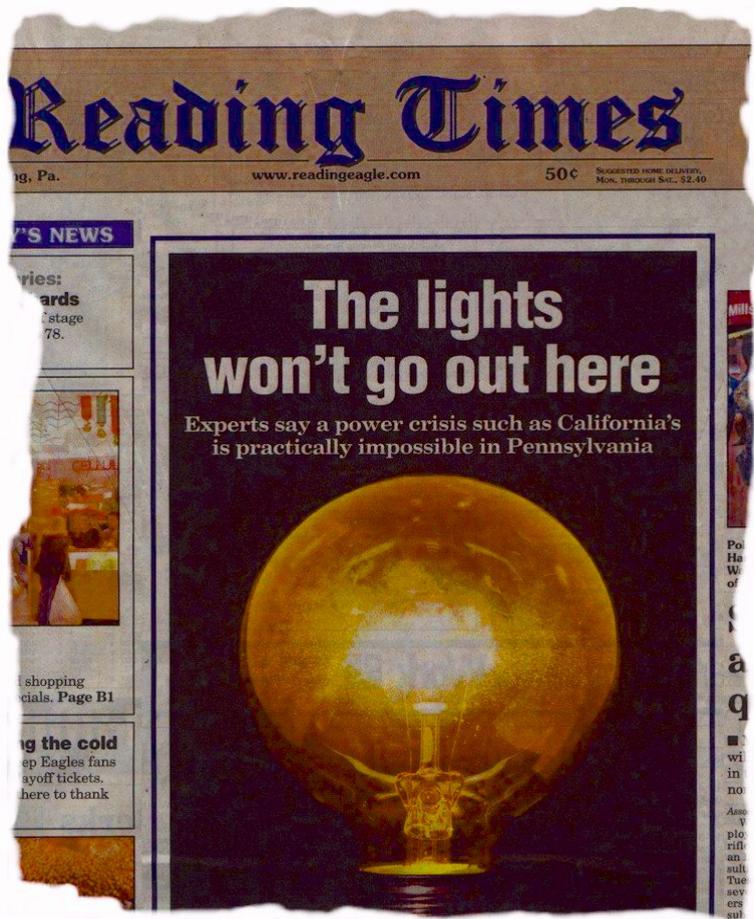




Session 1: The GEMSET Model -- Overview, Status and Plan



U.S. Electricity Supply Has National Attention



Reading Times, Wednesday December 27, 2000
(Pennsylvania newspaper article)

- The public is concerned about the problems of electric power prices (due to perceived shortages)
- There will be increased pressure for integrated energy planning
- DOE is even now in the spotlight for explaining what is happening
- DOE can choose to be in the spotlight for planning and providing solutions
- There is significant opportunity for DOE to help the nation map a balanced course for new generation if the focus is on the practical

DOE GEM-SET:



Government
Energy
Market
Segment
Evaluation
Tool

The GEMSET Model

- Evaluates how the performance, environmental characteristics, costs, flexibility, and introduction date of NETL technologies might fare when introduced in future power markets
- Uses NEMS to establish the overall national energy scenarios
- Uses Industry to establish needs and criterion
- Focuses in greater detail than NEMS on evaluations of market conditions expected to influence the market potential for NETL products and their competitors
- Assesses potential market size in different regions
- Uses FERC, NYMEX closings and futures, EIA, and other credible fuel historical values and forecasts for price projections
- Builds a future scenario of the competitive fleet make-up vs. time for the selected region
- Provides a technology neutral playing field to evaluate merit.



GEMSET Products

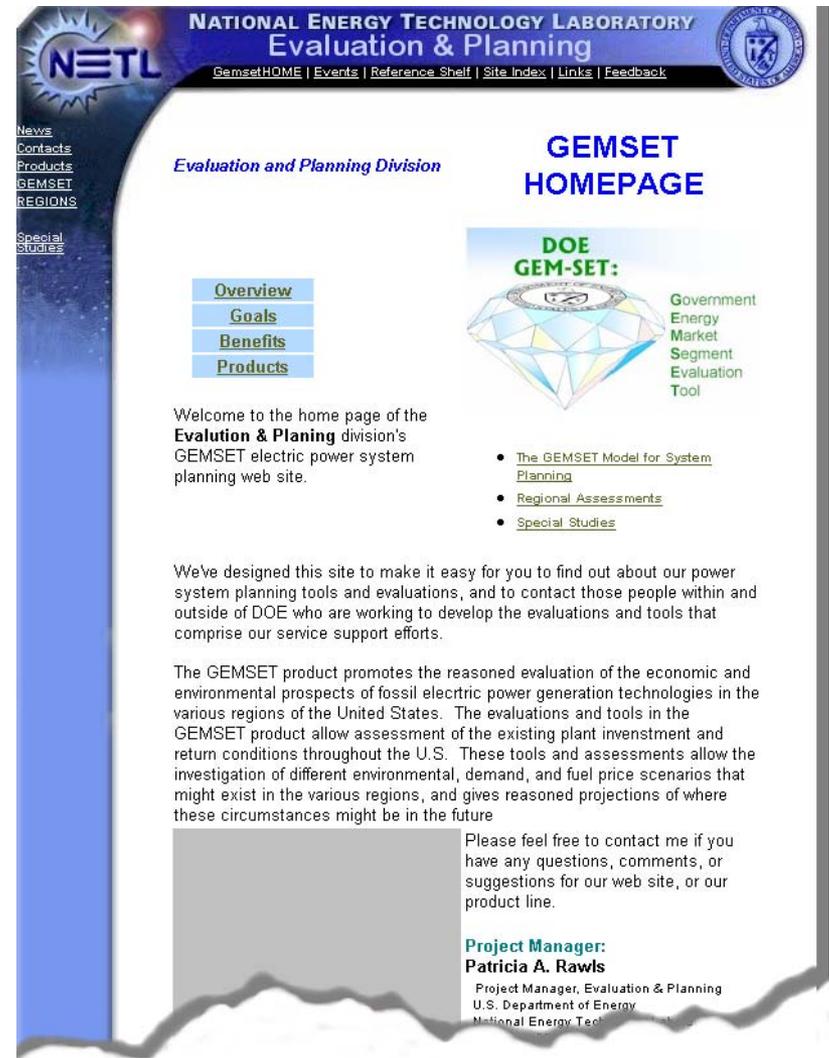


All Products are Available on the Internet

- We maintain a prototype Internet site to provide easy access to our products
- This allows easy update of the products by the contractor
- For access, type in *(all lowercase)*

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

- Select “**GEMSET**”
- Final version will be on the NETL web when development is completed



NETL
NATIONAL ENERGY TECHNOLOGY LABORATORY
Evaluation & Planning

GemsetHOME | Events | Reference Shelf | Site Index | Links | Feedback

News
Contacts
Products
GEMSET
REGIONS
Special Studies

Evaluation and Planning Division

GEMSET HOMEPAGE

DOE GEM-SET:
Government Energy Market Segment Evaluation Tool

Overview
Goals
Benefits
Products

Welcome to the home page of the Evaluation & Planning division's GEMSET electric power system planning web site.

- [The GEMSET Model for System Planning](#)
- [Regional Assessments](#)
- [Special Studies](#)

We've designed this site to make it easy for you to find out about our power system planning tools and evaluations, and to contact those people within and outside of DOE who are working to develop the evaluations and tools that comprise our service support efforts.

The GEMSET product promotes the reasoned evaluation of the economic and environmental prospects of fossil electric power generation technologies in the various regions of the United States. The evaluations and tools in the GEMSET product allow assessment of the existing plant investment and return conditions throughout the U.S. These tools and assessments allow the investigation of different environmental, demand, and fuel price scenarios that might exist in the various regions, and gives reasoned projections of where these circumstances might be in the future

Please feel free to contact me if you have any questions, comments, or suggestions for our web site, or our product line.

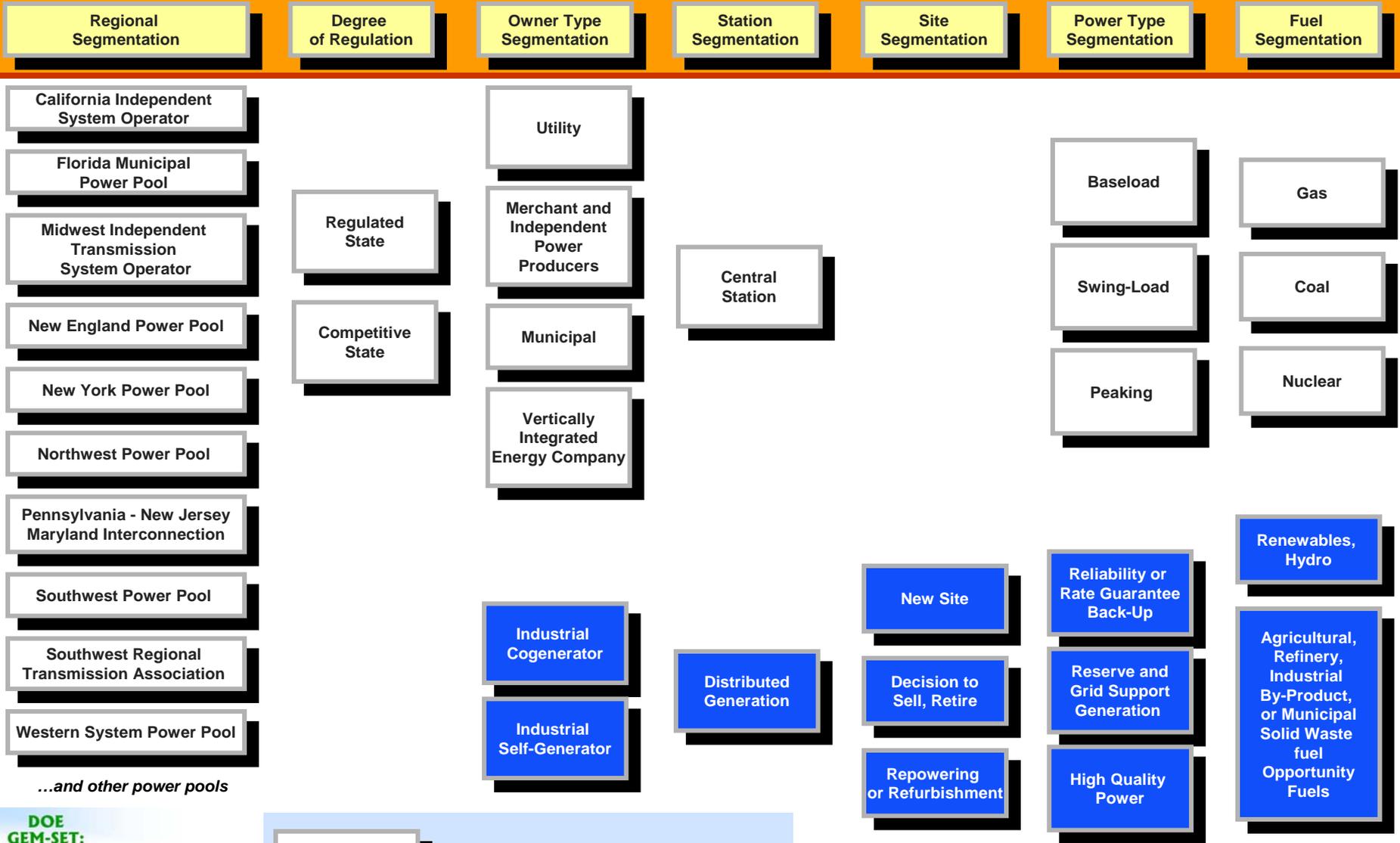
Project Manager:
Patricia A. Rawls
Project Manager, Evaluation & Planning
U.S. Department of Energy
National Energy Technology Laboratory



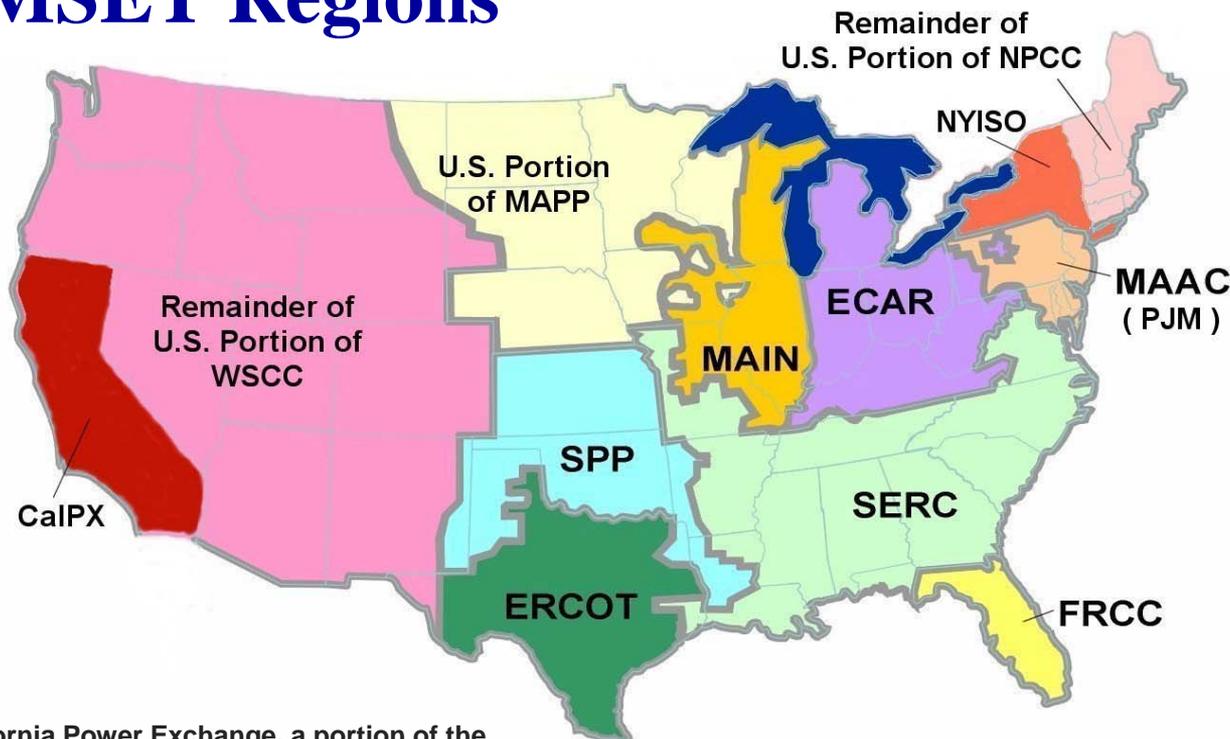
GEMSET Program Process

- How the market was viewed from the beginning
- The segmentation of the markets by FERC regions
- The “living documents” - Regional Characterizations
- Fleet Databases for each region
- Fuel projections by region
- Development of market prices of electricity

U.S. Electric Generation: Market-Setting Segmentation



The GEMSET Regions



- ✓ **CALPX** - The California Power Exchange, a portion of the NERC's Western Systems Coordinating Council (WSCC).
- **East Central** - East Central Area Reliability Coordination Agreement (ECAR).
- ✓ **Florida** - Florida Reliability Coordinating Council (FRCC).
- **Mid-America** - Mid-America Interconnected Network (MAIN).
- **Mid-Continent** - the U.S. portion of the Mid-Continent Area Power Pool (MAPP).
- **Northeast** - the U.S. portion of NERC's Northeast Power Coordinating Council (NPCC), excluding New York.
- ✓ **NYISO** - The New York ISO, a portion of NERC's Northeast Power Coordinating Council (NPCC).
- ✓ **PJM** - the Pennsylvania, New Jersey, Maryland Interconnect, which comprises the NERC's Mid Atlantic Area Council (MAAC).
- **Southeast** - Southeast Electric Reliability Council (SERC).
- **Southwest** - Southwest Power Pool (SPP).
- **Texas** - Electric Reliability Council of Texas (ERCOT).
- **Western** - the U.S. portion of the NERC's Western Systems Coordinating Council (WSCC), excluding California.

GEMSET Modeling Provides Planning Information

GOALS

DOE GEM-SET:



Government
Energy
Market
Segment
Evaluation
Tool

- Regional assessment of market conditions
- Assessment of fleet makeup vs. time
- Fuel Projections
- Develop market economics for a potential new technology
- Market potential assessment for that technology
- Provide ability to assess “what-if” scenarios



Market Potential Criterion

- **Production costs and risks**
- **Capital requirement and risks**
- **Unit operational flexibility, fuel flexibility, start-stop capability**
- **Environmental characteristics over load range, potential of economic success under regulatory scenarios of different stringency**
- **Perception of technical readiness**
- **Subjective industry perceptions and preferences**

Portfolio of Analysis Tools

- **Technology vs. time portfolio**
- **Regional characterization module**
 - Historical and projection
 - Demand
 - Electricity sale price profile expectation
 - Fleet make-up vs. time
- **Fuels characterization module**
- **Market analysis module**
 - For pre-set scenarios: GEMSET Desktop Model
- **Financial analysis module**

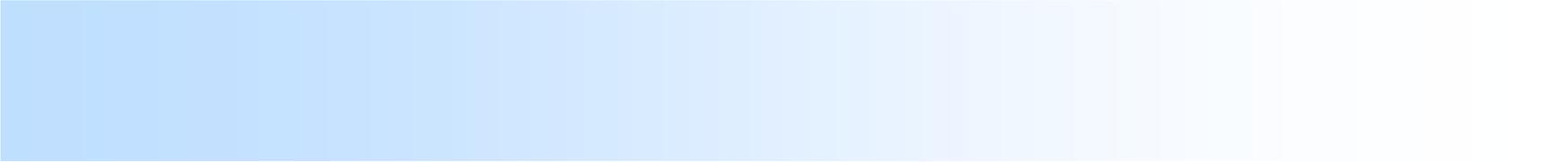
Value of the Model

- **Accurate regional real-world economics and preference criterion**
- **Repository for competitive technology data vs. time**
- **Technology and industry information gathered and updated regularly**
- **Technology-neutral assessment tool, it models the market a product must meet, and its success depending on how well it meets industry's needs**
- **“What-if” flexible**

Status

- **Five Regional Characterization Assessments Prepared**
 - ERCOT - Texas
 - 📄 CalPX - California
 - 📄 FRCC - Florida
 - 📄 NYISO – New York
 - 📄 PJM – Pennsylvania, New Jersey, Maryland
- **Fuels Characterization Completed, All Regions**
- **Financial Model Completed**
- **GEMSET Desktop Model Prototype Release 1.0 Ready**

these are “living documents,” and must be periodically revised



Session 2: Regional Characterization Highlights

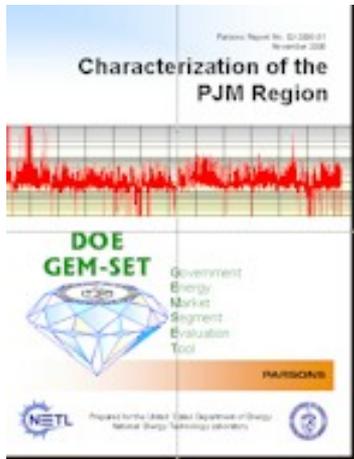


DISCUSSION ITEMS



- Highlights of what we have learned from the regional Characterizations
- Given the events of the past year (California & Enron), has the market changed?
- Demand & Fuel Projections

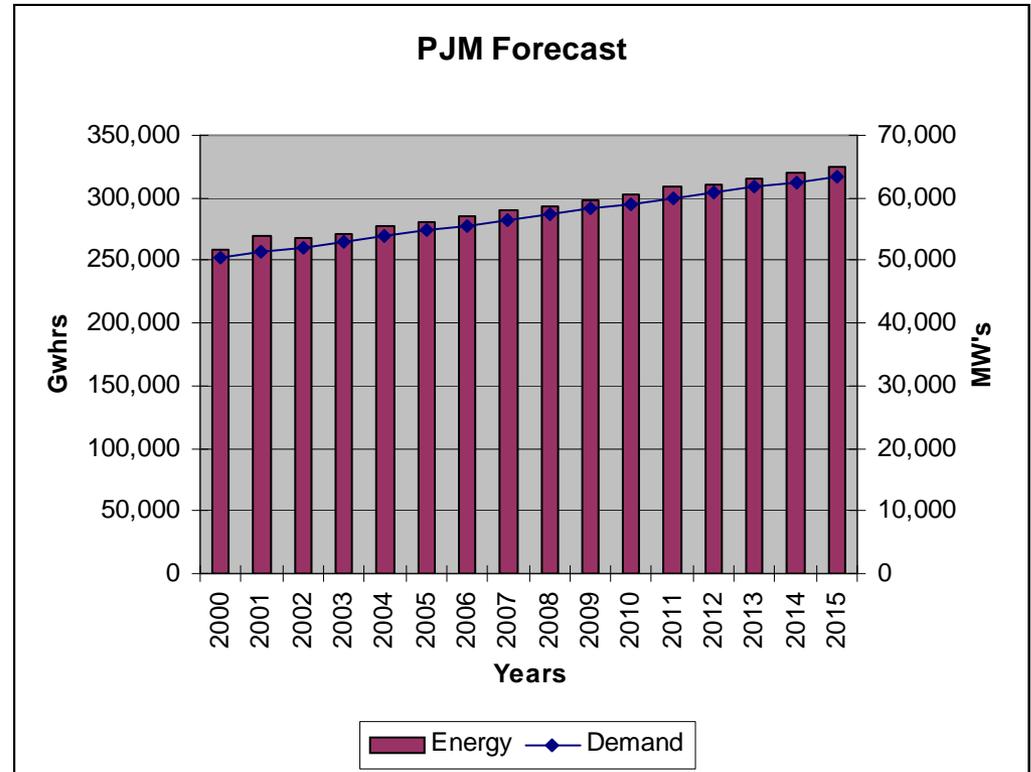
PJM Highlights



- **Competitive Market appears to be working in this region**
- **Demand/Energy forecast is less than 2% through 2015**
- **Approx. 20-25% of energy sold on hour-by-hour, the remaining through bi-laterals**
- **New plants being added to Fleet through an orderly process (a Queue)**
- **Customer savings are minimal from established tariffs (Set by PUC's)**

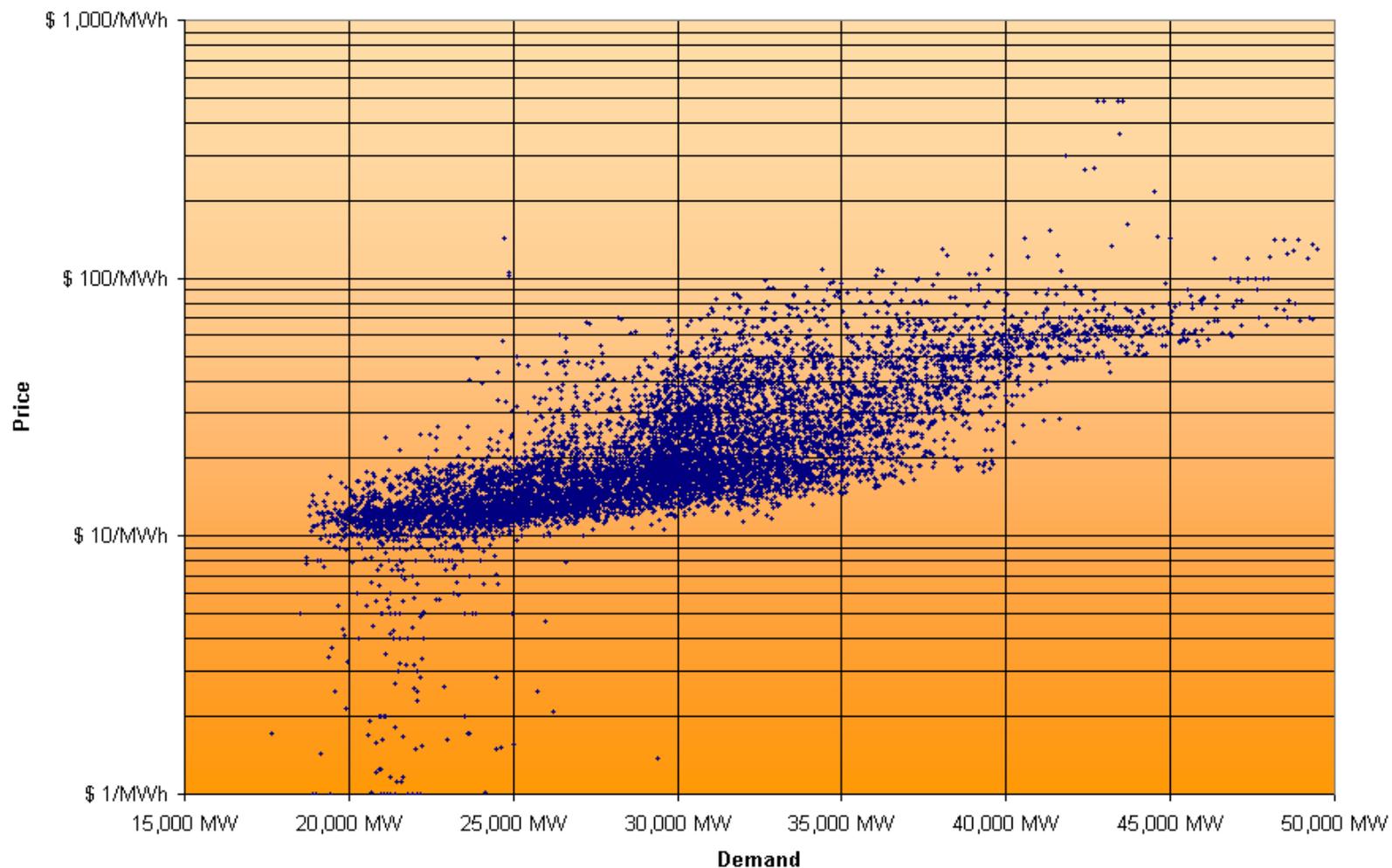
PJM FORECAST

- 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



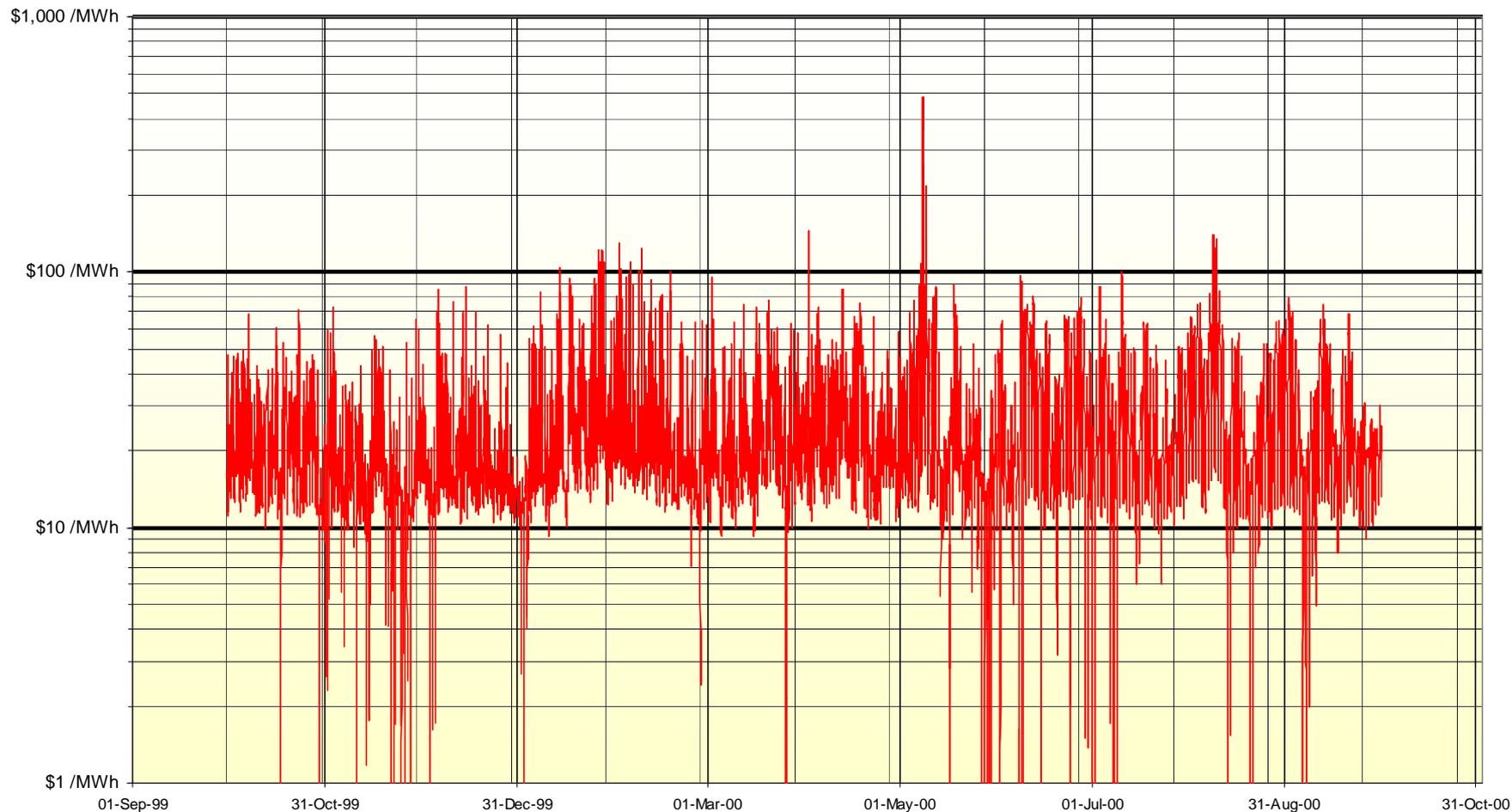
PJM Price vs. Demand Correlation

PJM Price vs. Demand for October 1999 - September 2000

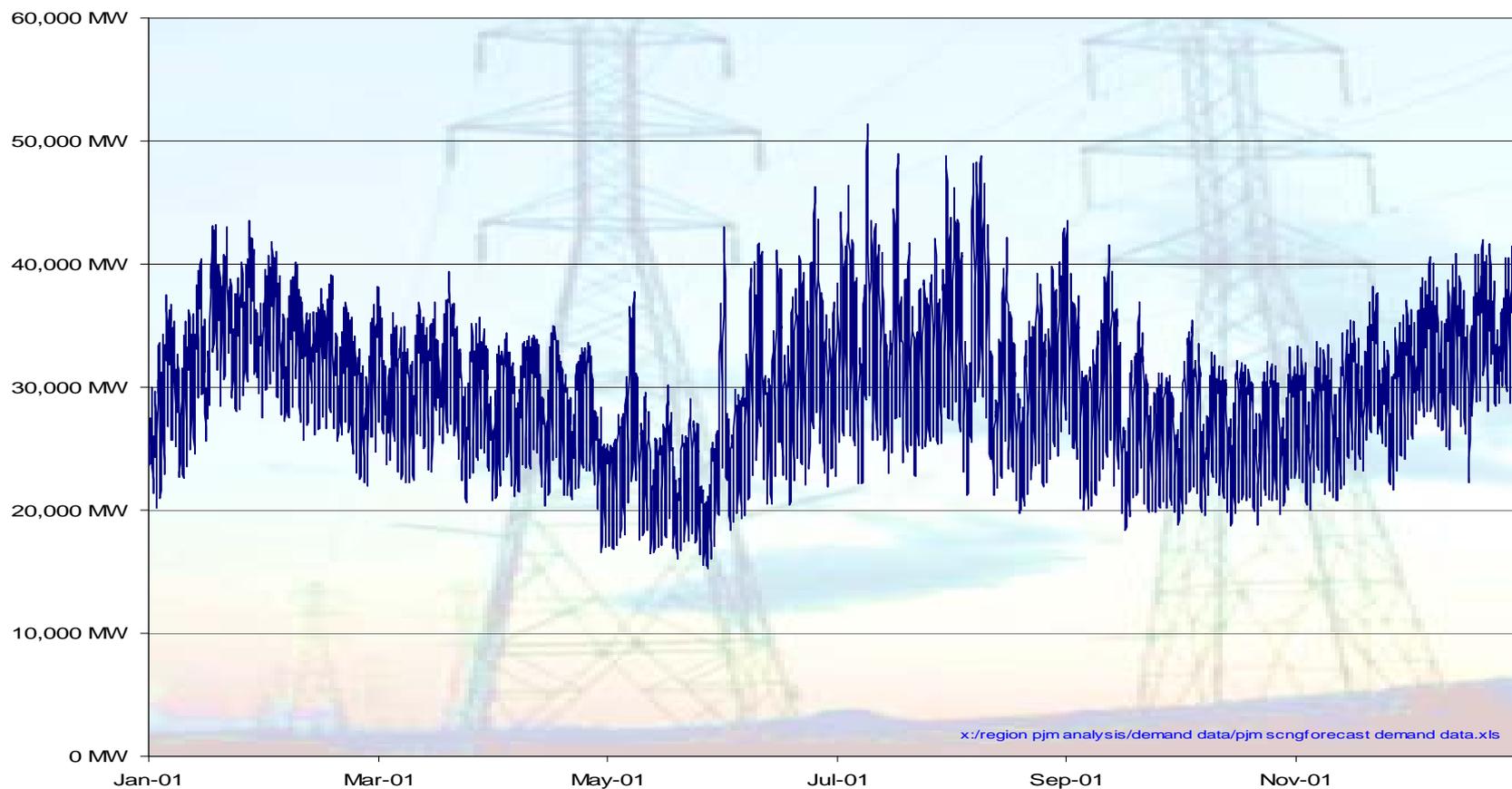


PJM Day-Ahead Price

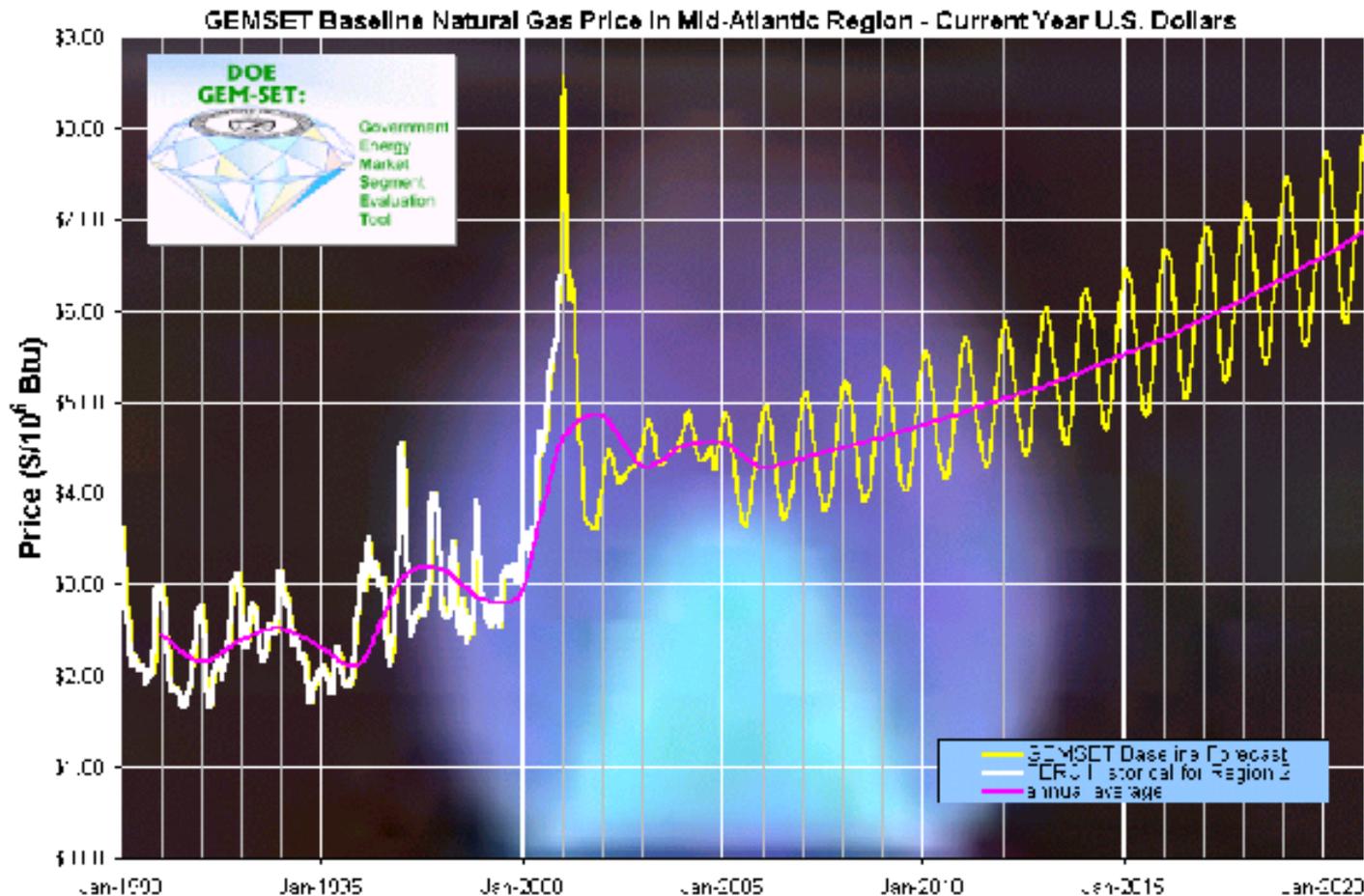
PJM Locational Marginal Price: PJM ZONE October 1999-September 2000



PJM Hourly Demands - 2001



Natural Gas Price Forecast - PJM

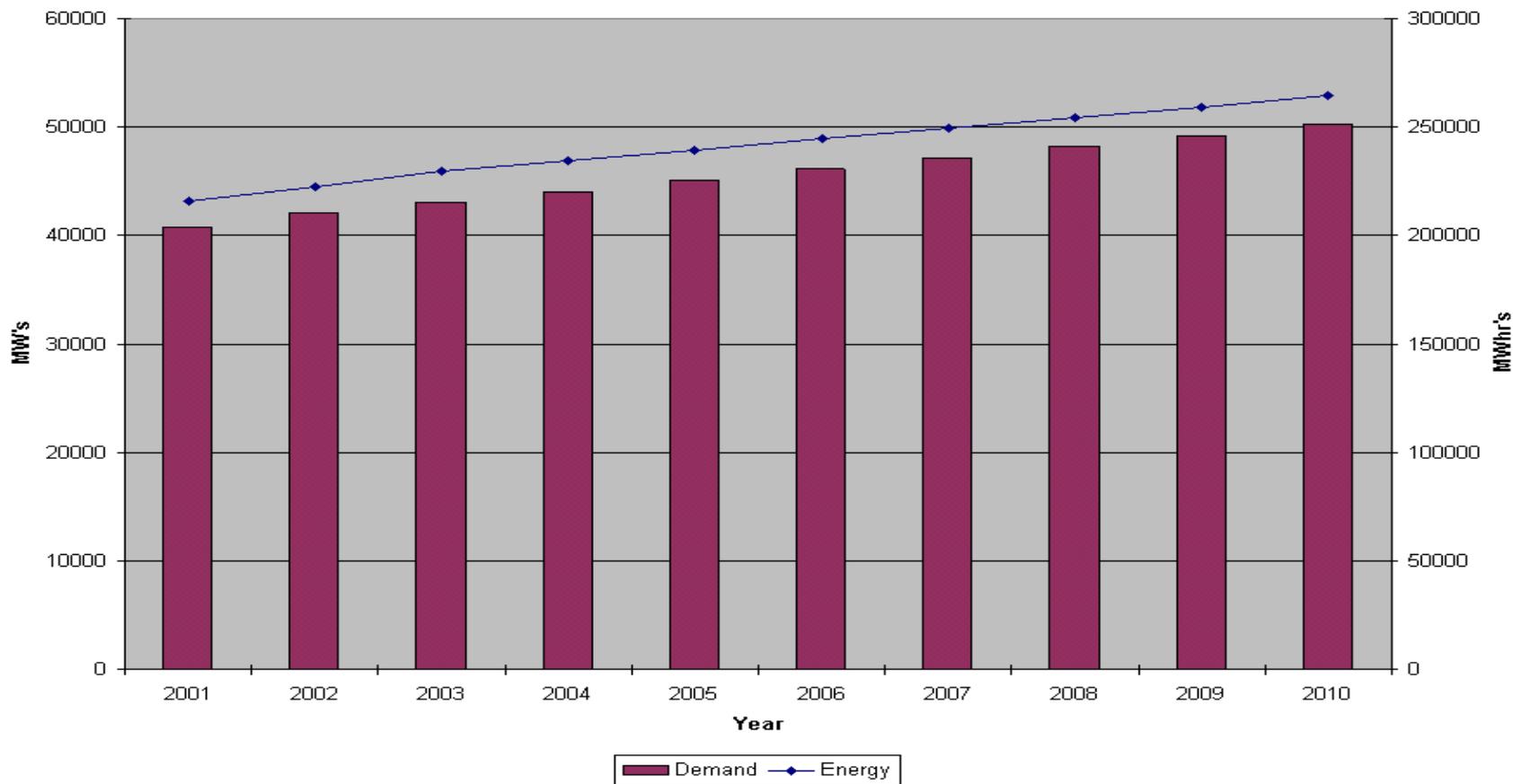




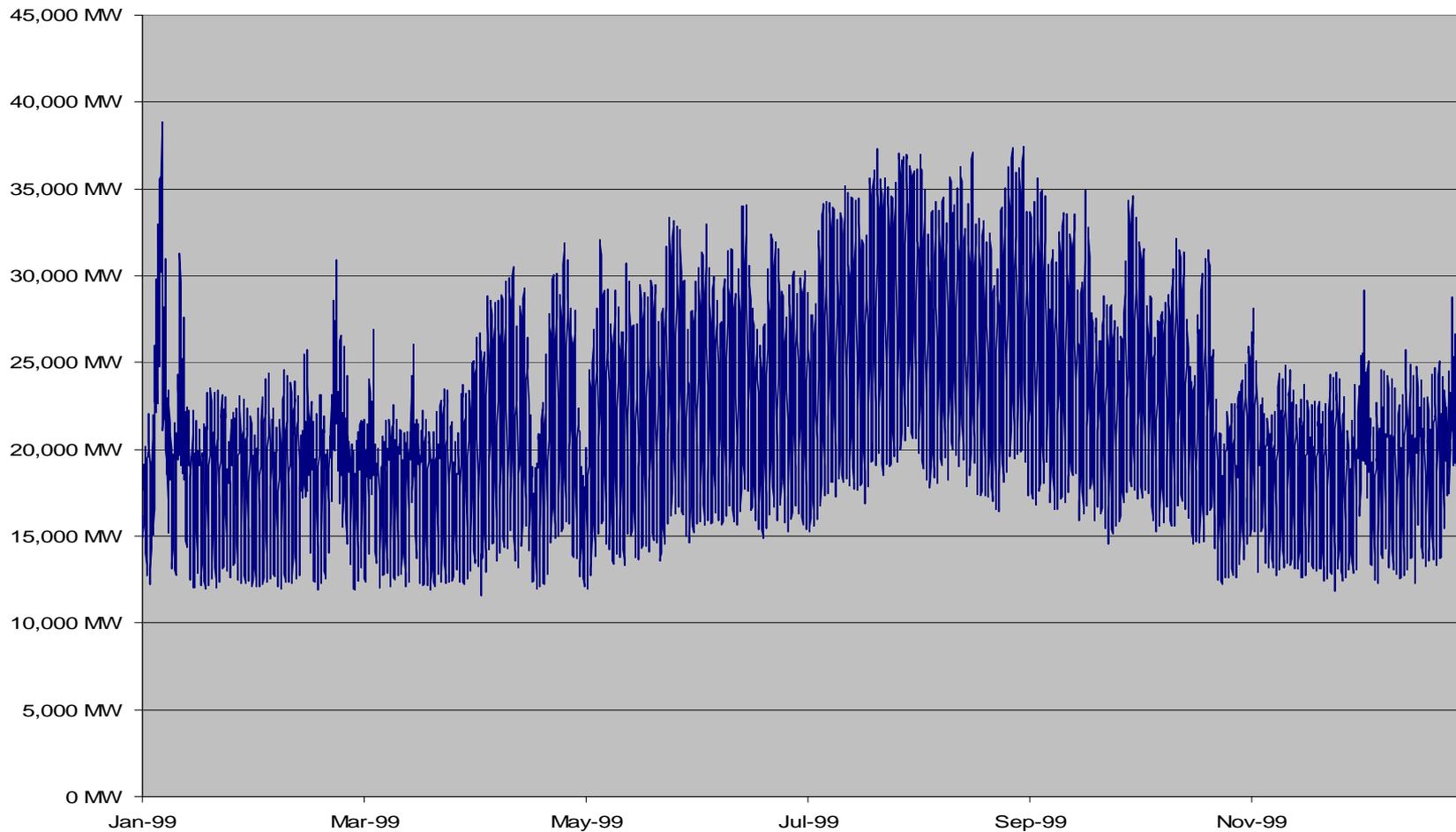
FRCC Highlights

- Will remain regulated market for foreseeable future
- Prices set by Florida Public Service Commission
- Load Growth expected to be approximately 2.3% through 2010
- Over 11,000 MW to be added (95% natural gas)

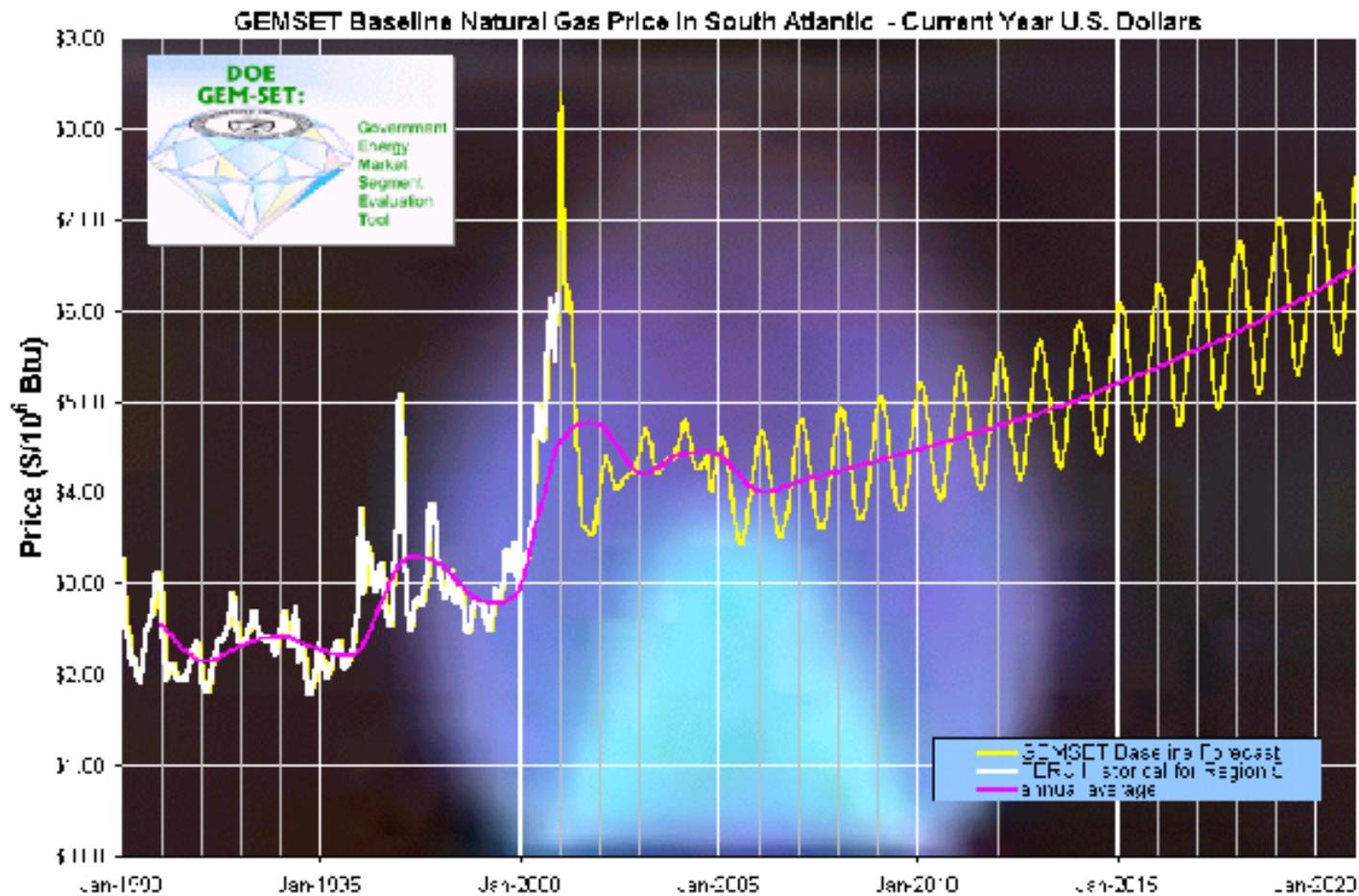
FRCC Demand & Energy Forecast

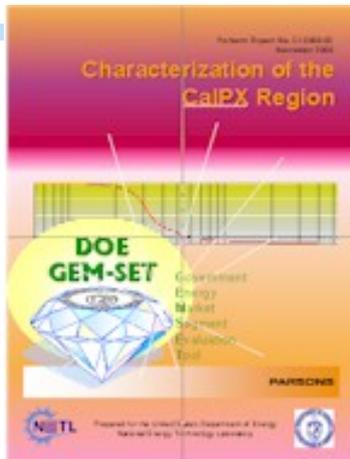


FRCC Hourly Demands - 1999



FRCC Natural Gas Forecast





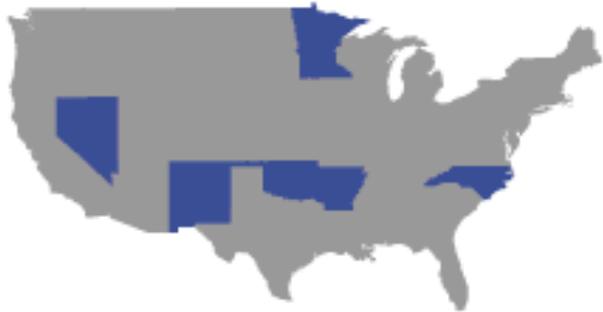
CalPX Highlights

- **Utter Chaos resulted from improper planning!!!**
- **Everyone searching for someone to blame**
- **Band-Aid solutions**
- **Continuation of problem for foreseeable future**
- **State now runs electric grid and provides the power**
- **No California Power exchange anymore**
- **Seems to have adequate power for the future, but could change rapidly**
- **Demand is down significantly, so latest forecast is suspect**

California's Woes Affect Deregulation in Other States

SHORTING OUT

A sample of states delaying implementation of electricity deregulation:



Nevada: Once proposed to start in September, deregulation could be four years off.



New Mexico: Sponsor of 1999 deregulation law wants to delay January 2002 start date by five years.



Arkansas: Legislation backed by state leaders was introduced Monday to delay opening of residential markets, scheduled for January 2002, until at least October 2003.



North Carolina: A deregulation proposal advanced by a special commission last spring isn't expected to be passed by 2001 legislature.

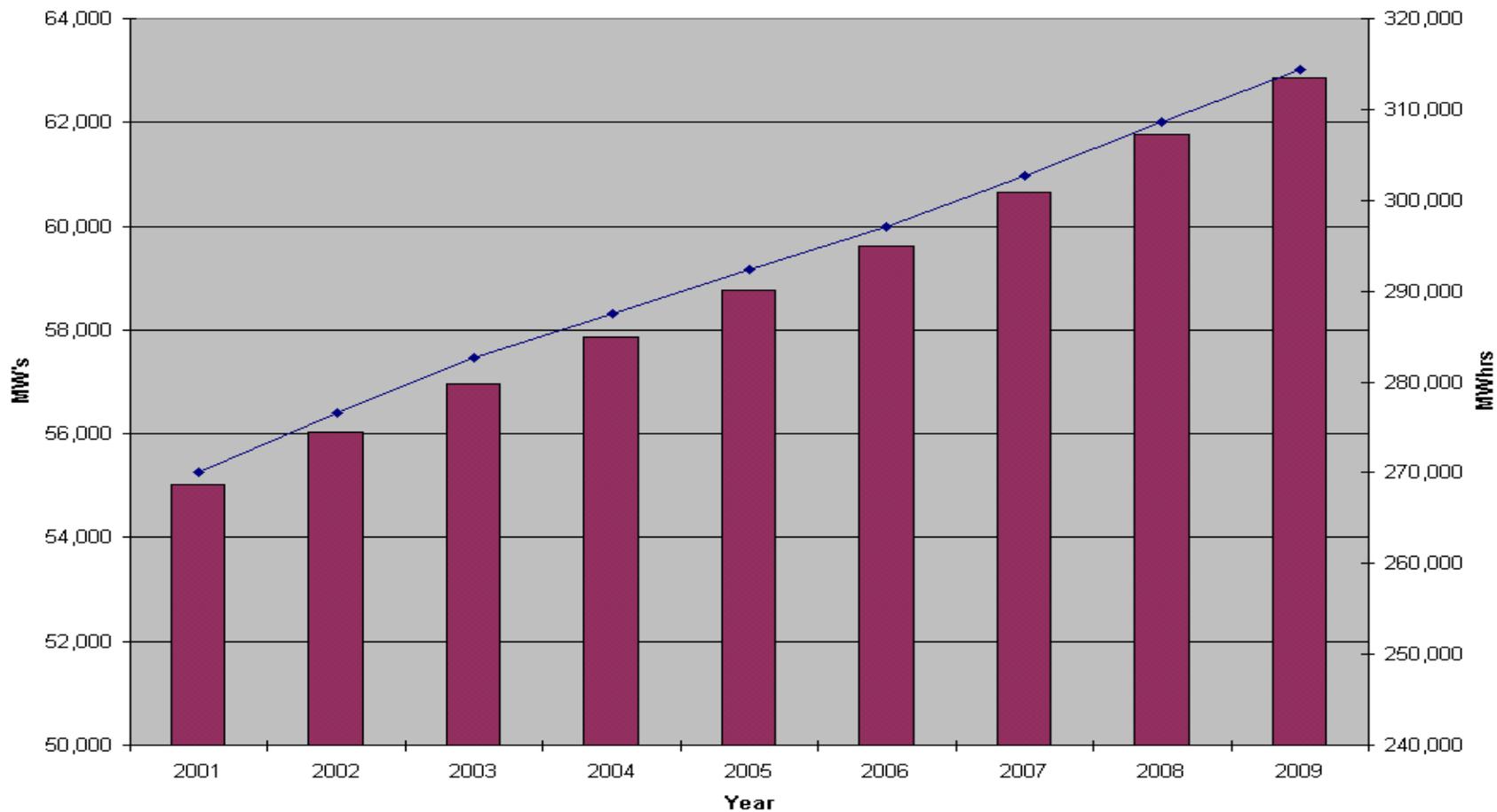


Minnesota: Gov. Jesse Ventura wants to keep existing regulations for now, and identify new sources of power.



Oklahoma: Attorney General Drew Edmondson asked lawmakers to repeal July 2002 start date and study the experience of other states.

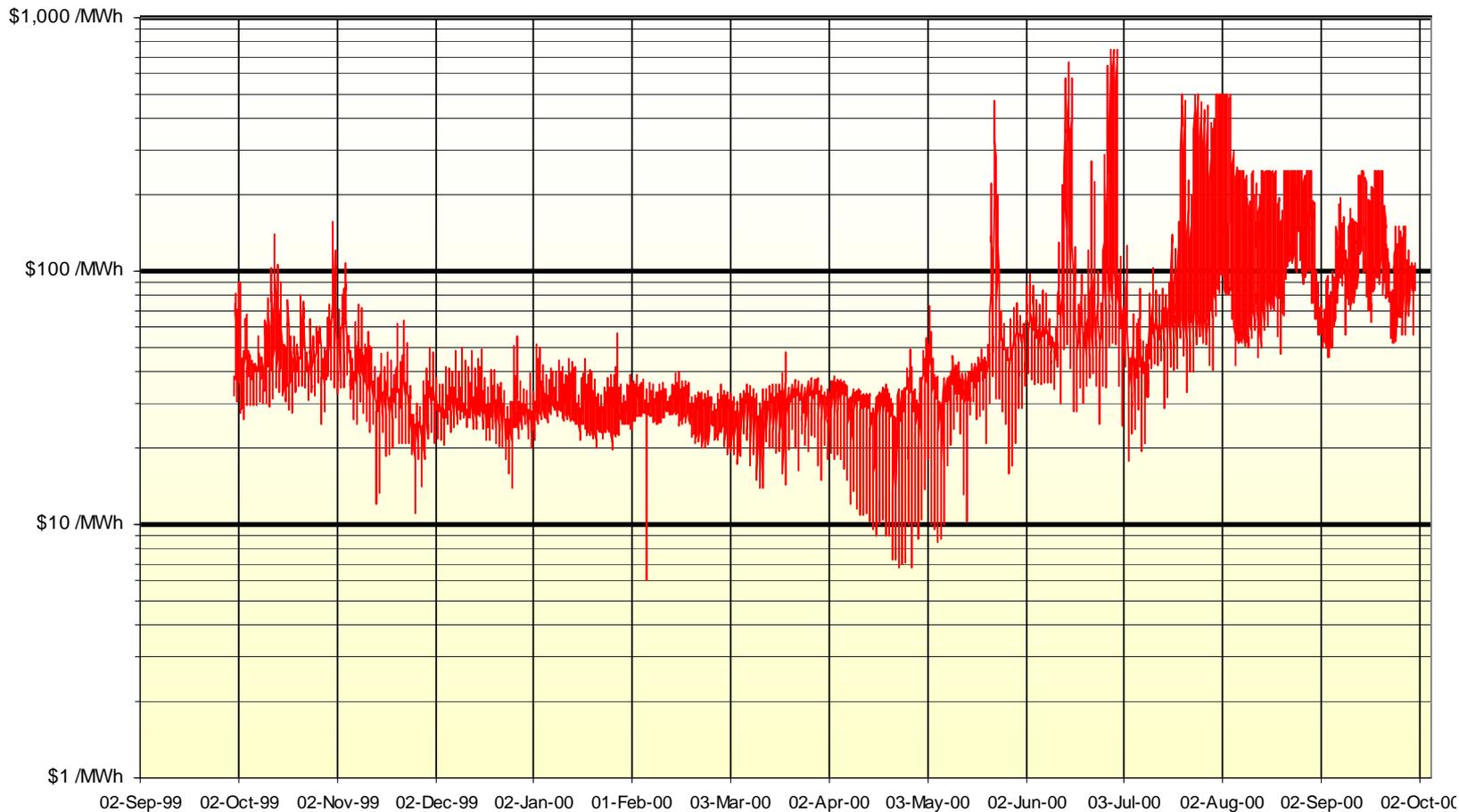
California Forecast -2009



CalPX Day-Ahead Price

(No Longer Applicable!)

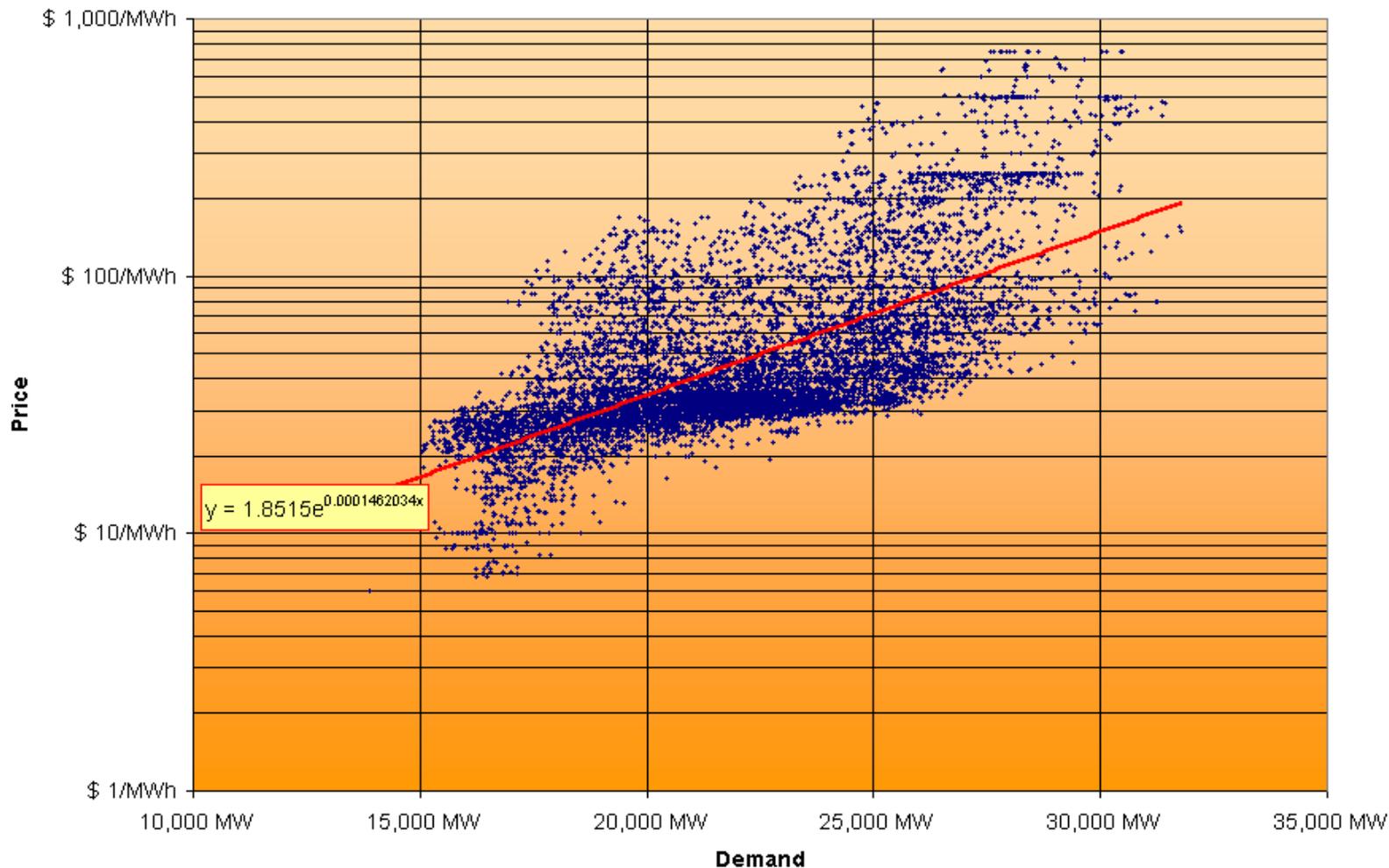
CalPX Day-Ahead Prices October 1999-September 2000



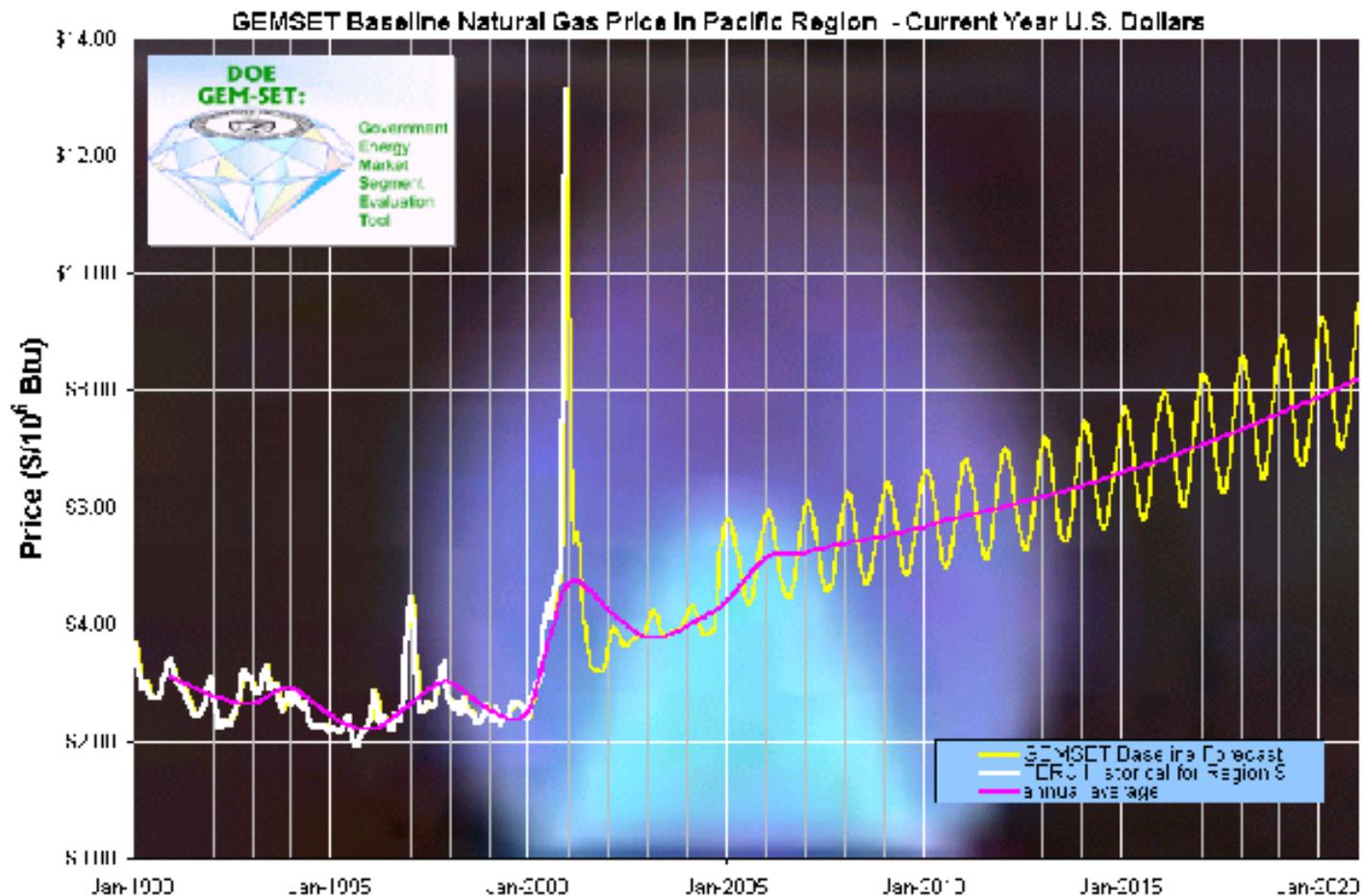
CalPX Price vs. Demand Correlation

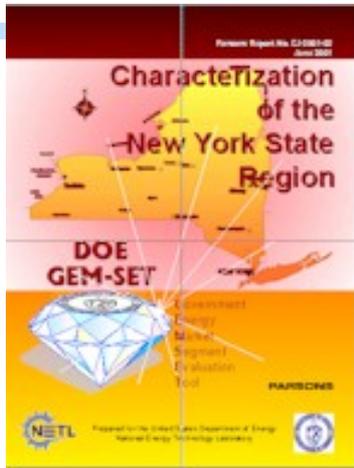
(No Longer Applicable)

Price vs. Demand CalPX October 1999-September 2000



California Natural Gas Forecast



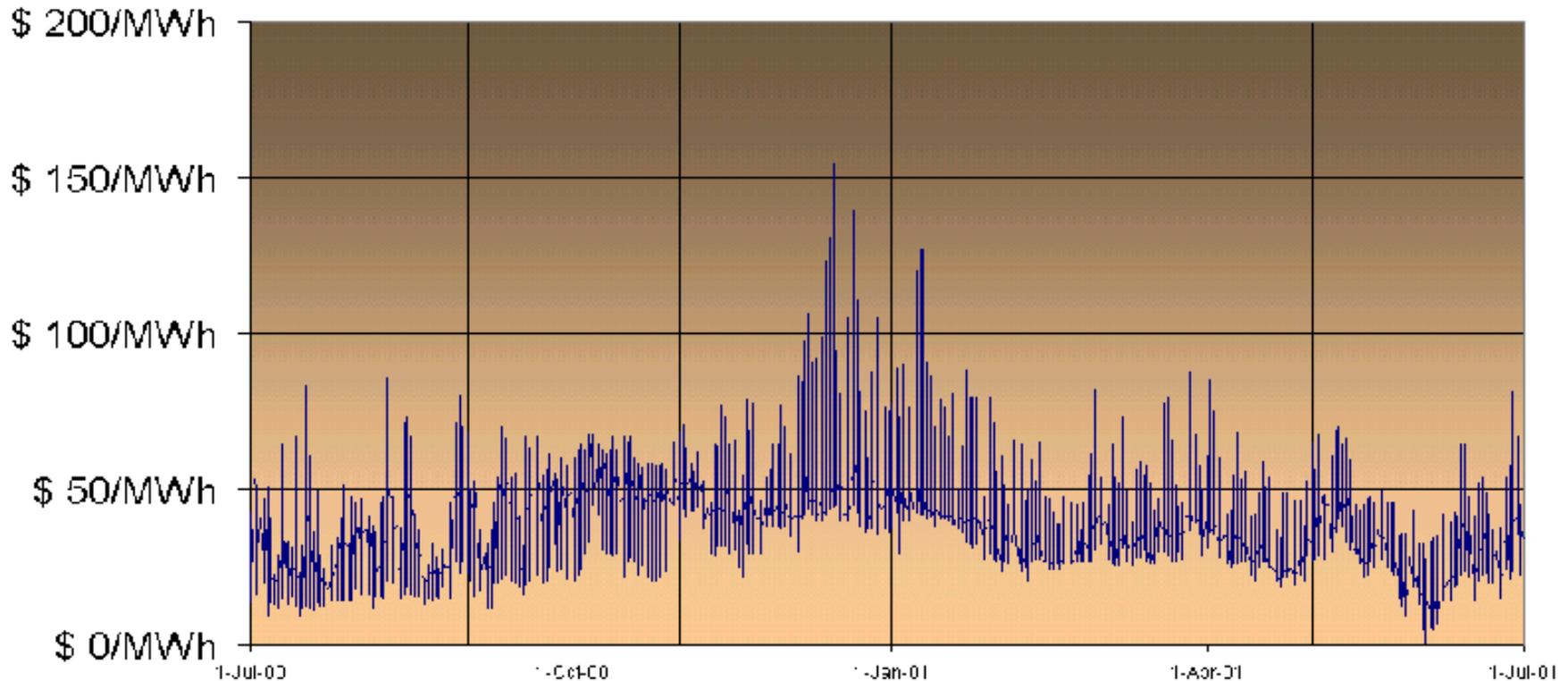


NYISO Highlights

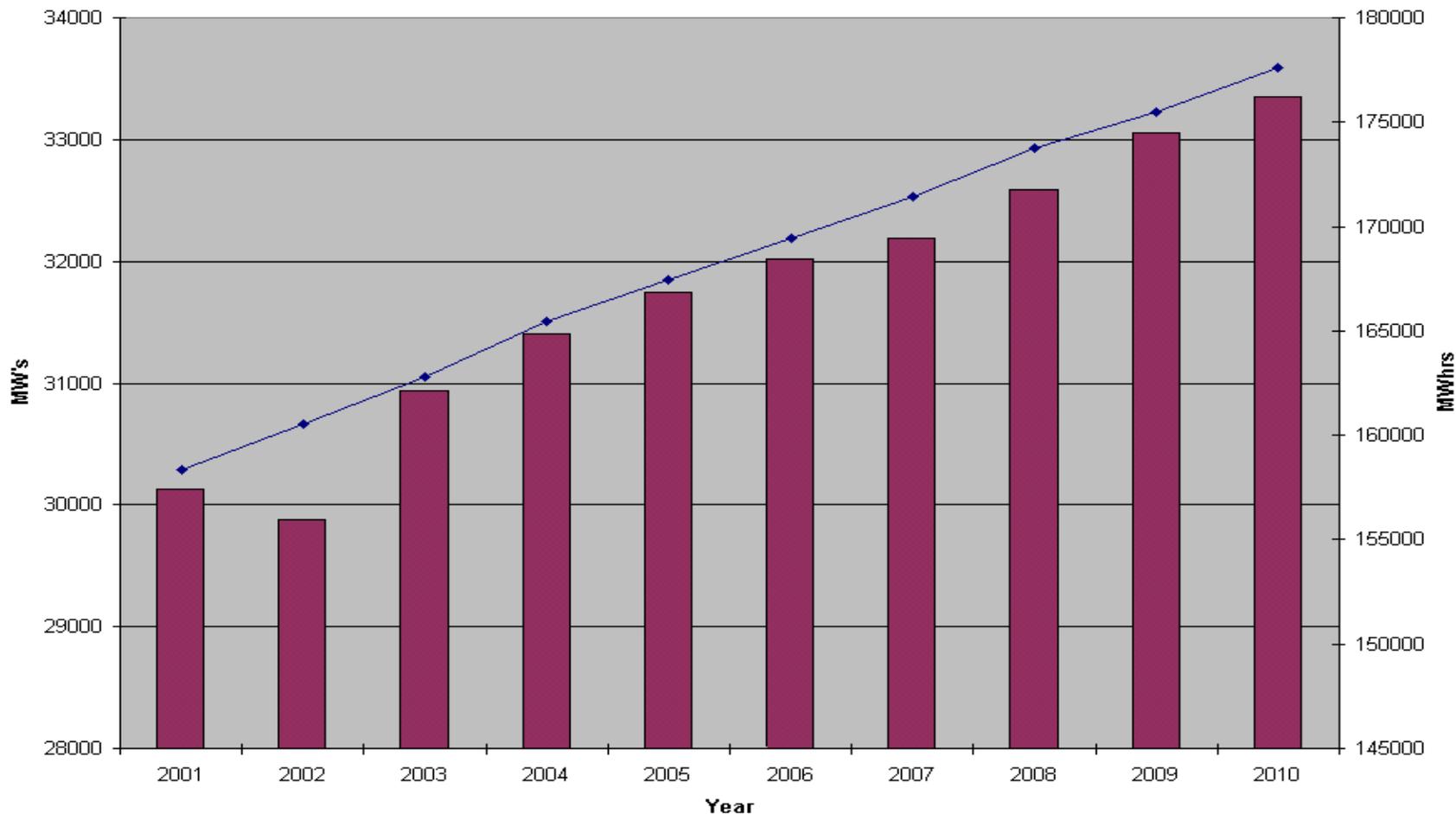
- Modest load growth through 2010 (less than 2%)
- Capacity required in New York City area
- Capacity additions through 2010 expected to be about 6,000 MW
- Transmission upgrades needed in Southeast region
- Competitive market is working

NYISO Pricing Highlights

NYISO Locational Marginal Price: July 1, 2000 - June 30, 2001

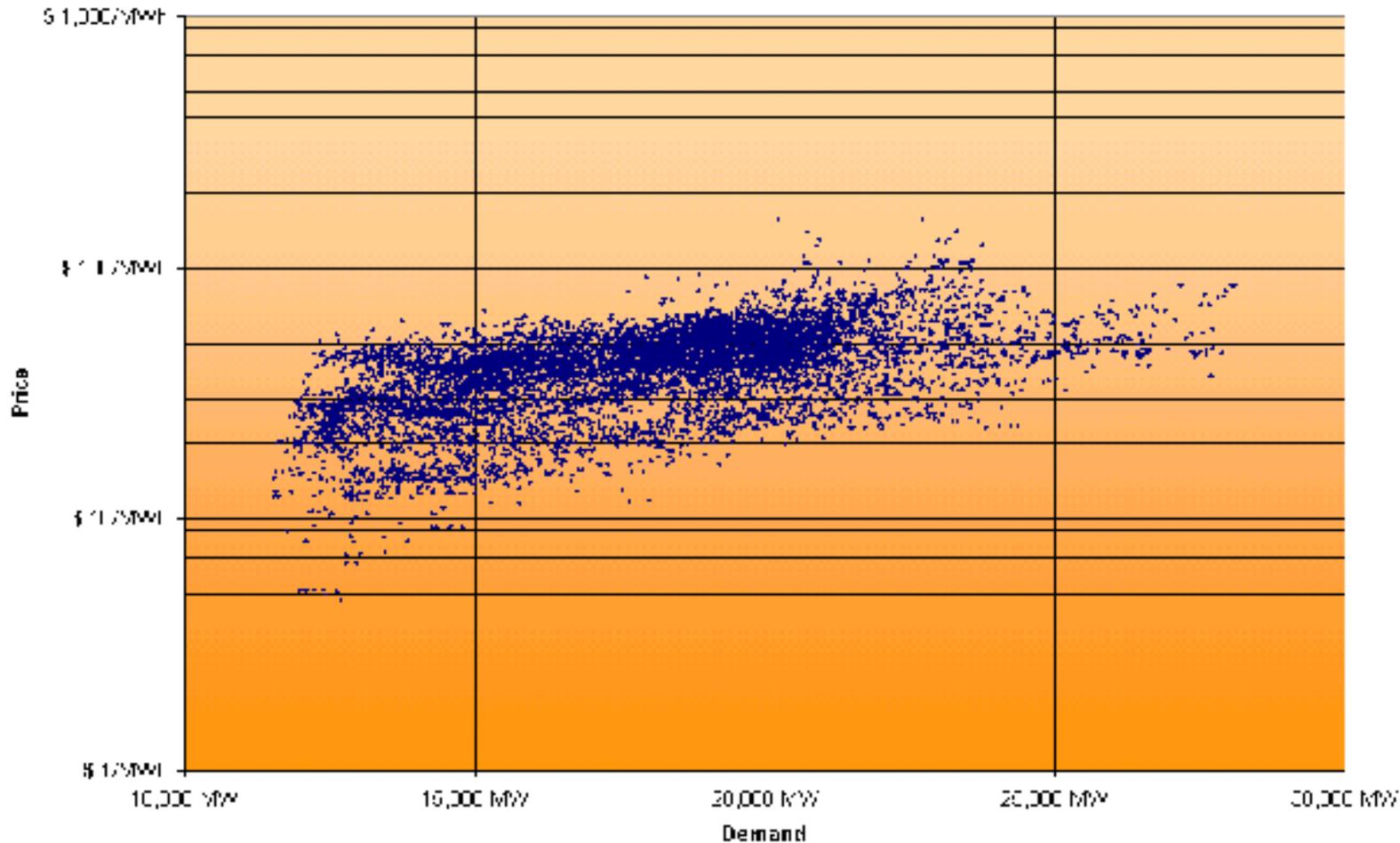


NYISO Forecast - 2010

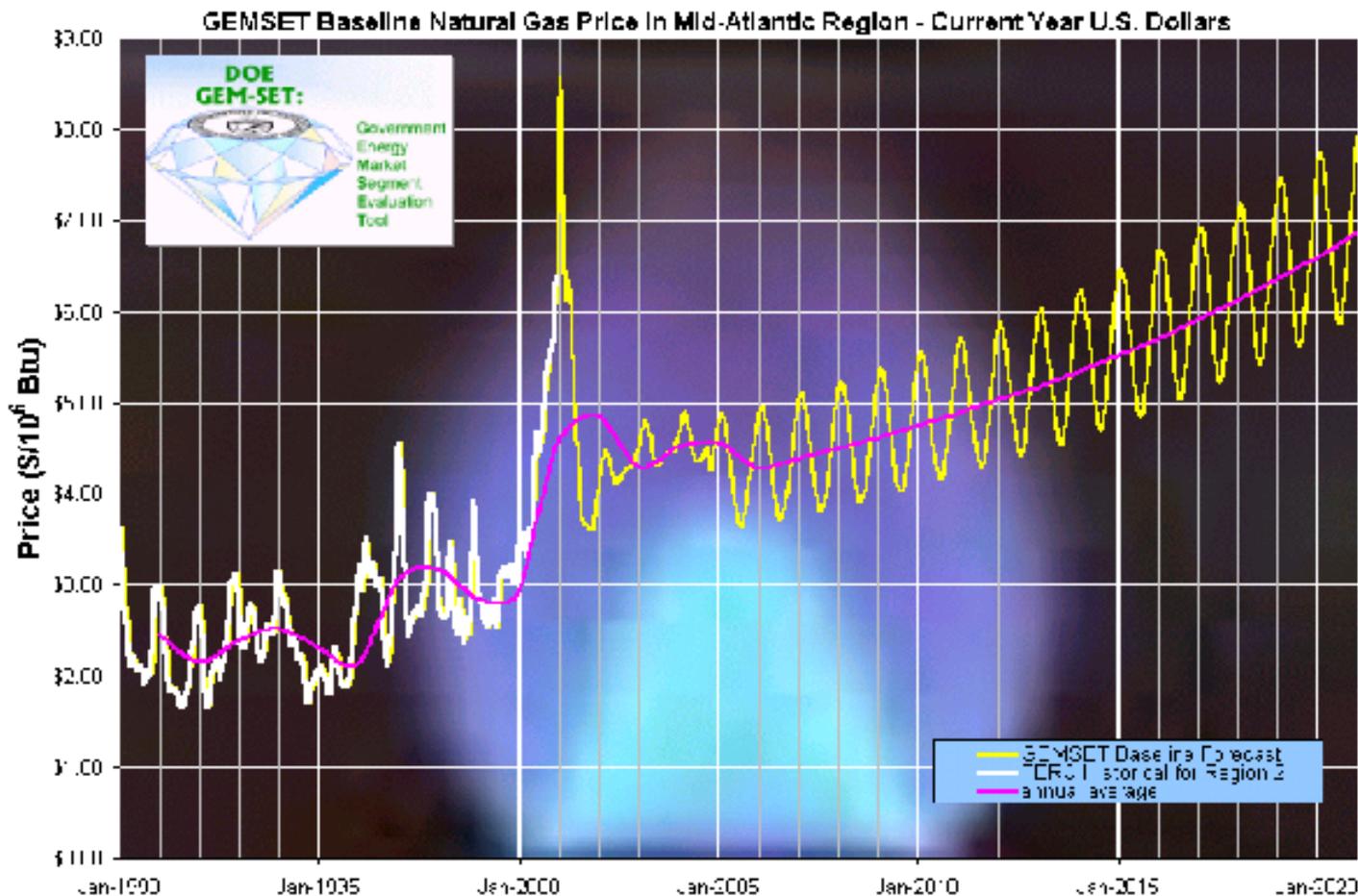


NYISO Price Vs. Demand

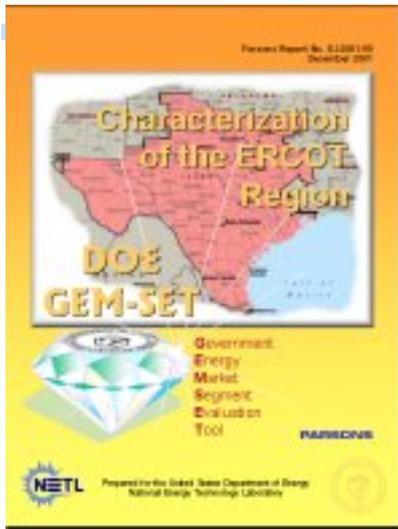
NYISO Price vs. Demand for the Year: July 2000 - June 2001



Natural Gas Price Forecast - NYISO

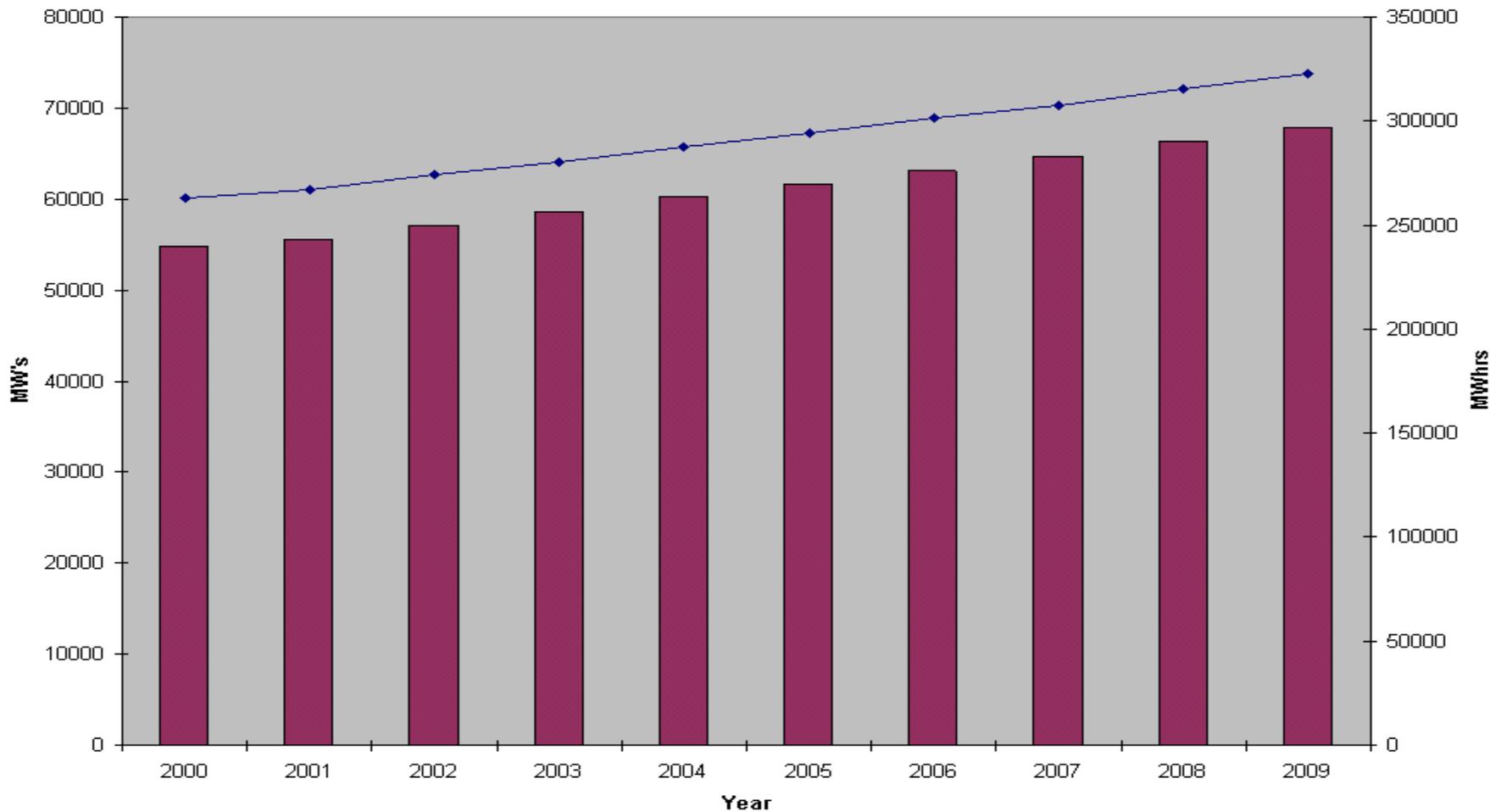


ERCOT Highlights

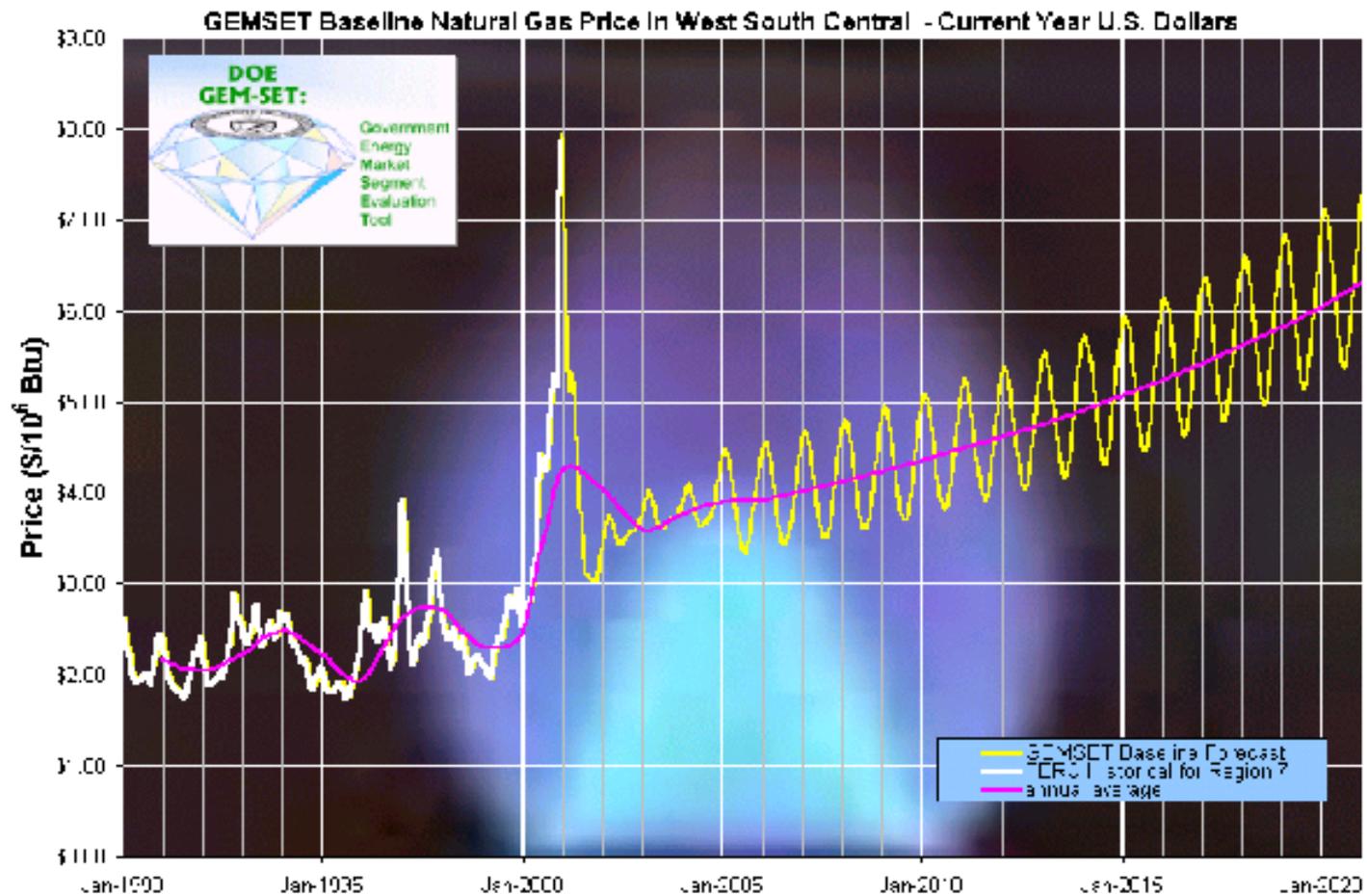


- Beginning stages of a competitive market (Pilot Program)
- Only 2-4% sold at market price, balancing only
- Majority of electricity generated by owners for themselves or bi-lateral arrangements
- Working out problems with data development

ERCOT Forecast

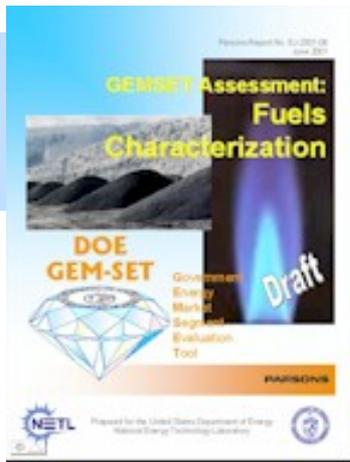


ERCOT Natural Gas Forecast

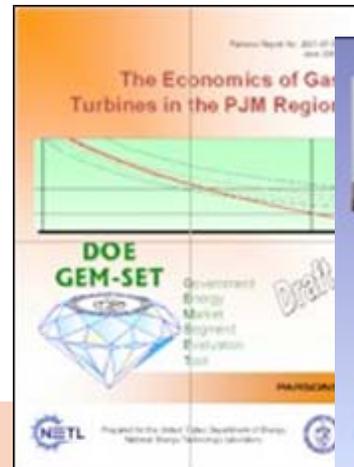


...Ten Minute Break





Session 3: Fuel Characterizations, and Economic & Financial Modules



Find A Better Way To Predict?

DOE GEM-SET:



Government
Energy
Market
Segment
Evaluation
Tool

Review of Pricing

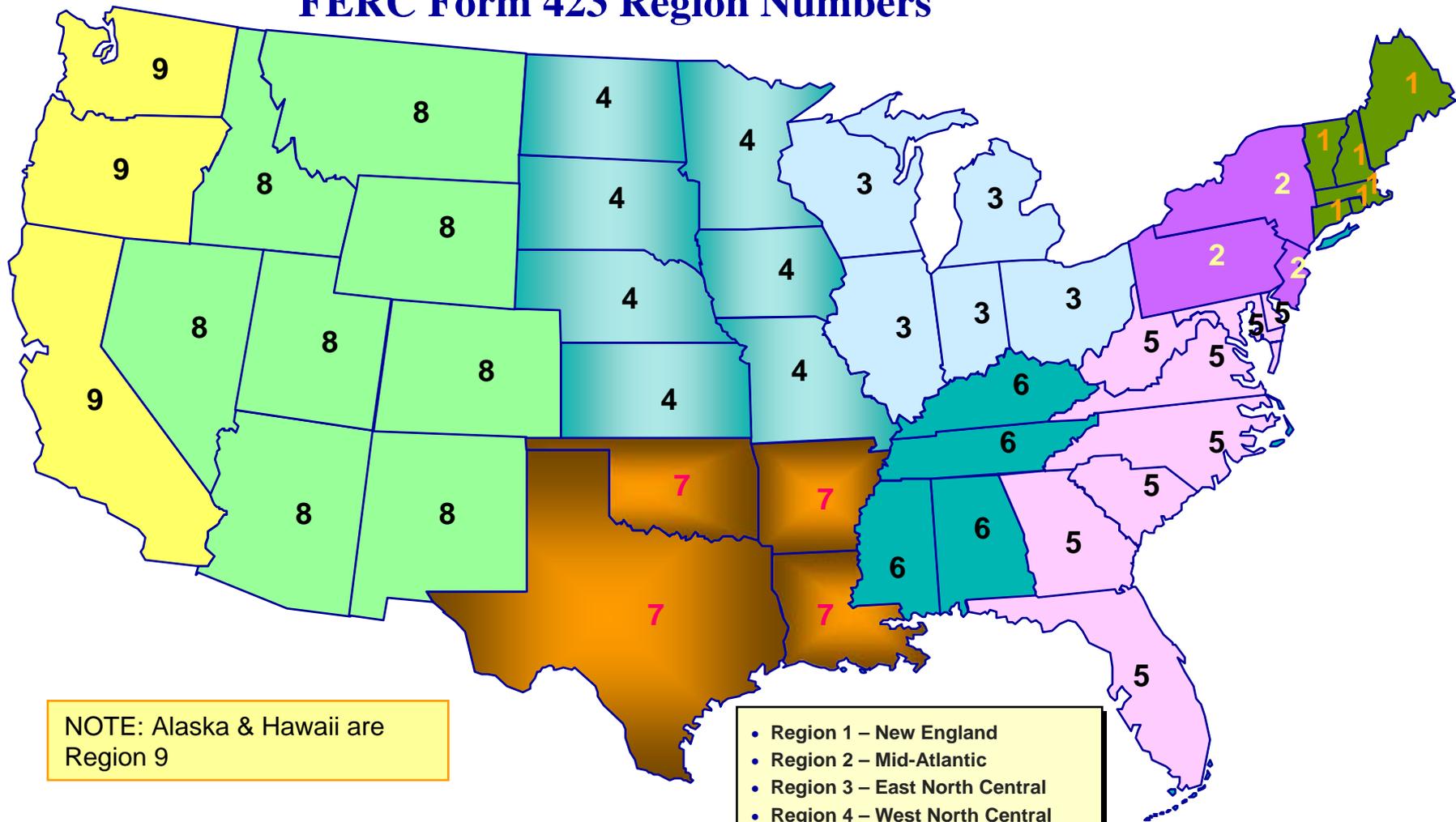
- Fuel costs are a key element influencing regional electric prices.
- GEMSET used a mix of historical, spot market, futures market and forecast data to establish its energy cost baseline.
- The historical delivered price to generating companies of the principal fossil fuels, natural gas, coal, and oil are documented for each region – From FERC Form 423
- Spot market price and futures trading provides near-term price information – from NYMEX
- Future projections from the EIA NEMS model are used to bound possible future changes in fuel price.
- Other fuel resources are also modeled: nuclear, hydroelectric resource, municipal solid waste, etc.

Projections are made for each fuel in each region



GEMSET Fuel Regions

FERC Form 423 Region Numbers



NOTE: Alaska & Hawaii are Region 9

- Region 1 – New England
- Region 2 – Mid-Atlantic
- Region 3 – East North Central
- Region 4 – West North Central
- Region 5 – South Atlantic
- Region 6 – East South Central
- Region 7 – West South Central
- Region 8 – Mountain
- Region 9 – Pacific



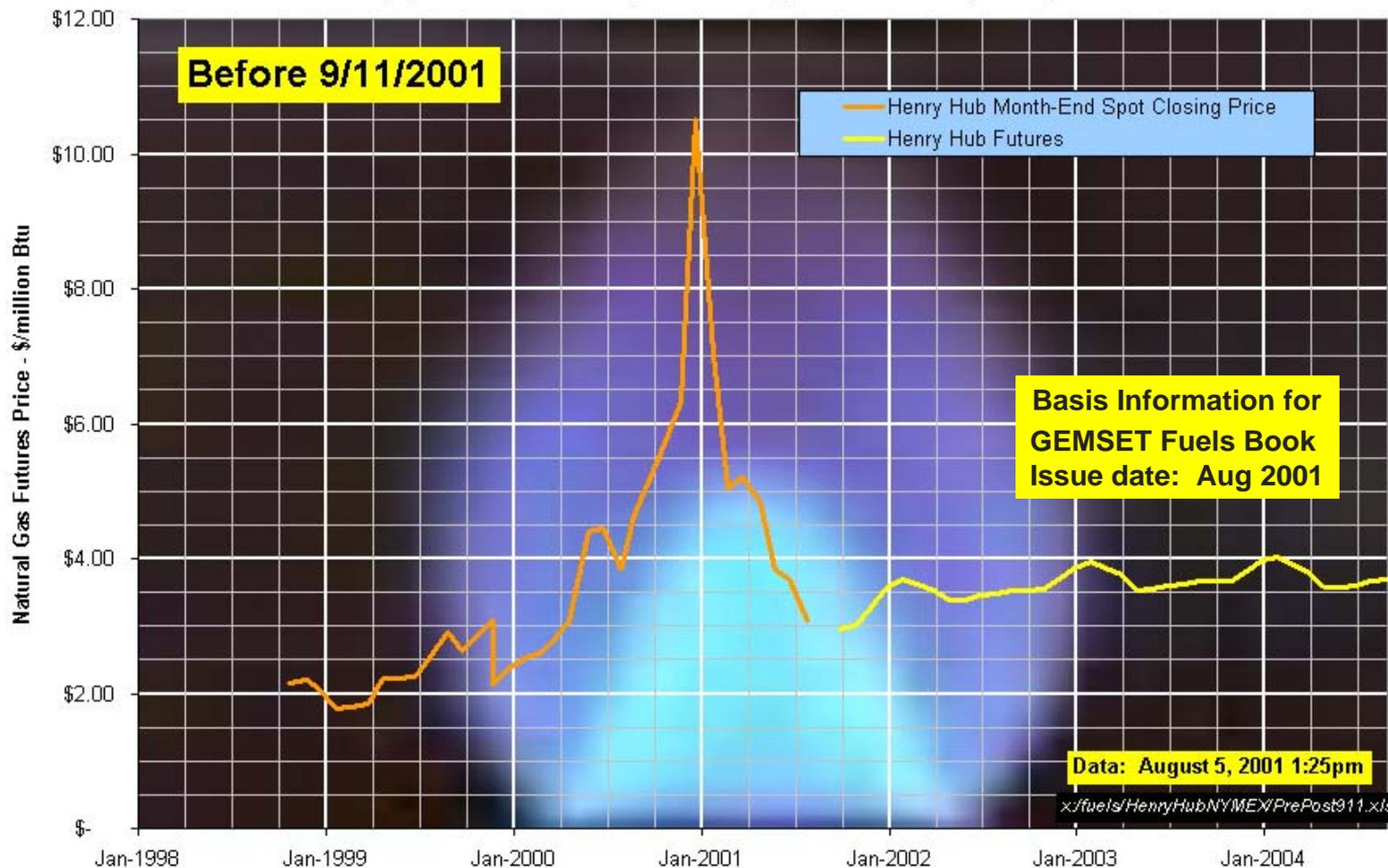
Henry Hub

- Henry Hub (Louisiana) natural gas prices are traded on the NYMEX commodities market
- Closing prices are recorded every week by the EIA's Natural Gas Weekly; these provide a historical record of spot market price for natural gas.
- NYMEX futures trading establishes a reasonable basis for forecasting natural gas price for the next 3-5 years
- These prices do not include delivery

Near-Term Forecasts Adjusted to Henry Hub Trading

New York Merchantile Exchange (NYMEX) Henry Hub Natural Gas Futures Market

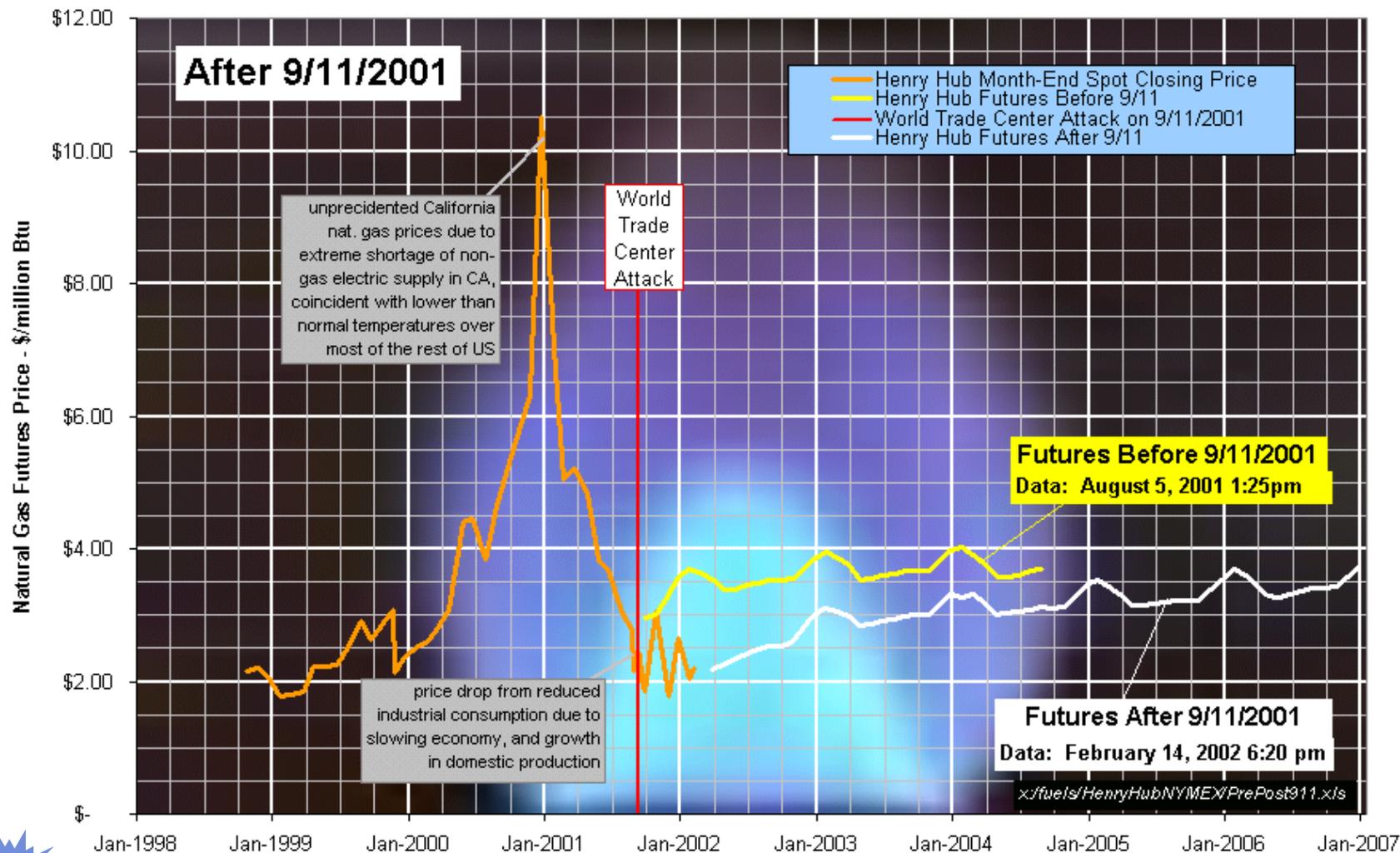
http://quotes.ino.com/exchanges/?r=NYMEX_NG Data: 2001 Aug 05 1:25pm



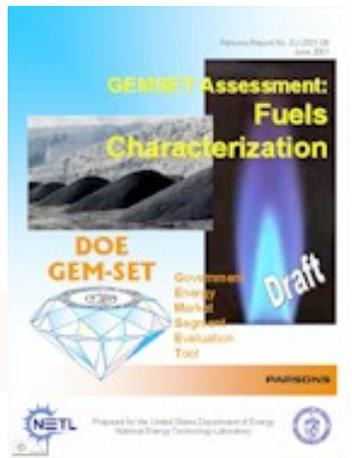
Recent Henry Hub Trading

New York Merchantile Exchange (NYMEX) Henry Hub Natural Gas Futures Market

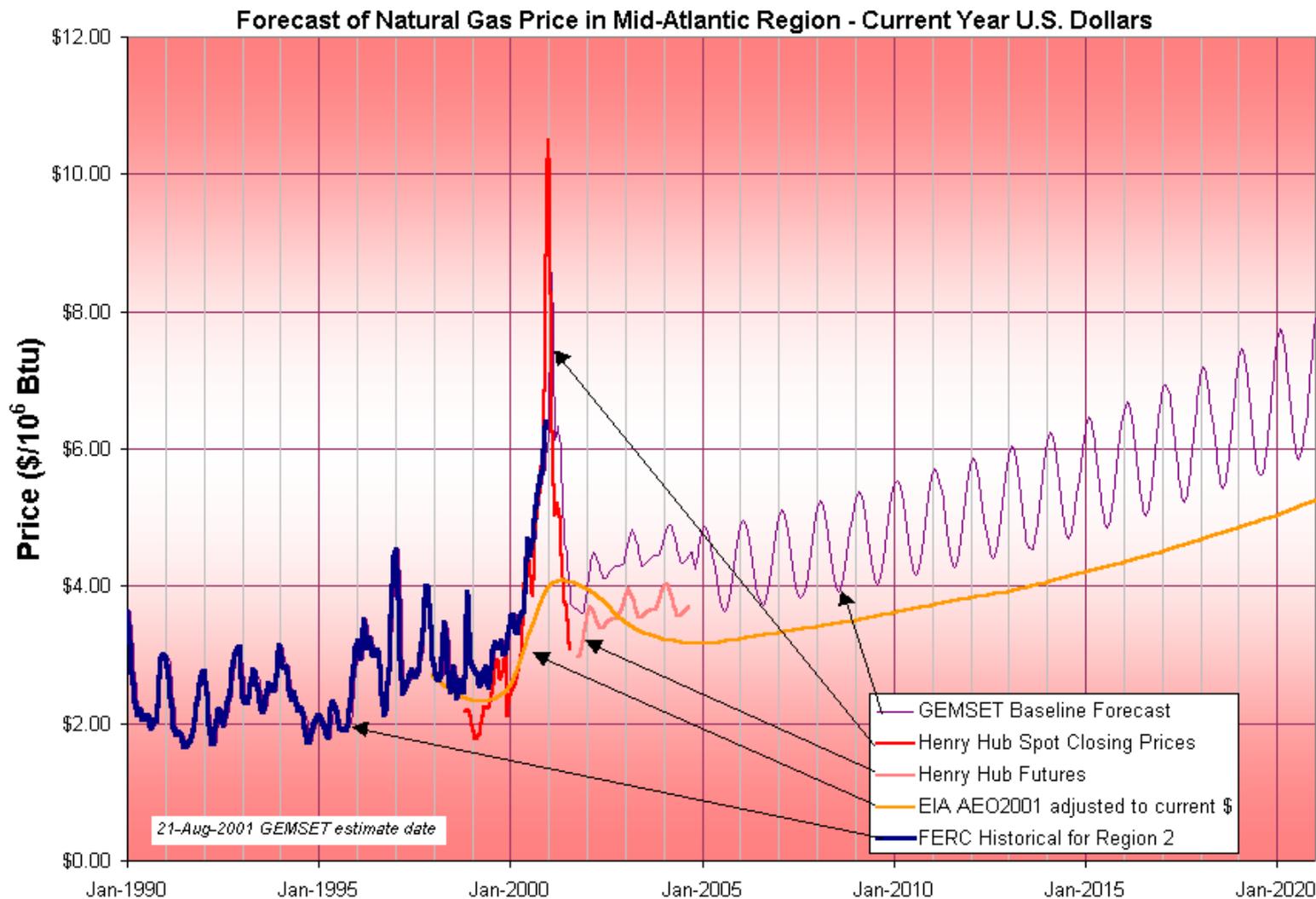
<http://www.nymex.com/markets/newquotes.cfm?showAll=on&contract=NG#NG> 14 Feb 2002 6:20 pm



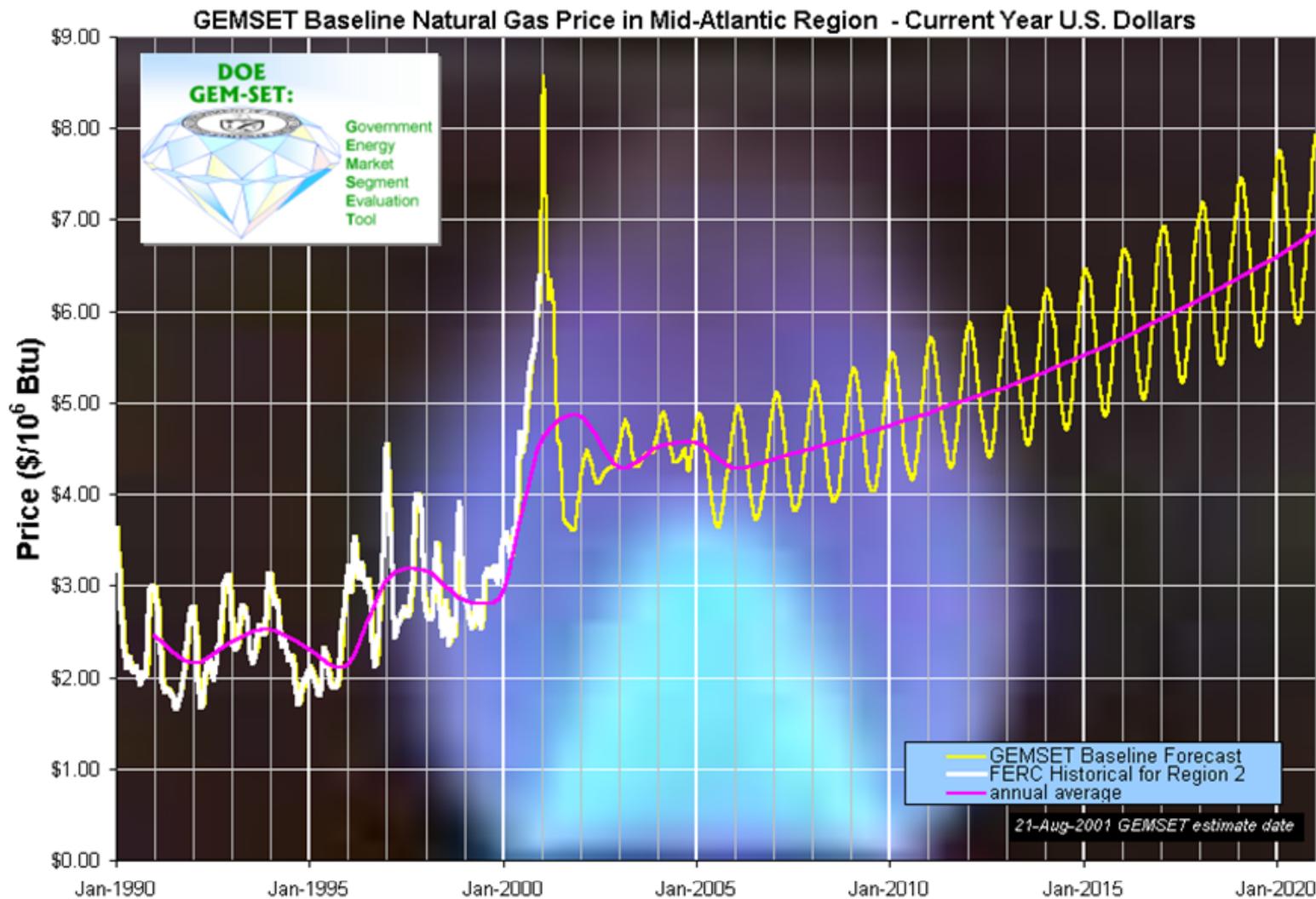
How GEMSET Develops Regional Fuel Price Estimates



Example: Natural Gas in FERC Region 2



Example Result



GEMSET Economic & Financial Evaluations

- **GEMSET Desktop Model:**

- Estimates fuel, O&M, Capital of selected technologies based on capacity factor estimates from fleet stackings
- Compares alternative generation options from baseline inputs
- Allows user to input selected items of their choice

- **Nextant Financial Model:**

- Provides detailed estimates of financial robustness of selected technologies
- Inputs on capacity factor and revenue should be derived from Desktop Model results
- This model is an add-on to the GEMSET program to facilitate more detailed evaluations

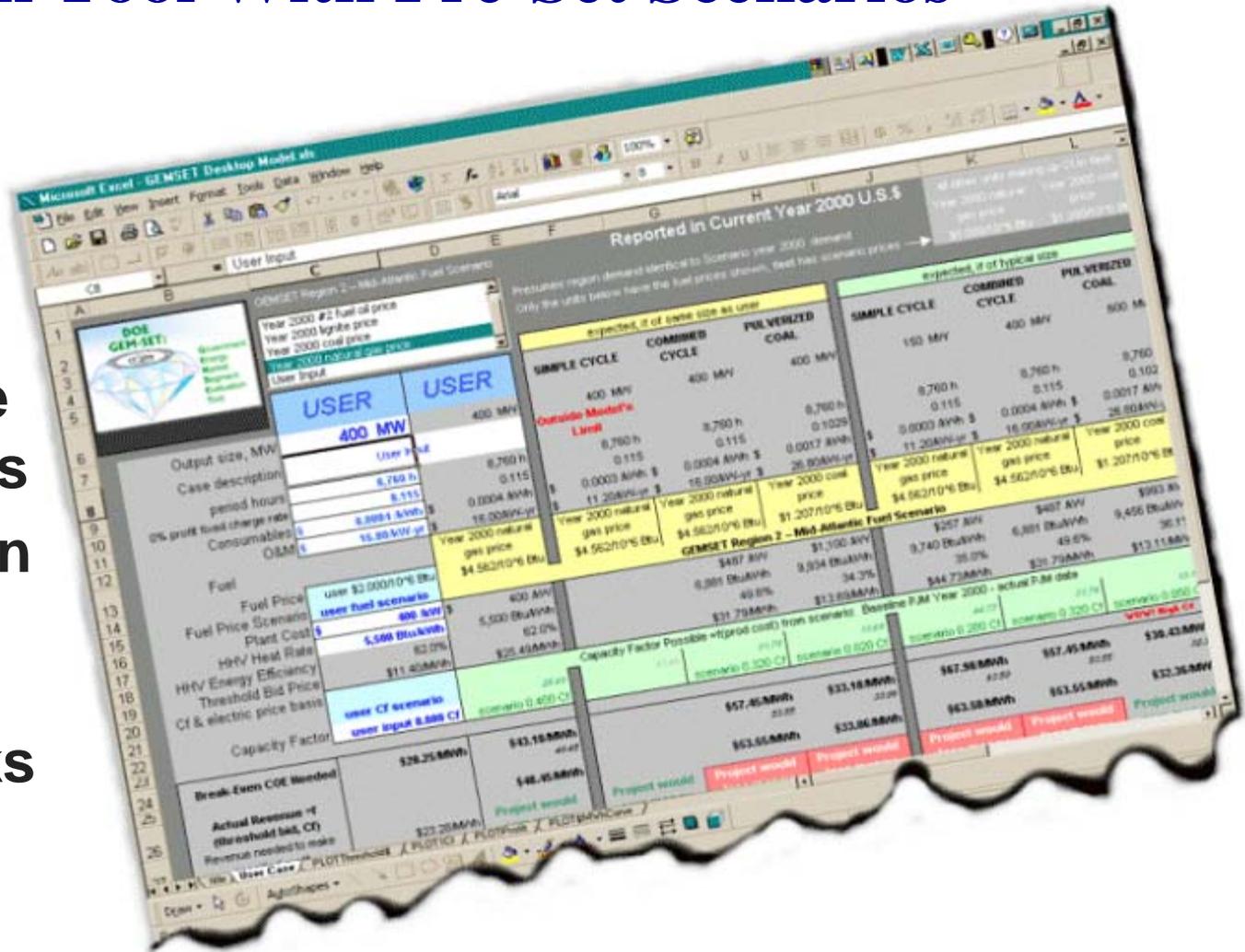
The GEMSET Desktop Model

A desktop model is available for exercising plant capacity factor, revenue, and economics within the built-in scenario choices



The Desktop Model Provides and Evaluation Tool With Pre-Set Scenarios

- User case flexibility
- Cf, revenue calculations
- Comparison to GT, CC, and PC benchmarks



GEMSET Financial Model Results

Overview

Gemset Analysis
for

CC

**DOE
GEM-SET:**



Government
Energy
Market
Segment
Evaluation
Tool



Project Description

The CC involves the construction of a Gas-fired 1000 MW integrated gasification combined cycle (IGCC) plant that has a total initial capital cost of \$737,849,494 (dollars thousand). The CC is located in Western US and, on an annual basis, will generate the following outputs (see shaded box to the right):

> 7,220,000 MWh of Electricity

Project Timing

The scheduled start date for plant construction is January 1, 2000. The CC has an estimated construction period of 36 months. Plant start-up will commence on January 1, 2003.

Project Financial Structure and Key Results

The capital structure for CC is 70% debt and 30% equity. Key project financial results include:

- > 81% Internal Rate of Return
- > \$ 1,799,172,661 Net Present Value (in Thousand Dollars) at a 10% Discount Rate
- > 5.8 Benefit to Cost Ratio (BCR)
- > The Payback Year (on equity) is 2003

Additional Comments



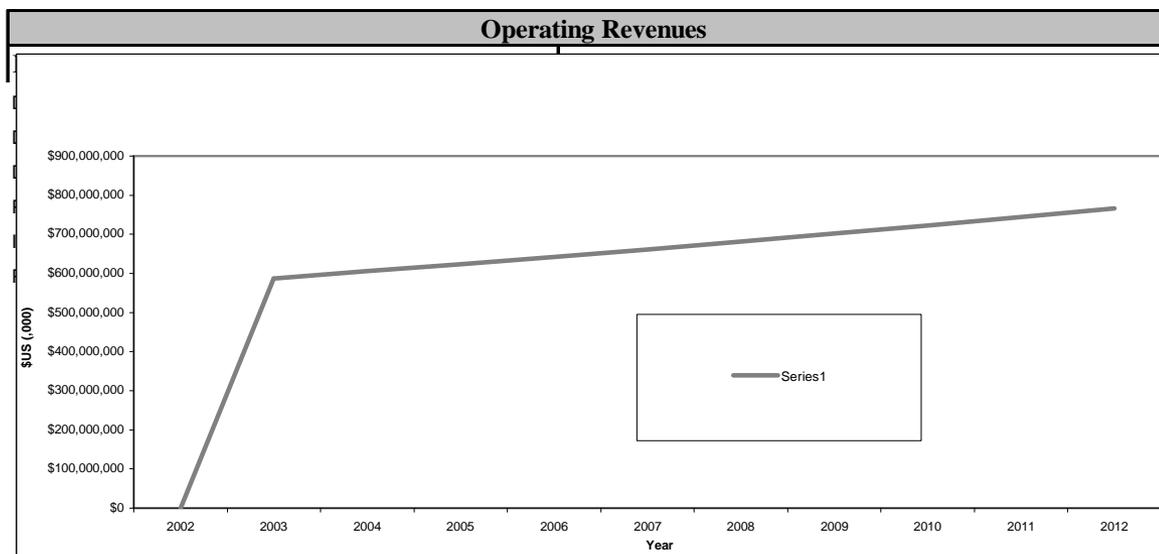
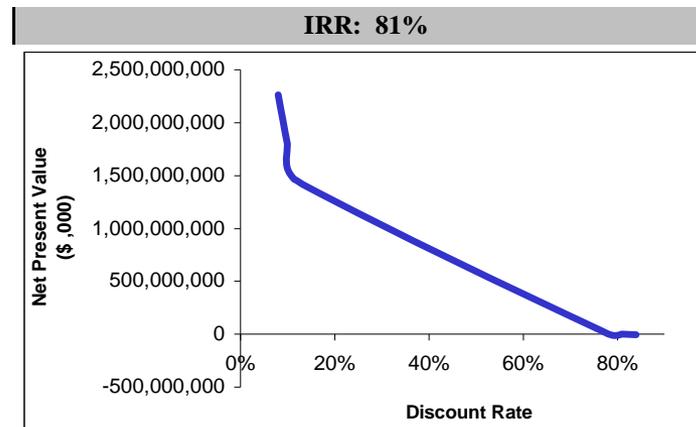
GEMSET Financial Model Results

IRR & Revenues

CC
Eastern US

Key Financial Results	
Internal Rate of Return (IRR)	81%
Payback Year (on equity investr	2003
Benefit to Cost Ratio	5.80

NPV (in Thousand Dollars)	
NPV at 8% discount rate	\$2,260,584,850
NPV at 10% discount rate	\$1,799,172,661
NPV at 12% discount rate	\$1,448,927,914

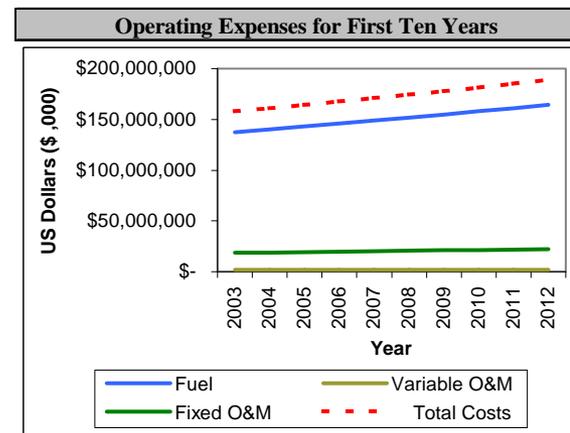
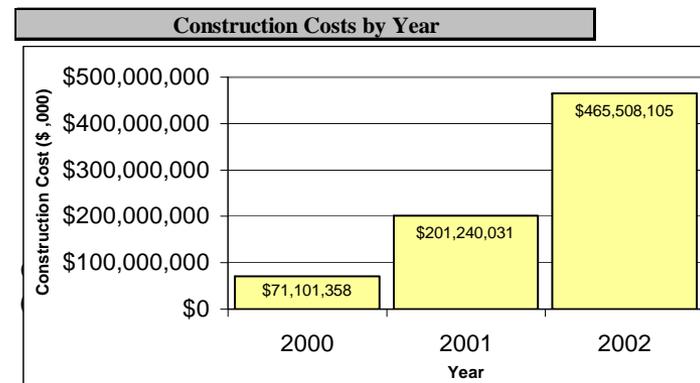


GEMSET Financial Model Results

Construction & Operating Costs

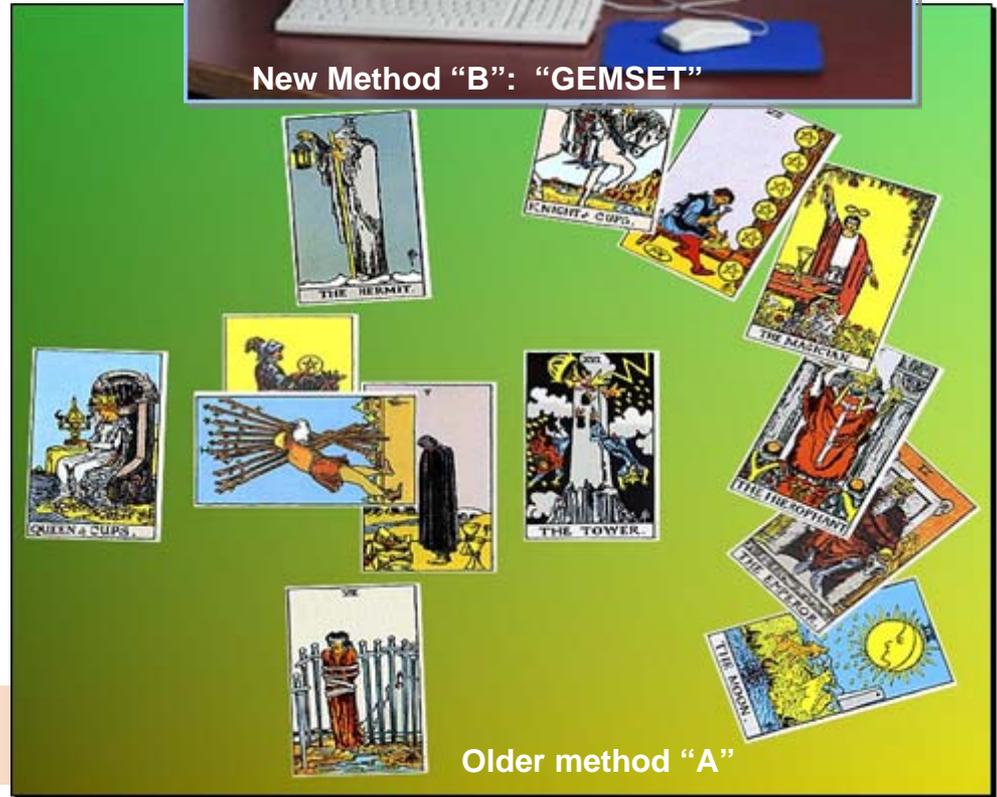
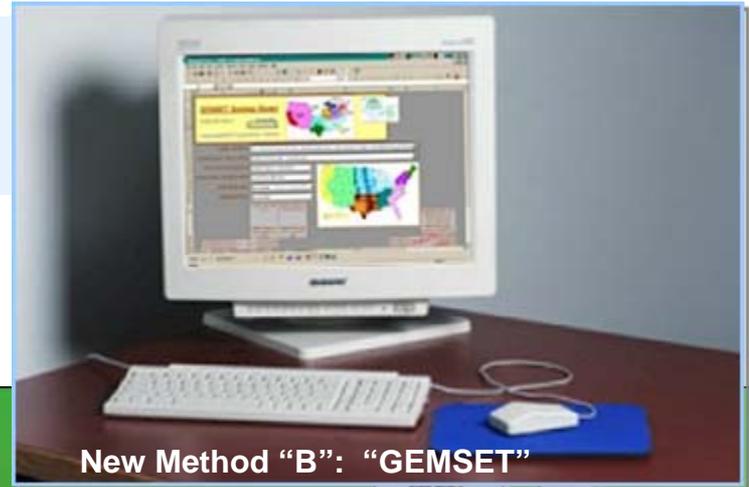
CC
Eastern US

Construction/Project Cost (in Thousand Dollars)		
Capital Costs	Category	Percentage
EPC Costs	\$506,500,000	69%
Initial Working Capital	\$41,132,253	6%
Owner's Contingency (% of EPC Costs)	\$45,585,000	6%
Development Fee (% of EPC Costs)	\$20,260,000	3%
Start-up (% of EPC Costs)	\$10,130,000	1%
Initial Debt Reserve Fund	\$26,194,693	4%
Owner's Cost (in thousand dollars)	\$0	0%
Additional Capital Cost	\$0	0%
<i>Total Capital Costs</i>	<i>\$649,801,946</i>	<i>88%</i>
Financing Costs		
Interest During Construction	\$73,514,120	10%
Financing Fee	\$14,533,428	2%
Additional Financing Cost #1	\$0	0%
Additional Financing Cost #2	\$0	0%
<i>Total Financing Costs</i>	<i>\$88,047,548</i>	<i>12%</i>
Total Project Cost/Uses of Funds	\$737,849,494	100%
Sources of Funds		
Equity	\$221,354,848	30%
Debt	\$516,494,646	70%
Total Sources of Funds	\$737,849,494	100%



Session 4: How GEMSET Forecasts the Future

GEMSET Support for Sub-Policy Planning



Forecasting the Future

- **Projecting Demand**
- **Projecting Fuel Price**
- **Projecting Environmental Regulation**
- **Technology Characterization vs. Time**

- **Forecasting Energy Price**
- **Synthesizing the Makeup of the Fleet vs. Time and Scenario**

Fleet Modeling Under Different Scenarios

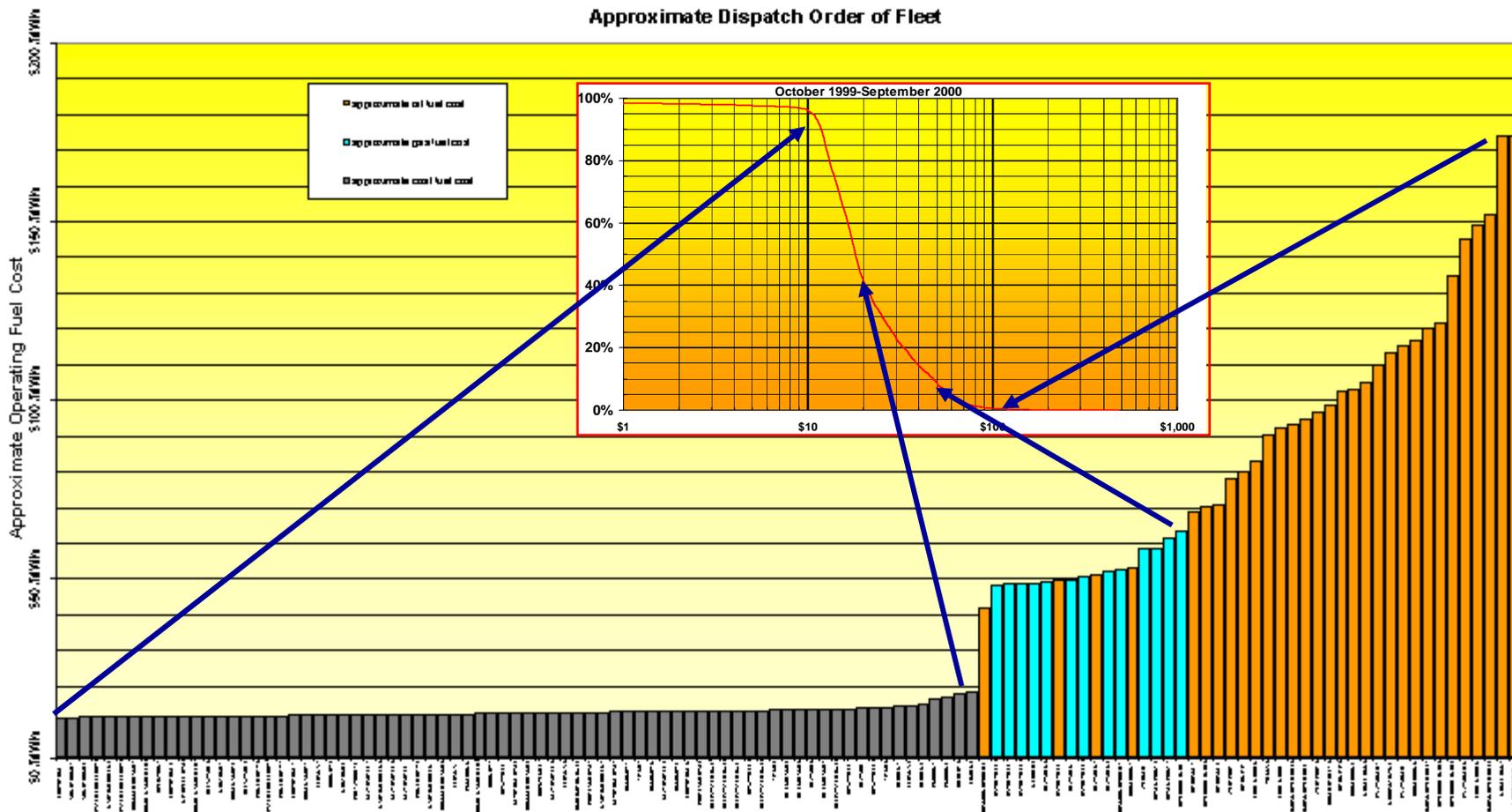
The problem:

- Estimate demand
- Estimate fuel and operational costs
- Estimate change in revenue
- Estimate change in capacity factor

How?

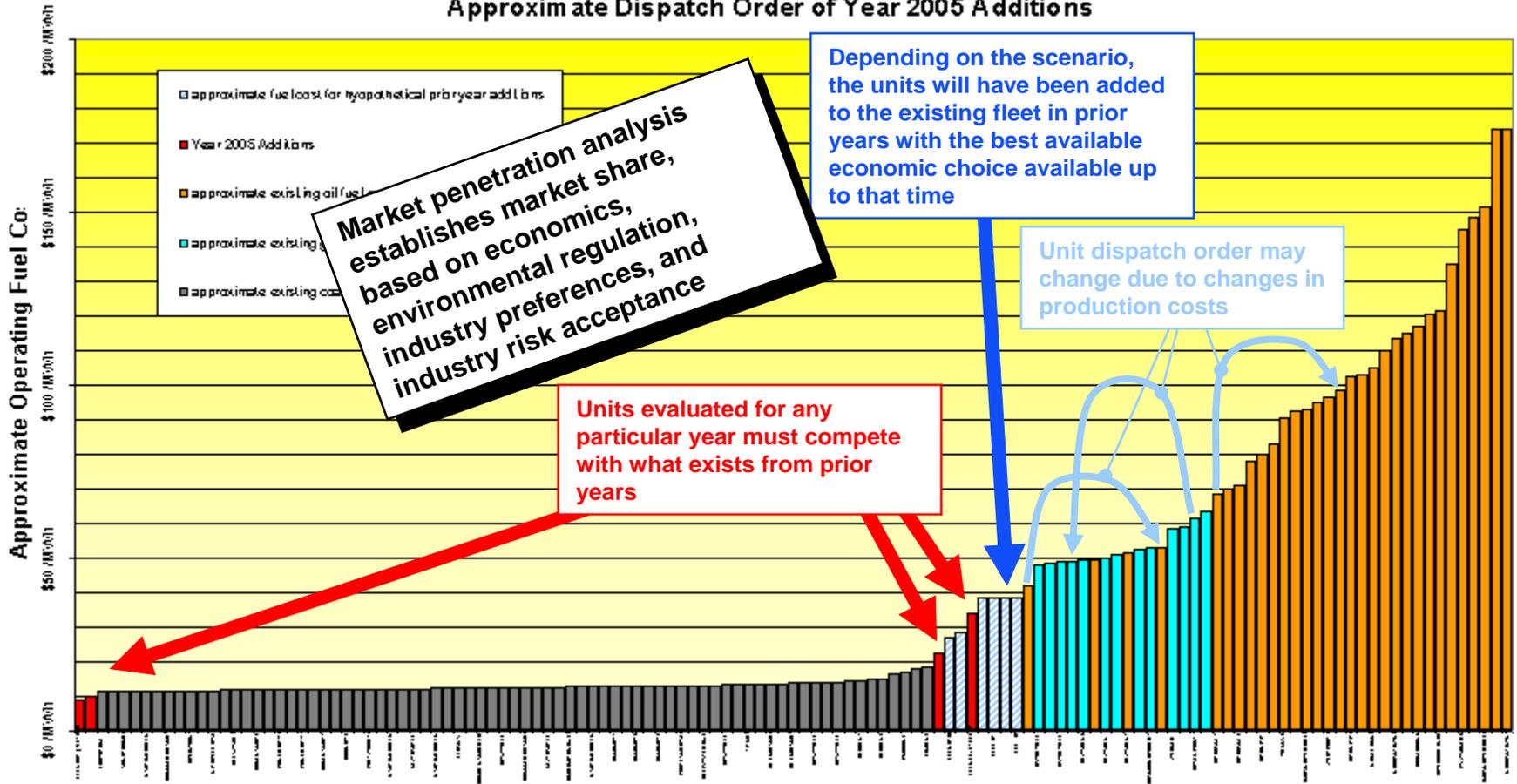
Build Region from Existing Fleet

Approximate Dispatch Order of Fleet



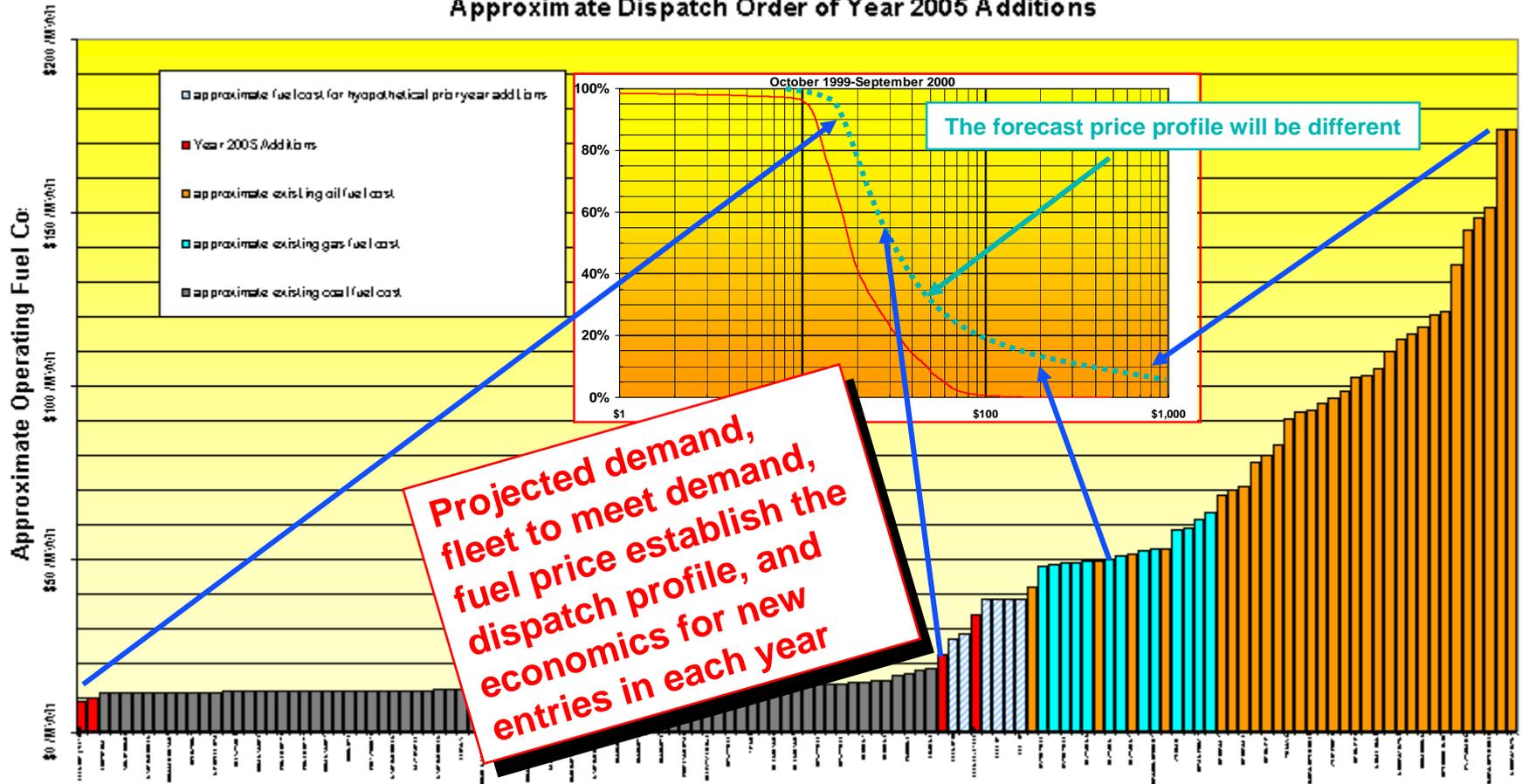
Build Region from Existing Fleet

Approximate Dispatch Order of Year 2005 Additions



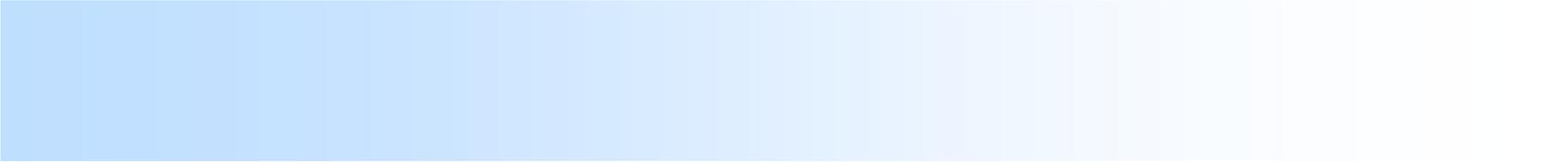
Forecast Prices and Dispatch for the New Scenario

Approximate Dispatch Order of Year 2005 Additions



Synthesizing the Make-Up of the Fleet vs. Time and Scenario

- **Existing fleet modeled from units in operation**
 - Retirement profile established for each class plant
 - Environmental improvement upgrade profile for each class
 - Refurbish/life-extend profile for each class
 - Repower profile for each class (DOE product candidate)
- **GEMSET Market Penetration Analysis by Year establishes fleet make-up**
- **GEMSET Market Penetration Analysis for Target technology**



Session 5: GEMSET Plans / The Next 6 Months and Beyond



Future

- Finalization of ERCOT and WSCC which are underway
- Characterize Remaining GEMSET Regions
 - *On the Road*: Power Owner Input
 - *On the Road*: ISO and Planner Input
- Expand GEMSET Technical, Environmental, and Cost characterizations
- Complete Prototype the GEMSET Model
 - GEMSET Market Penetration Analysis by Year establishes fleet make-up
 - GEMSET Desktop Environmental Module
- Populate the Databases
- **APPLY** the GEMSET Model to technology evaluations posed by DOE
- Characterize International Market?
- ***Maintain!***



Environmental Policy Support

GEMSET Support for Sub-Policy Planning

Future



Projecting Environmental Regulation

Baseline

- Booked EPA and Regional regulations

Alternatives:

- Proposed regulations
- Menu of preset carbon reduction futures
- Allow user “what-if” variants

Environmental compliance cost must be monetized for each conventional and emerging generation technology at varying levels of emission control

Future

Technology Characterization vs. Time

Heat rate, reliability, cost vs. environmental for:

Existing Fleet --

- Existing fleet characterization in region

Future Fleet --

- Technology vs. time for existing technologies
- GEMSET technology, intro date, vs. time for competing emerging technologies fleet

User input for intro date, characteristics vs. time for target technology

Future

Sources of Information

- **Fleet information:**

- EPA data (lagged by 2 years) on plant level
- Presume each unit at site equivalent
- Presumption of fuel composition

- **New Technology Information:**

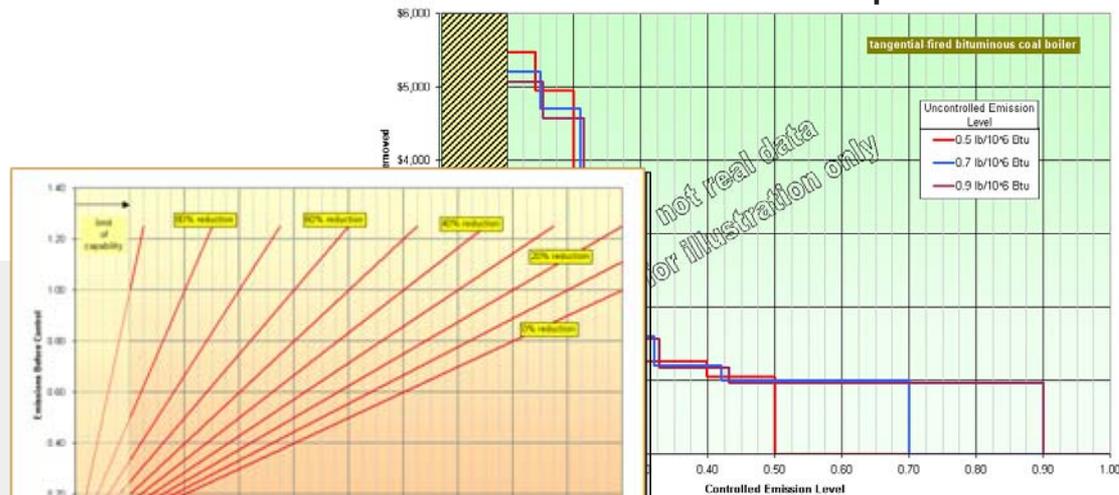
- From product managers for new technology
- From vendors for commercial technology
- Menu of fuel composition/price

Underway

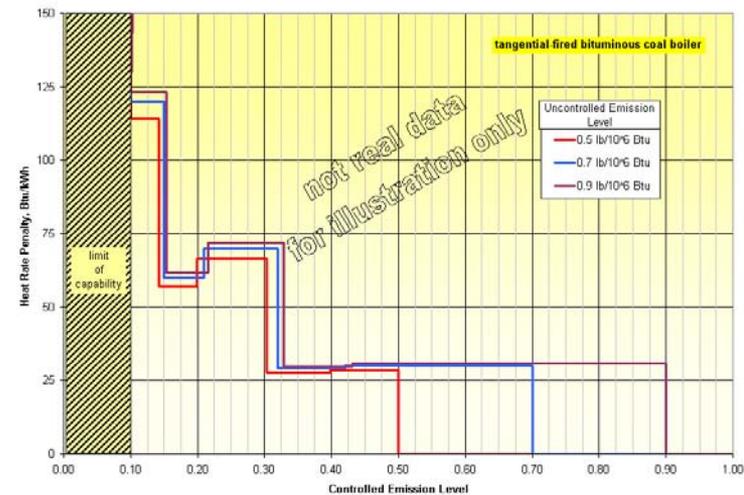
Future

Unit Environmental Technology Data

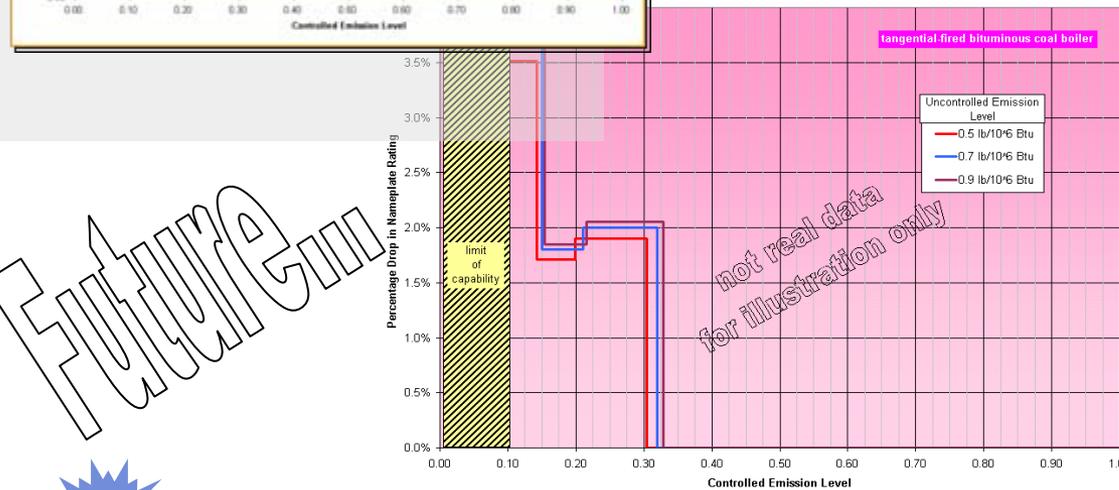
Increment in capital cost



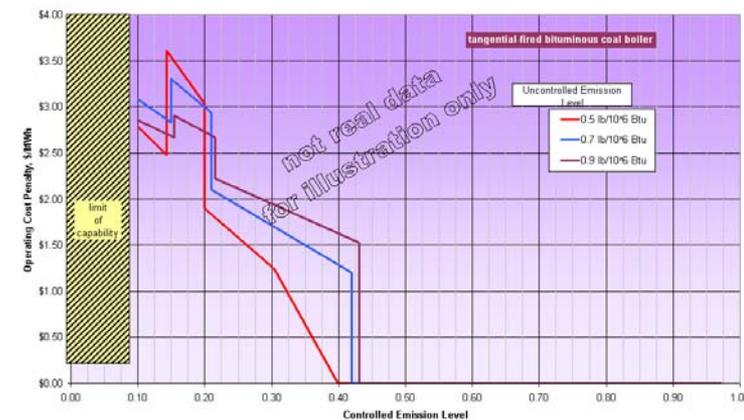
Heat rate penalty



Loss of capacity rating



Increment in operating cost

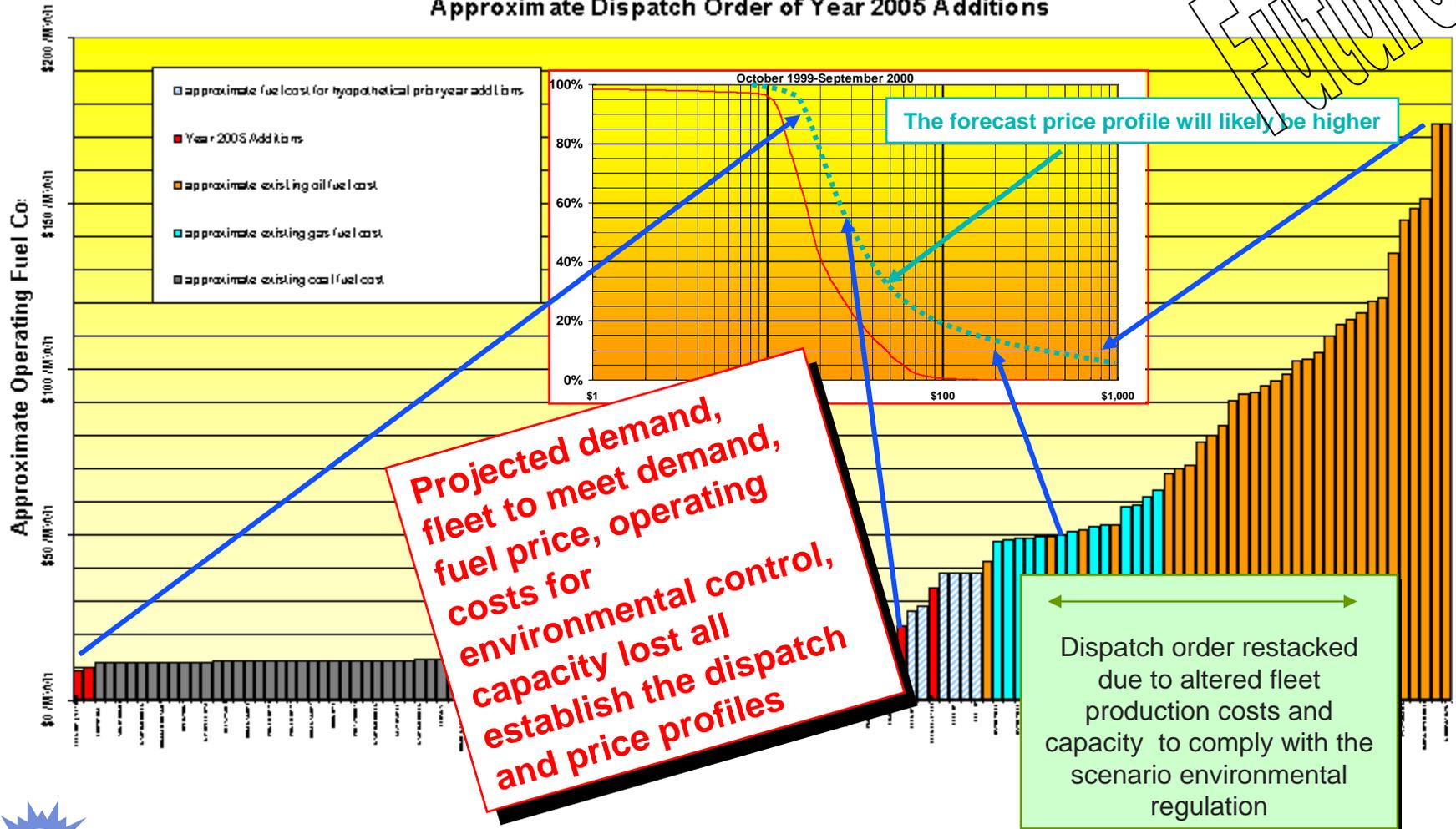


Future



Forecast Prices and Dispatch for the New Environmental Scenario

Approximate Dispatch Order of Year 2005 Additions



ENTURA

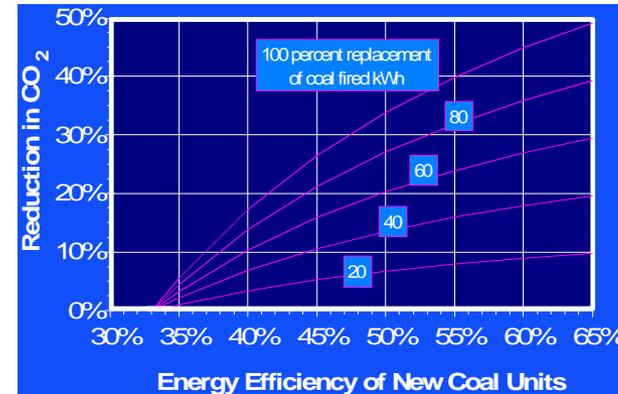
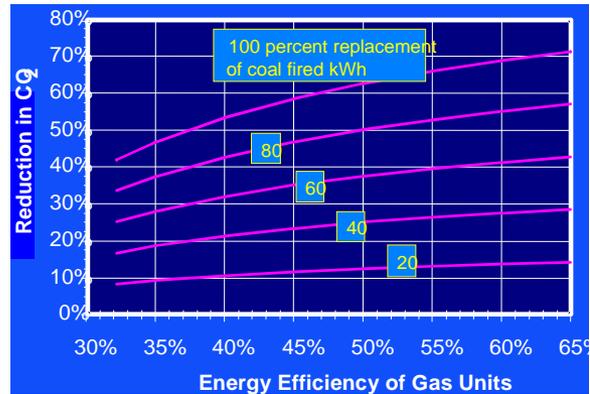
Expected Products to Support Environmental Studies

- **Parametric Environmental Compliance Technical and Cost Data Book – the ‘rule-book’ of approximation algorithms**
- **Environmental Characterization and Forecast Data Book – summary of what’s on the books, what might be coming in each region**
- **Updated GEMSET Environmental Modules for detail evaluations, and pre-establishing scenarios for desktop model**
- **Upgrade GEMSET Desktop Scenario Model for Environmental Screening**

Future

Some Types of Environmental Studies...

EMERG



- Independent assessment of the impact on the electric generation fleet of regional environmental emissions policies
- Establish the impact of policies on regional electric price - how much will electric price change to consumers? What replacements are needed to meet goal?
- Establish capacity factor of different types of units in different environmental regulation circumstances
 - very important: if units get pushed off baseload, the fleet change needed to replace the capacity might cause more net harm than good
- Assess individual unit costs to comply, and economic implications of cost to introduce technology
 - With all other units confronted with same regulation
 - With only new units confronted with regulation



**O.K.
We've Built the Tools...**

...It's Time To Use Them.





What Information Will The Boss Need?



Session 6: Roundtable Discussion: What Are the Important Problems that GEMSET Can Help You Solve?

Audience raises general issues or addresses questions for the project



You Need To Think About How the GEMSET Model Could Help

- DOE is the only show in town for advanced electric generation research; make it count, **LISTEN** to industry, understand their needs
- How can GEMSET enhance my sub-policy planning recommendations?
- How can I use GEMSET information to help my product line better address industry's needs?
- How can I exercise the GEMEST information to help develop products and implementation strategies that better address national energy priorities?
- Would exercising GEMSET “what-if” investigations better establish what should be done and when?



Closing Remarks

Pat Rawls, NETL

Some useful tools

