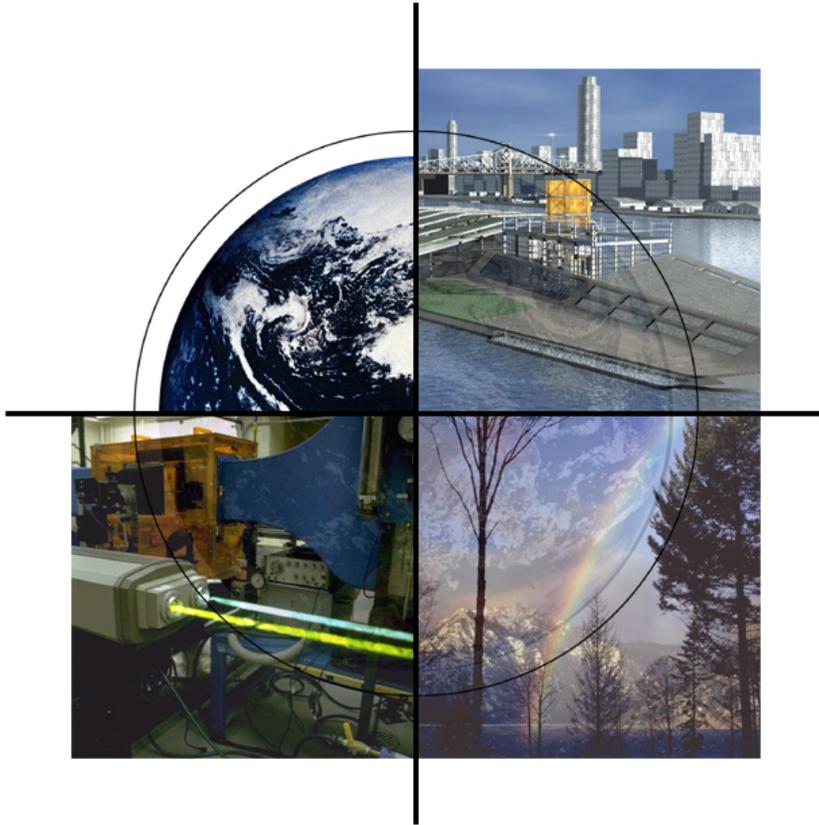


# Tipping Point or Opportunity for Clean Coal Technologies?



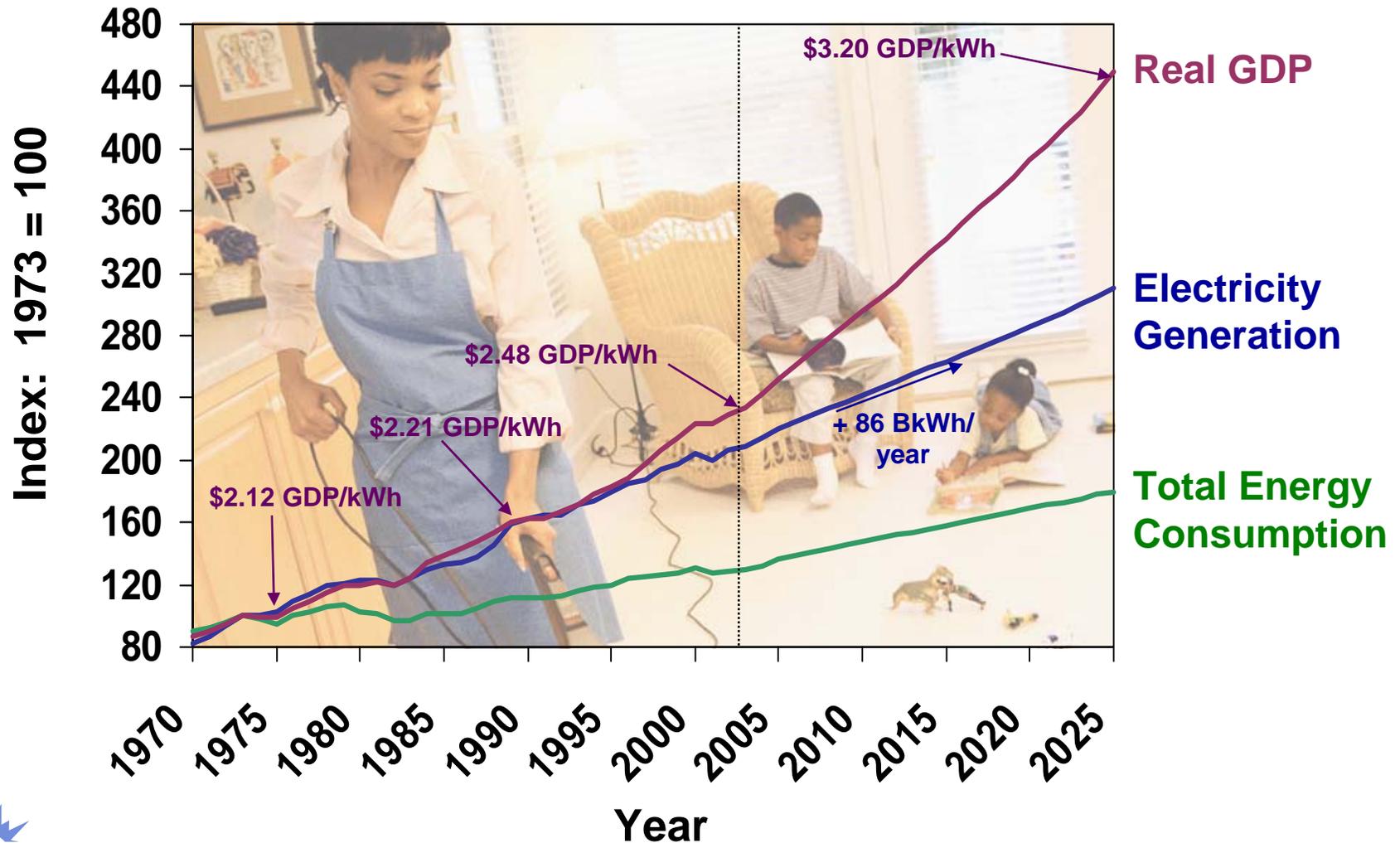
*Presented at:  
ProcessLink™  
Users Summit - 2004*

*By:  
Mike Eastman, Manager-  
Clean Coal Technology  
Demonstrations  
February 10, 2004*

National Energy Technology Laboratory

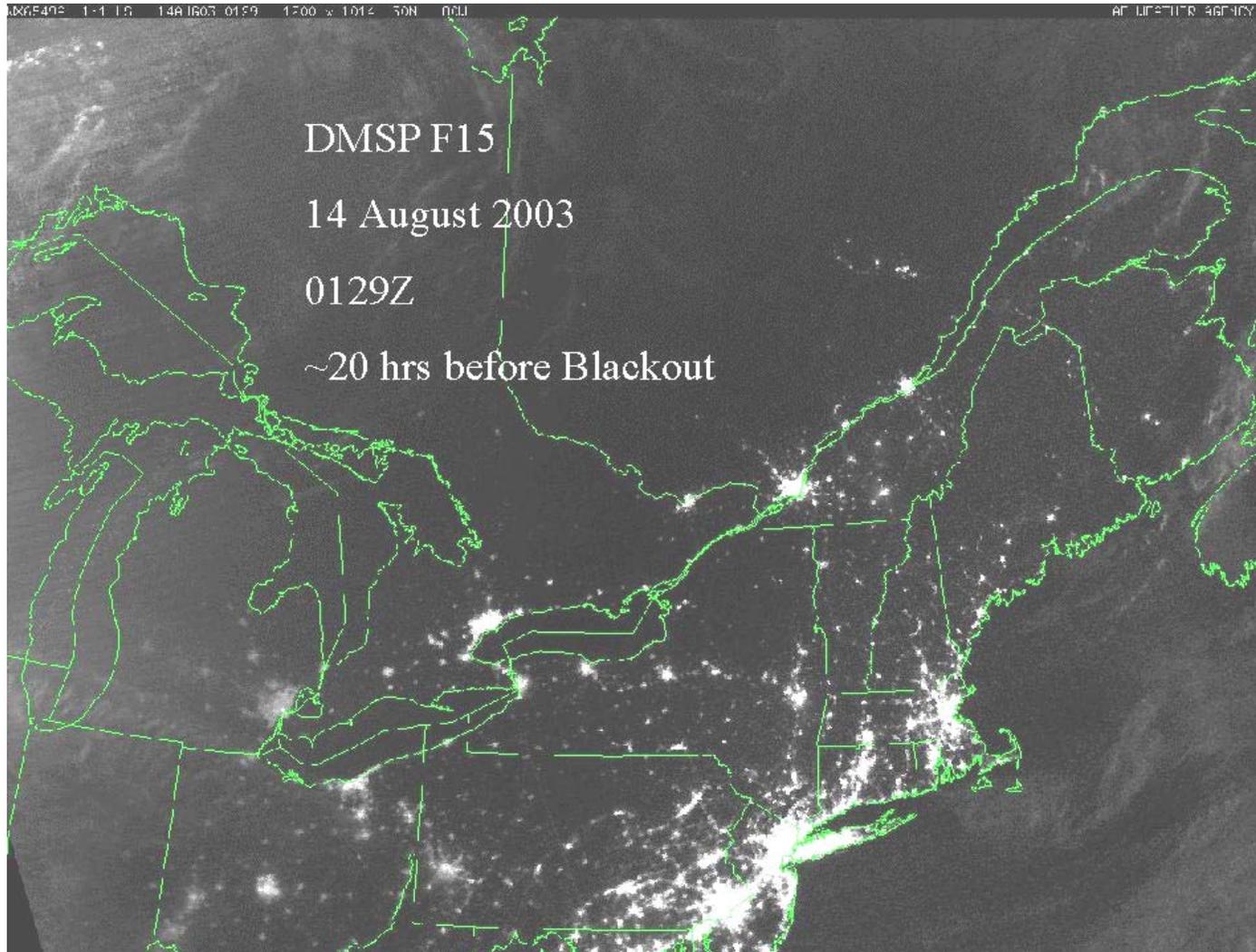


# Energy Use Compared to Economic Growth



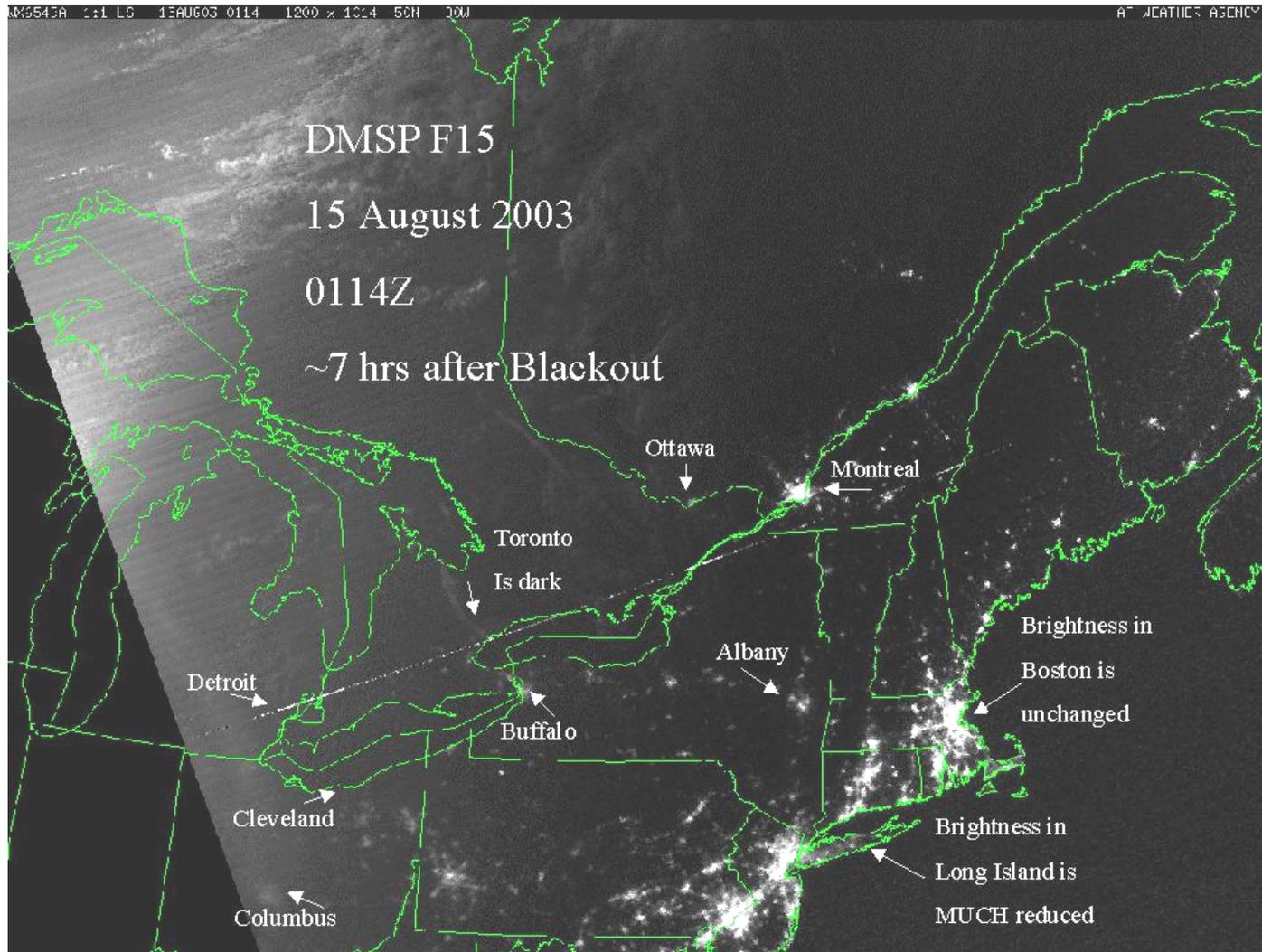
# 2003 Electric Power Blackout (before)

(photos courtesy of NOAA)

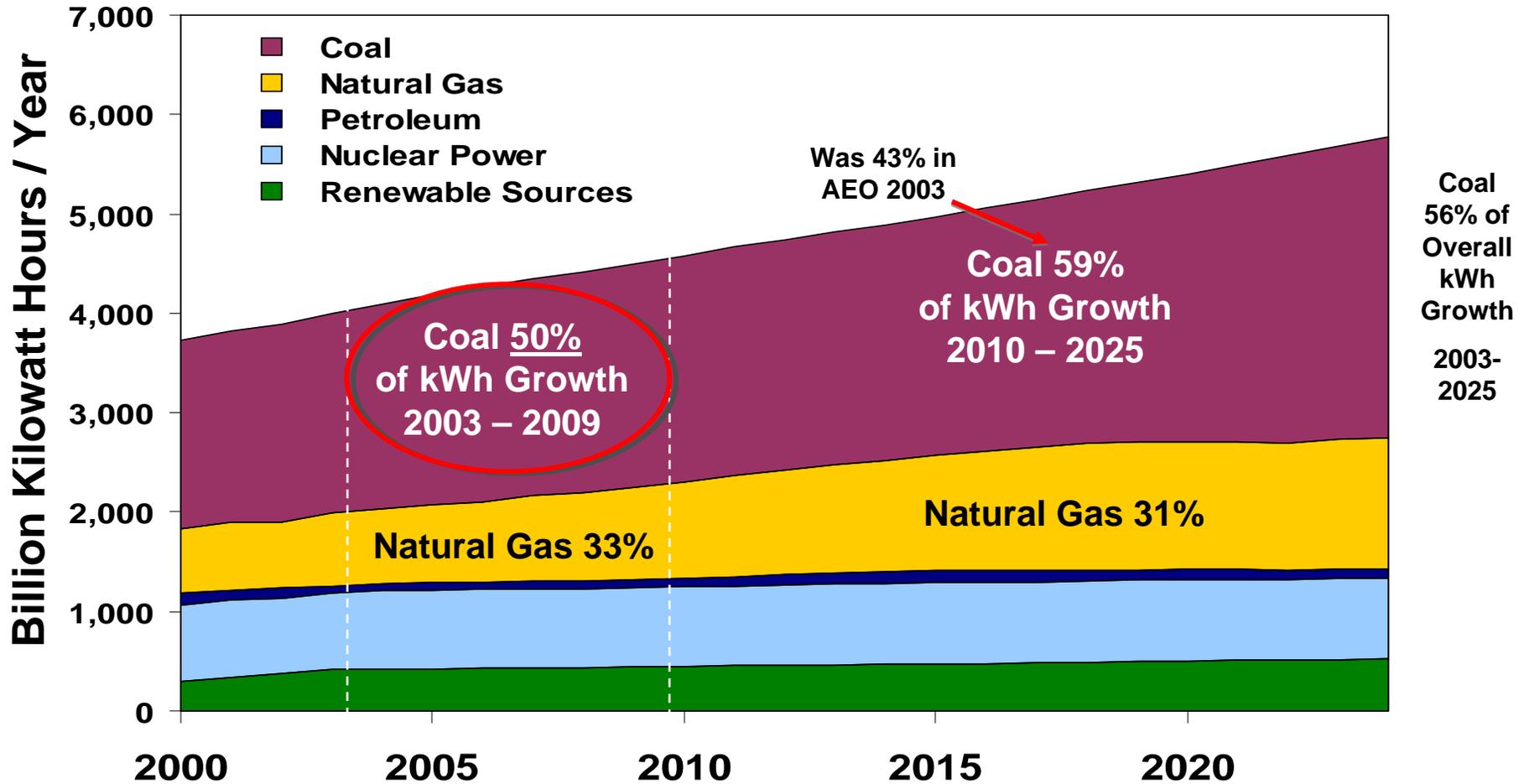


# 2003 Electric Power Blackout (after)

(photos courtesy of NOAA)



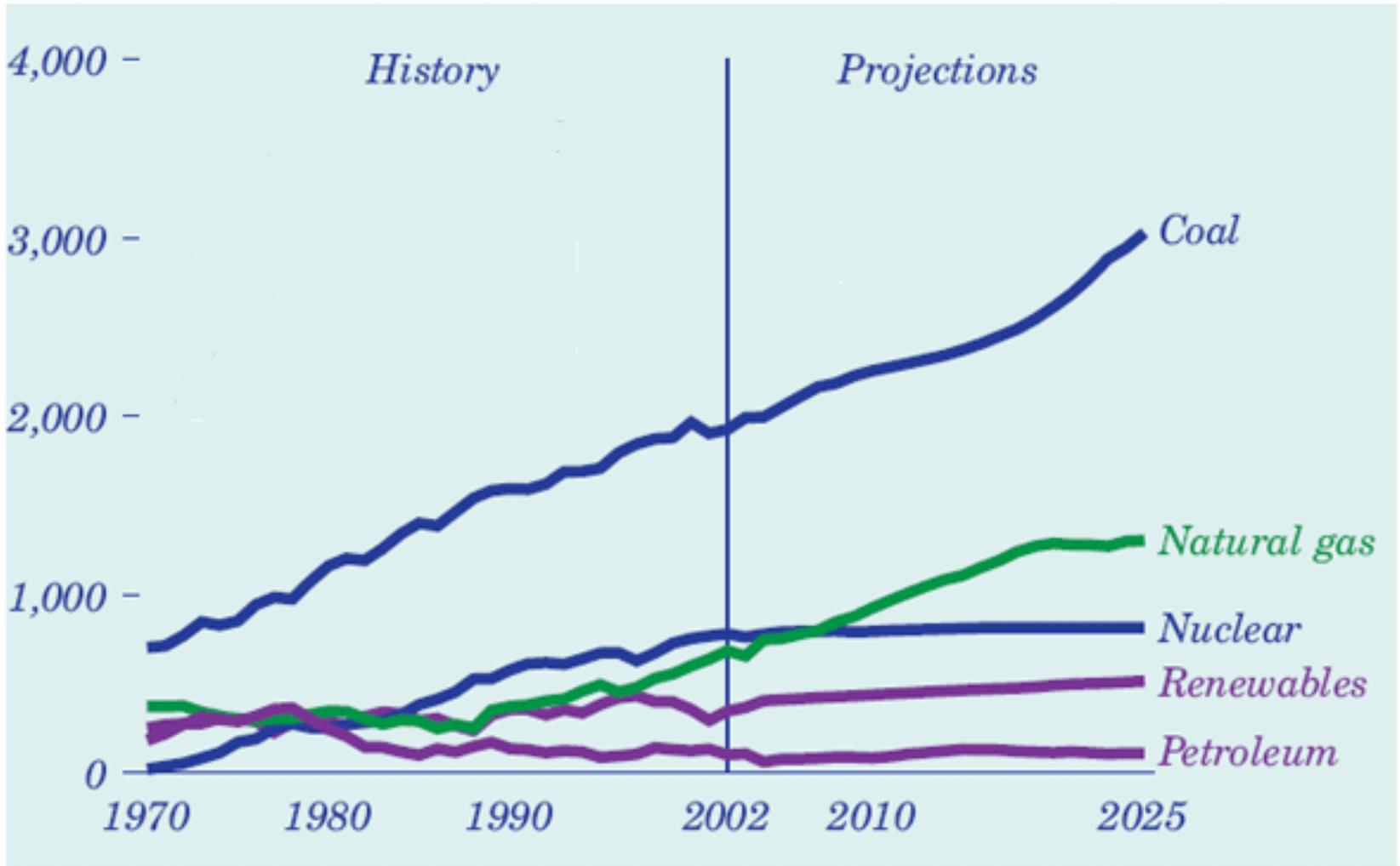
# Fuel Mix for Electricity Growth AEO'04



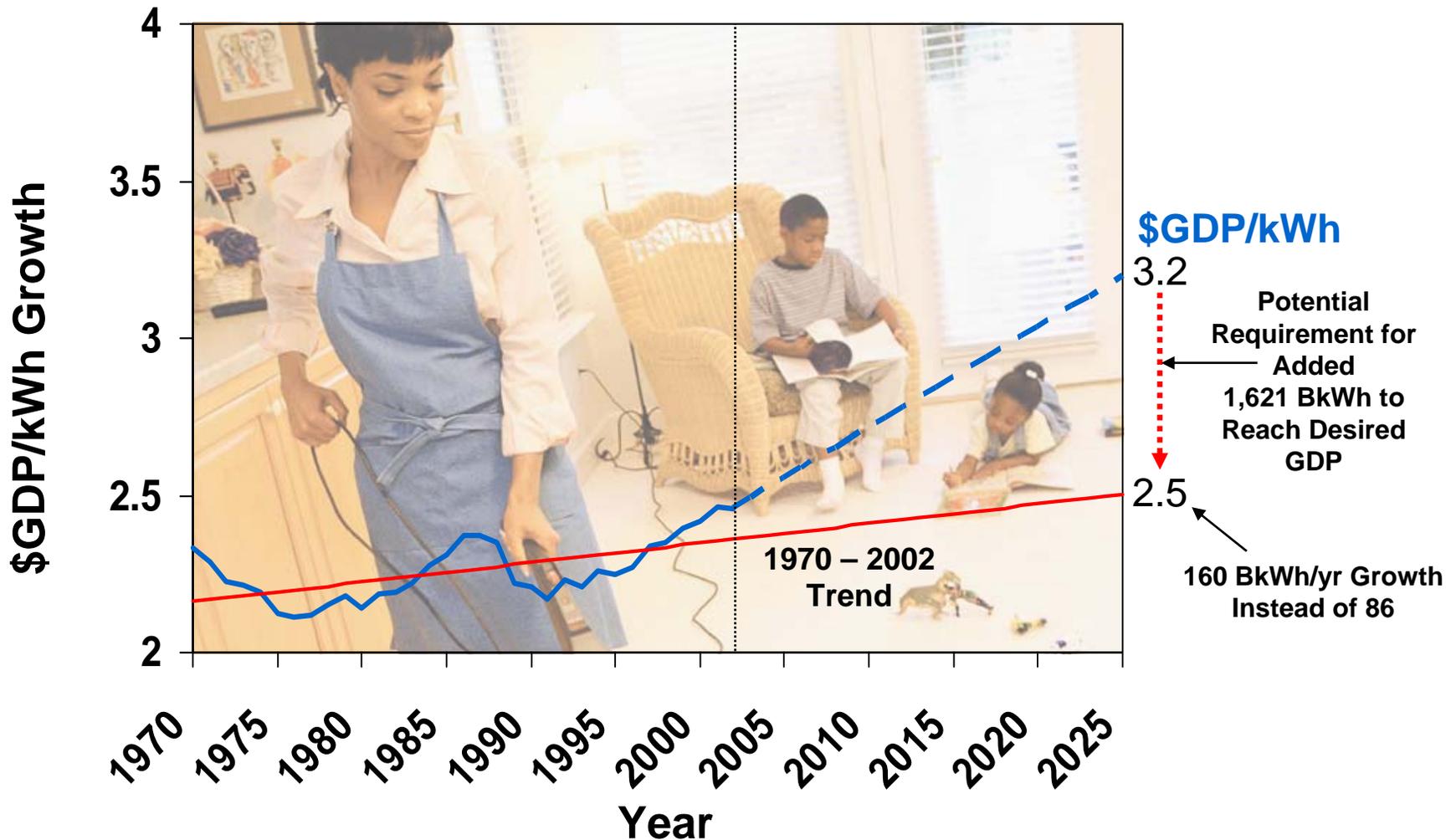
*Coal Expected To Provide 50% of Incremental kWhs (2003 to 2009) Despite Few Additions*



# Electricity generation by fuel, 1970-2025 (billion kilowatthours)



# Electricity & Economic Growth

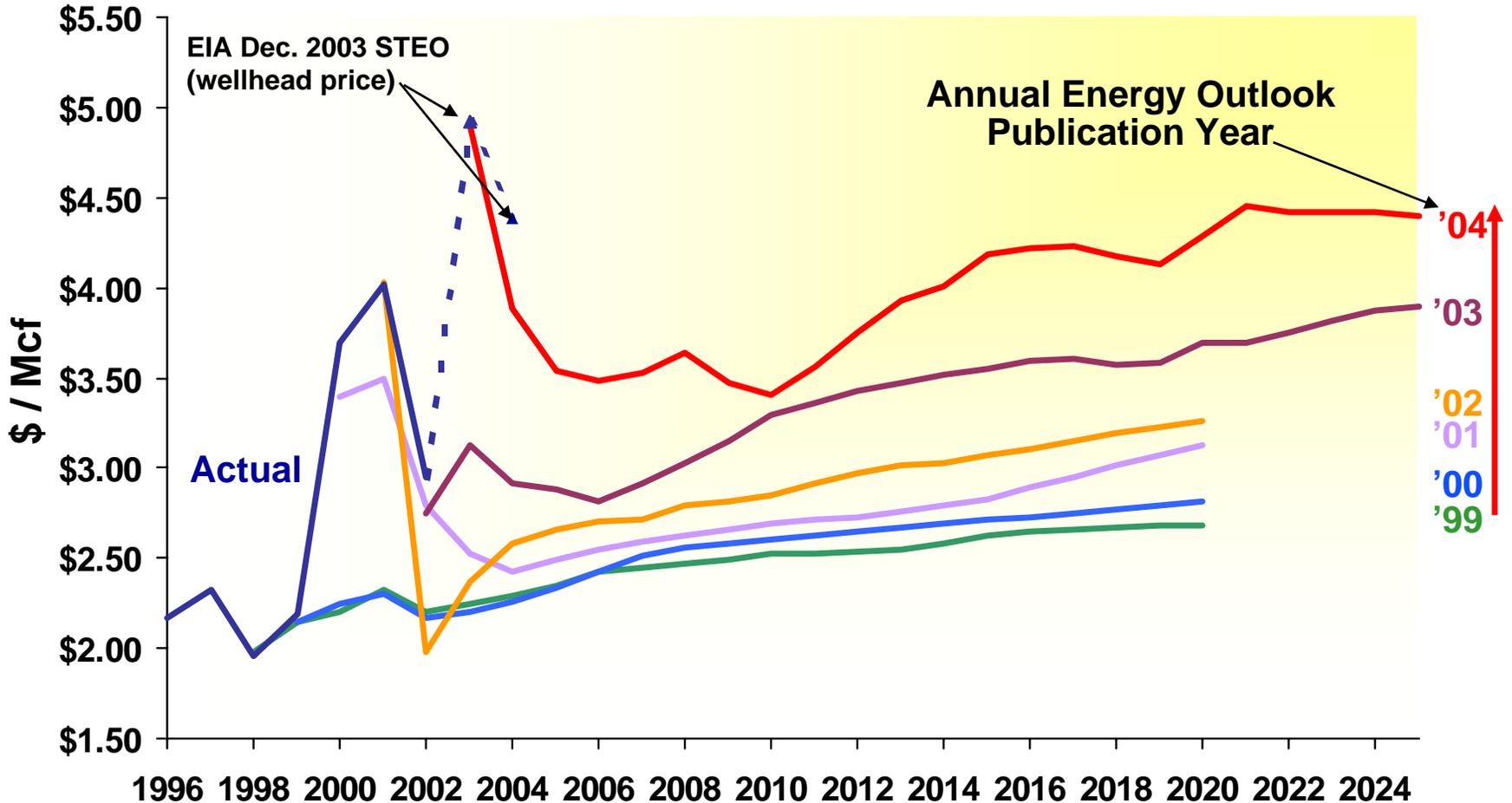


**Disengagement of Forecast GDP and Electric Generation  
May Underestimate Electricity Growth Requirement by 74 BkWh/yr (46%)**



# Changing Forecasts After 4 Years of High Price

## *Paradigm Shift in a Fuel Price for Electricity?*

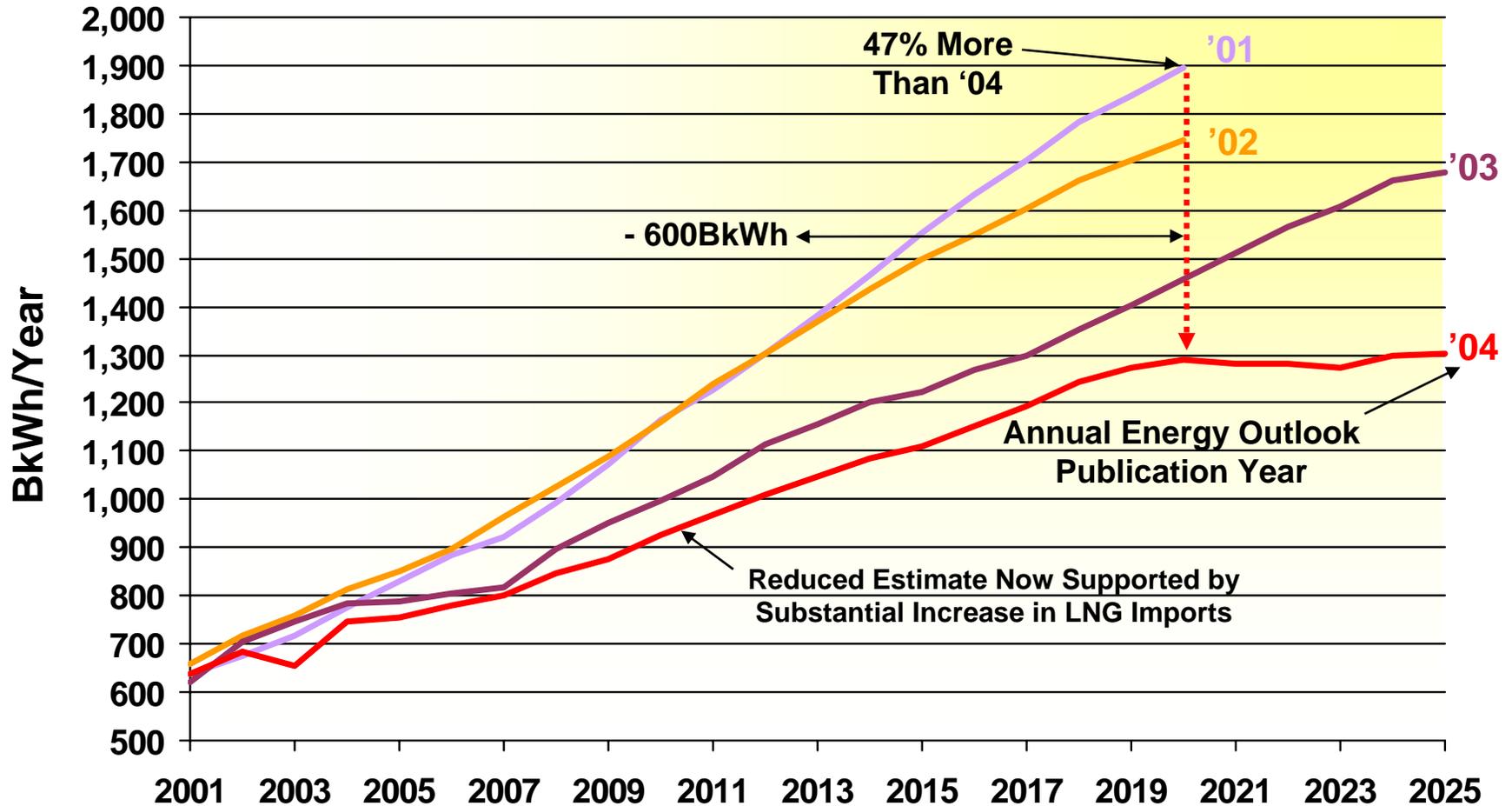


*Growing Recognition of New Price Plateau at \$4–5 /MMBtu*  
*AEO 2004 Near Term Optimism Based on LNG, Increased Drilling*



# Changing Natural Gas Generation Forecasts

## *Paradigm Shift in Fuel Use for Electricity*



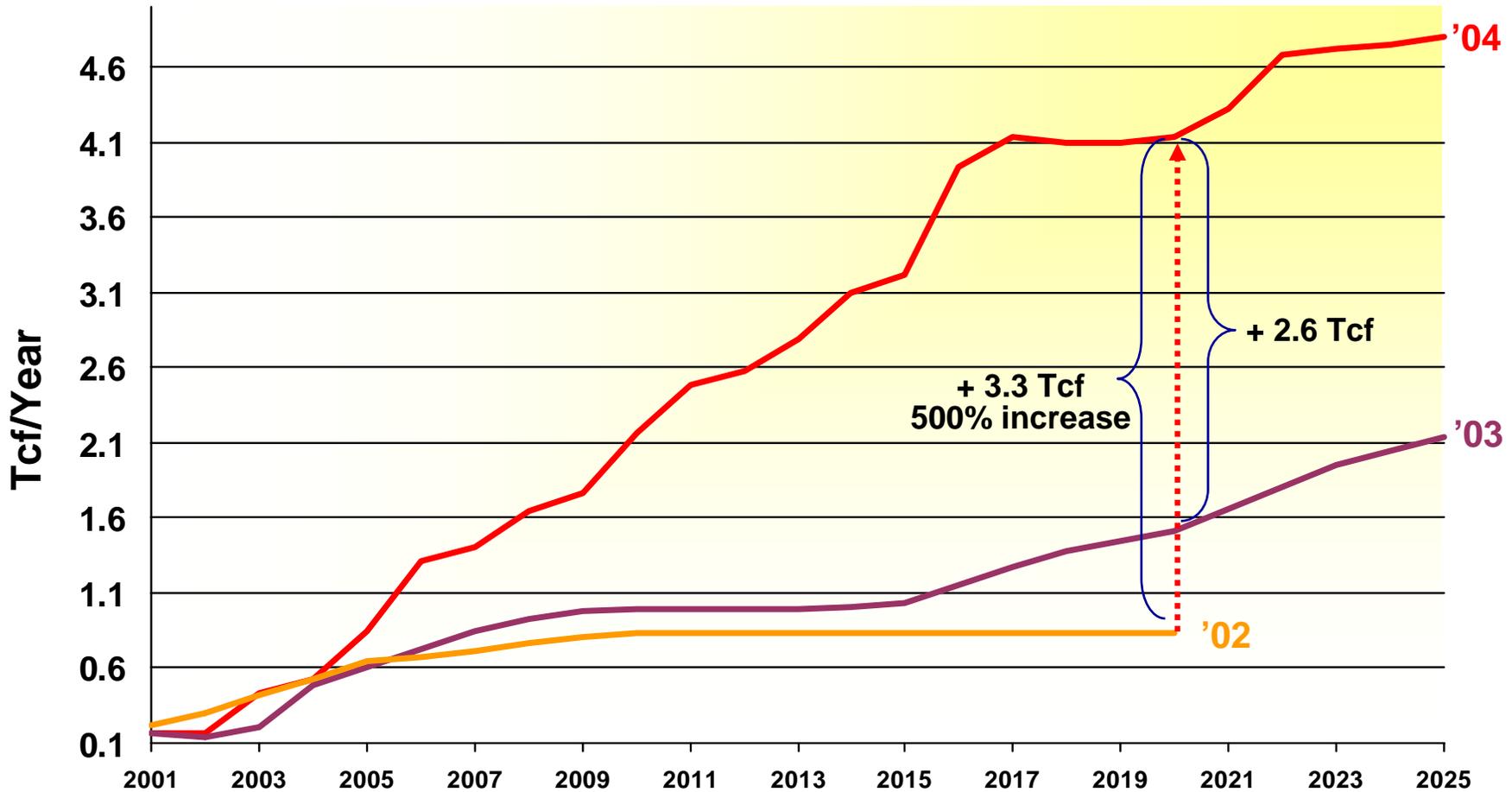
*Gradual Recognition of Natural Gas Supply Constraints*

*Three Year Decline (2020) Nearly Equal to Today's Gas kWh Production*



# Changing LNG Import Forecasts

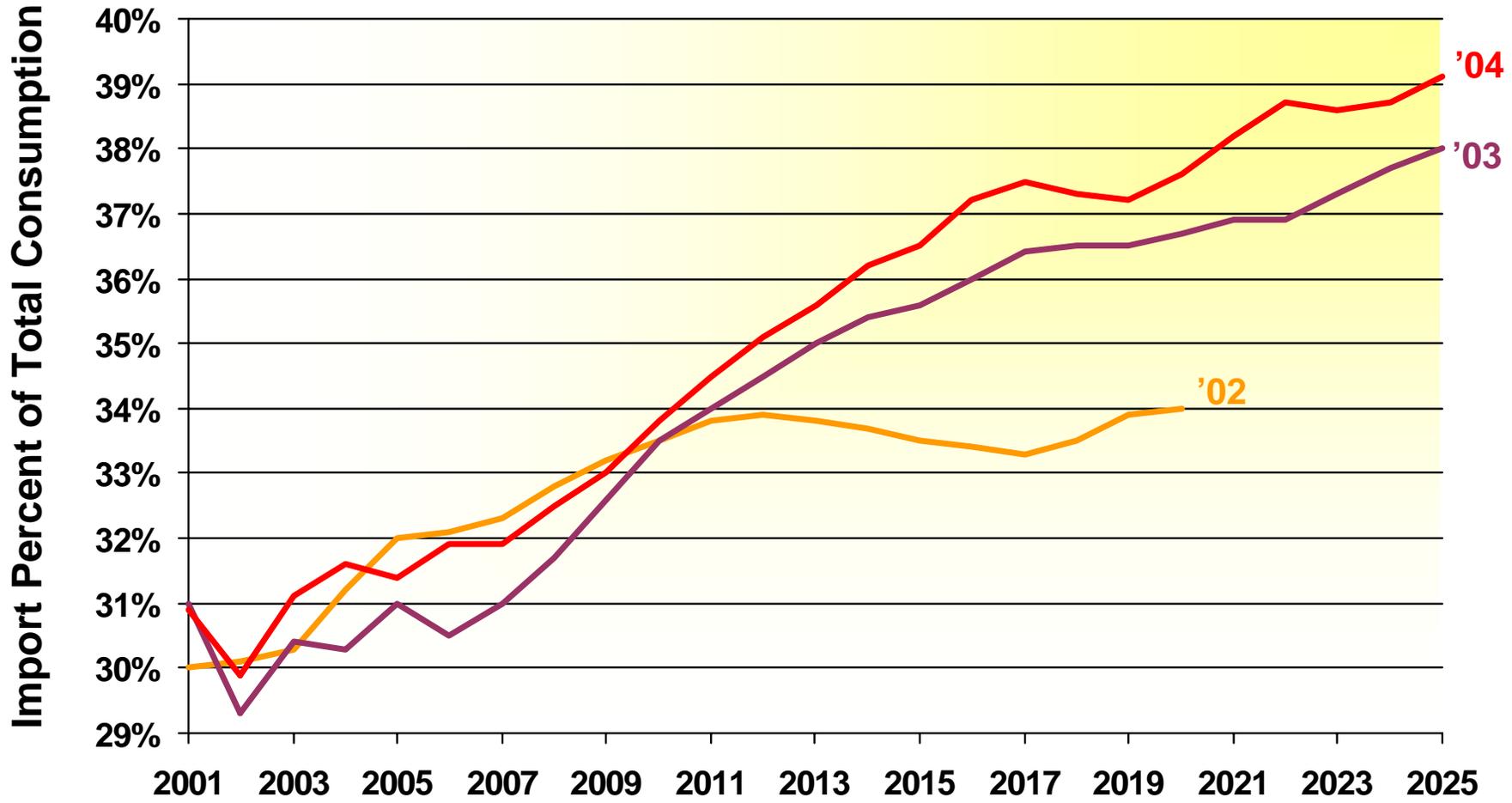
## *Shift in Imported Fuel for Gas-fired Generation*



***Rapid Increase in LNG Supply Assumption  
Supports Natural Gas Generation Potential***



# Increasing Dependence On Energy Imports

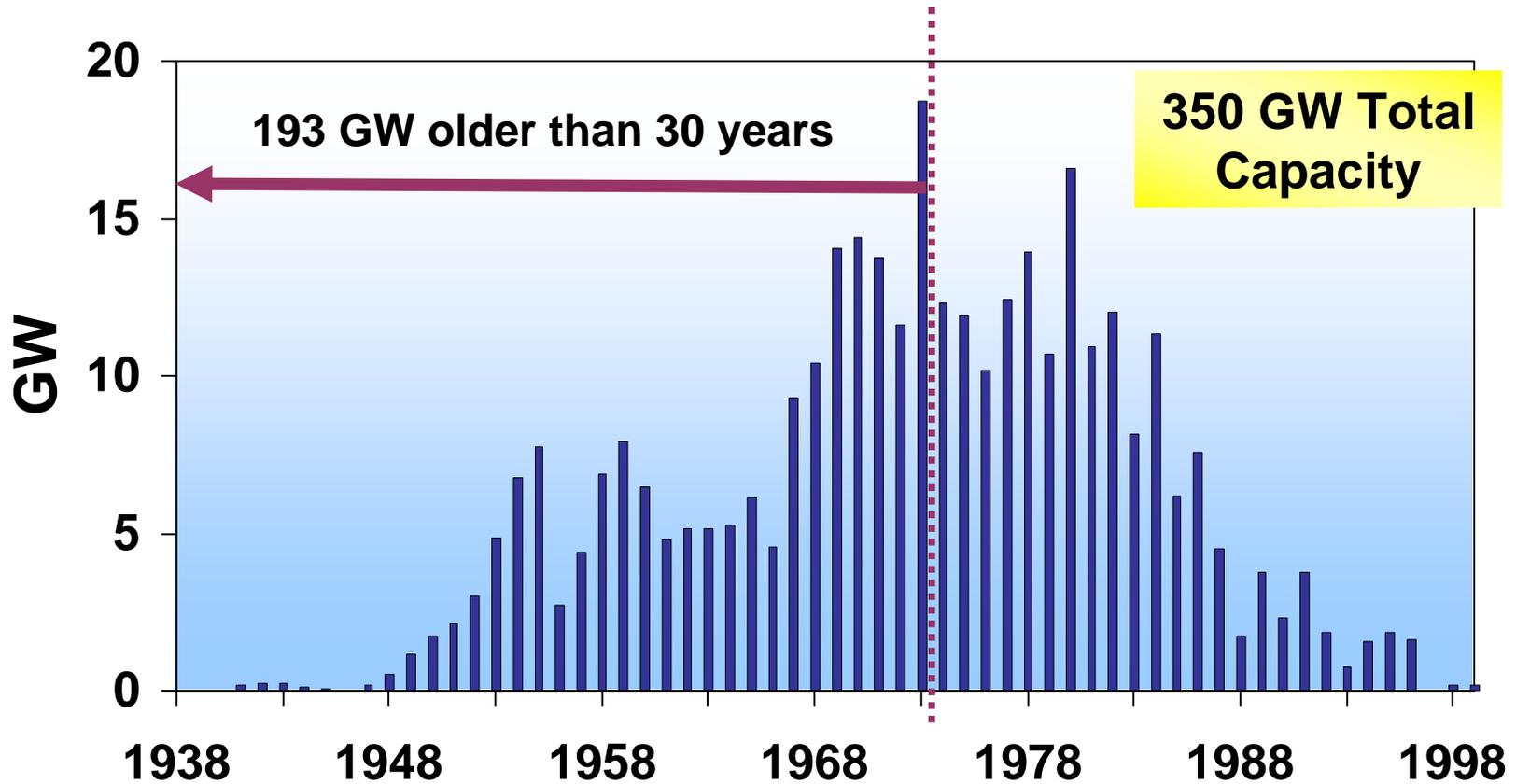


*Rise in Foreign Energy Dependence → Decline in Energy Security*



# North American Coal Units

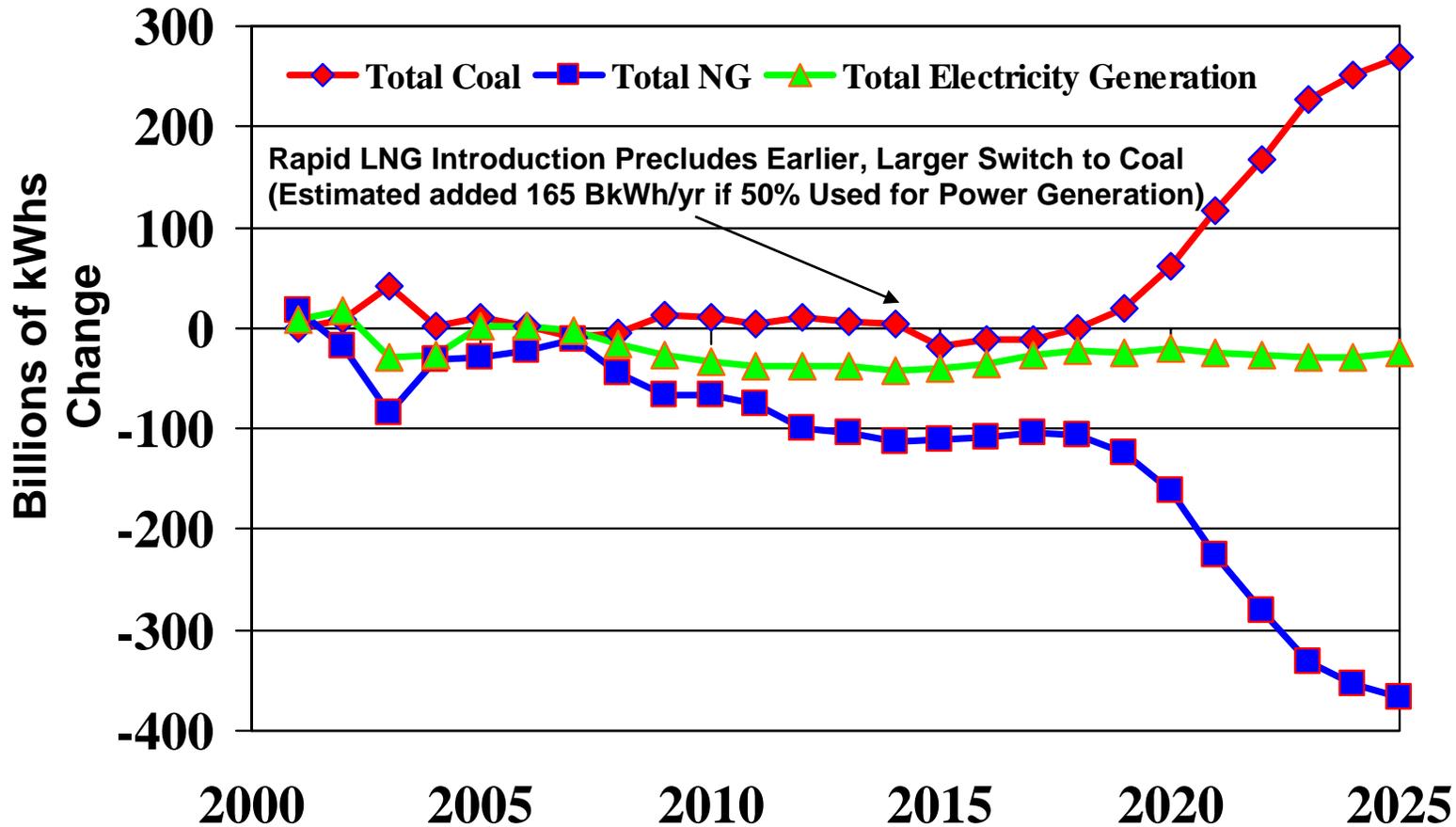
## *First Year of Operation*



Many coal plants will need to be replaced or repowered starting in 2020



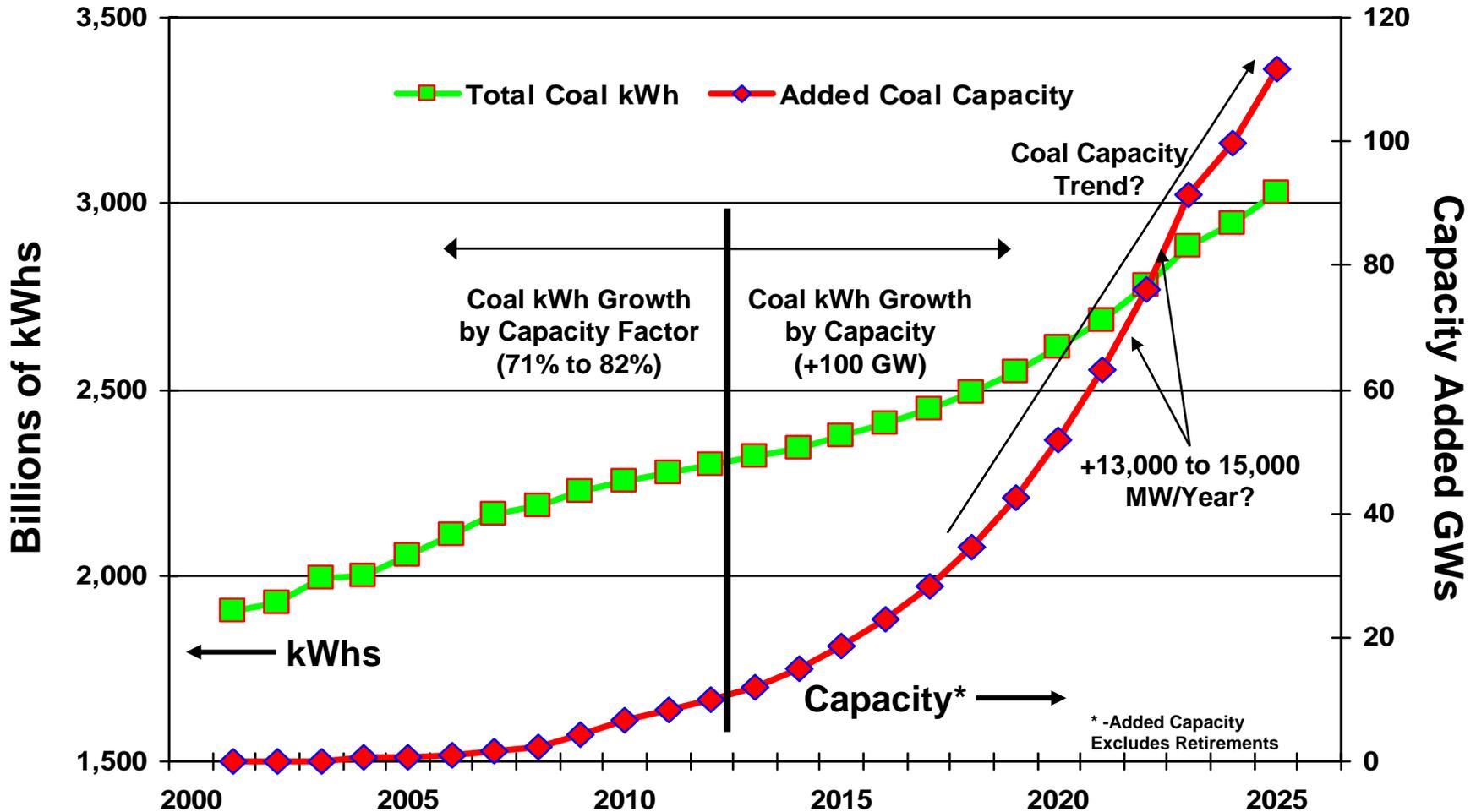
# kWh Forecast Delta AEO'03 to AEO'04



*Substantial Back-end Switch to Coal from Natural Gas  
for Incremental kWh Production*



# Coal kWh and Capacity Forecast AEO'04

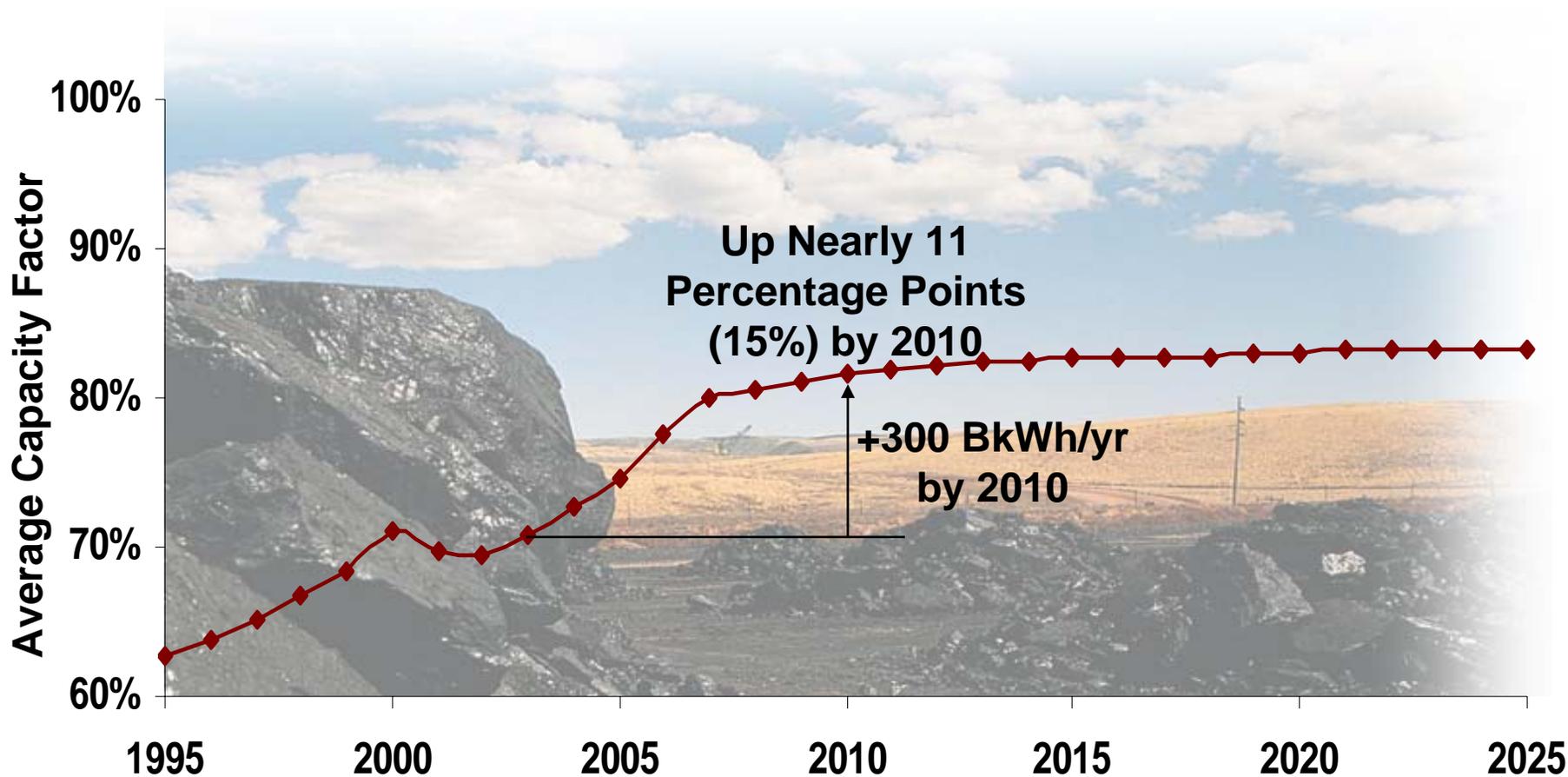


*Back-end Reliance on Coal-fired Capacity Growth*

*Can Coal-fired Power Industry Wait 20 Years for Meaningful Business?*



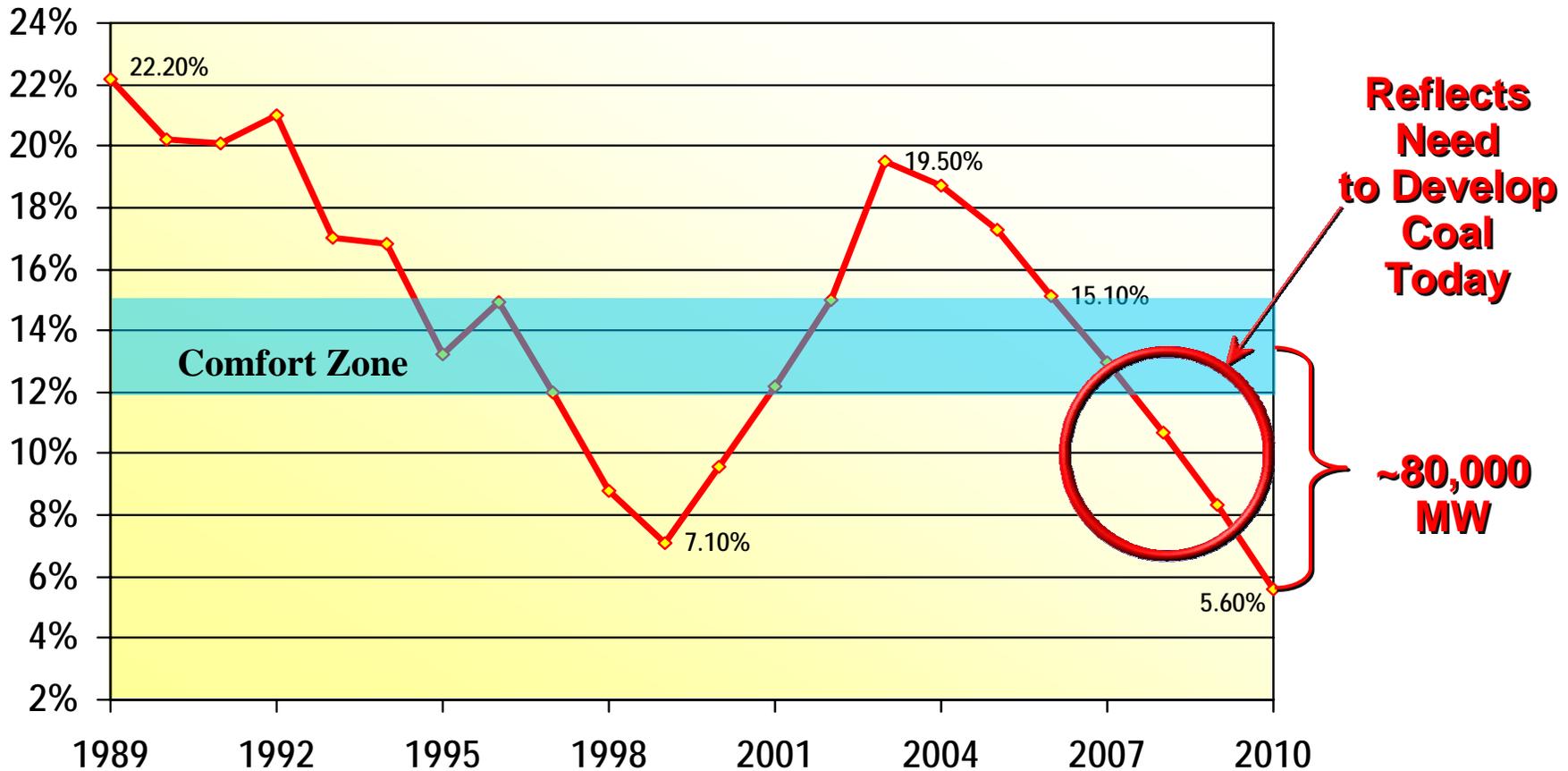
# Coal Capacity Factors Increase (AEO'03)



*Coal Capacity Factors Continue to Provide Over Half of Incremental Electricity Production Over Next Several Years*



# U.S. Capacity Margins



*Natural Gas Fuel Constraints Will Likely Cause Near-Term Margin Deficiencies; Can LNG Respond?*



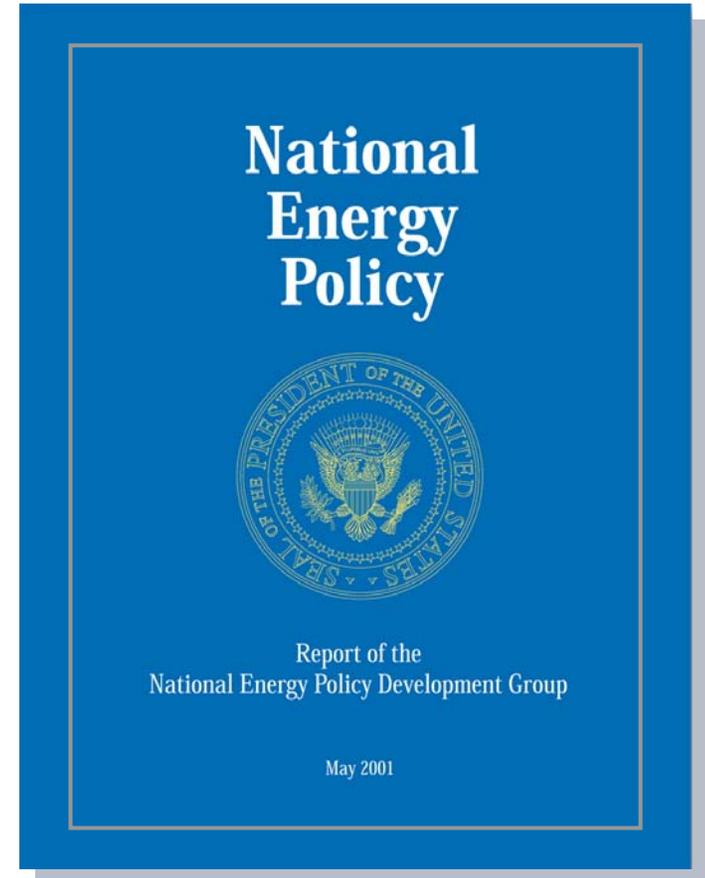
# So What?

- **Putting megawatts on the grid at the rates required to meet forecasts will require—**
  - Getting absolute most from existing fleet
    - process optimization will play big time!
  - Getting reliable operation from new (more complex) plants
    - process control will play big time!
- **Realizing a reliable power grid is highly dependent on reliability of individual plants**

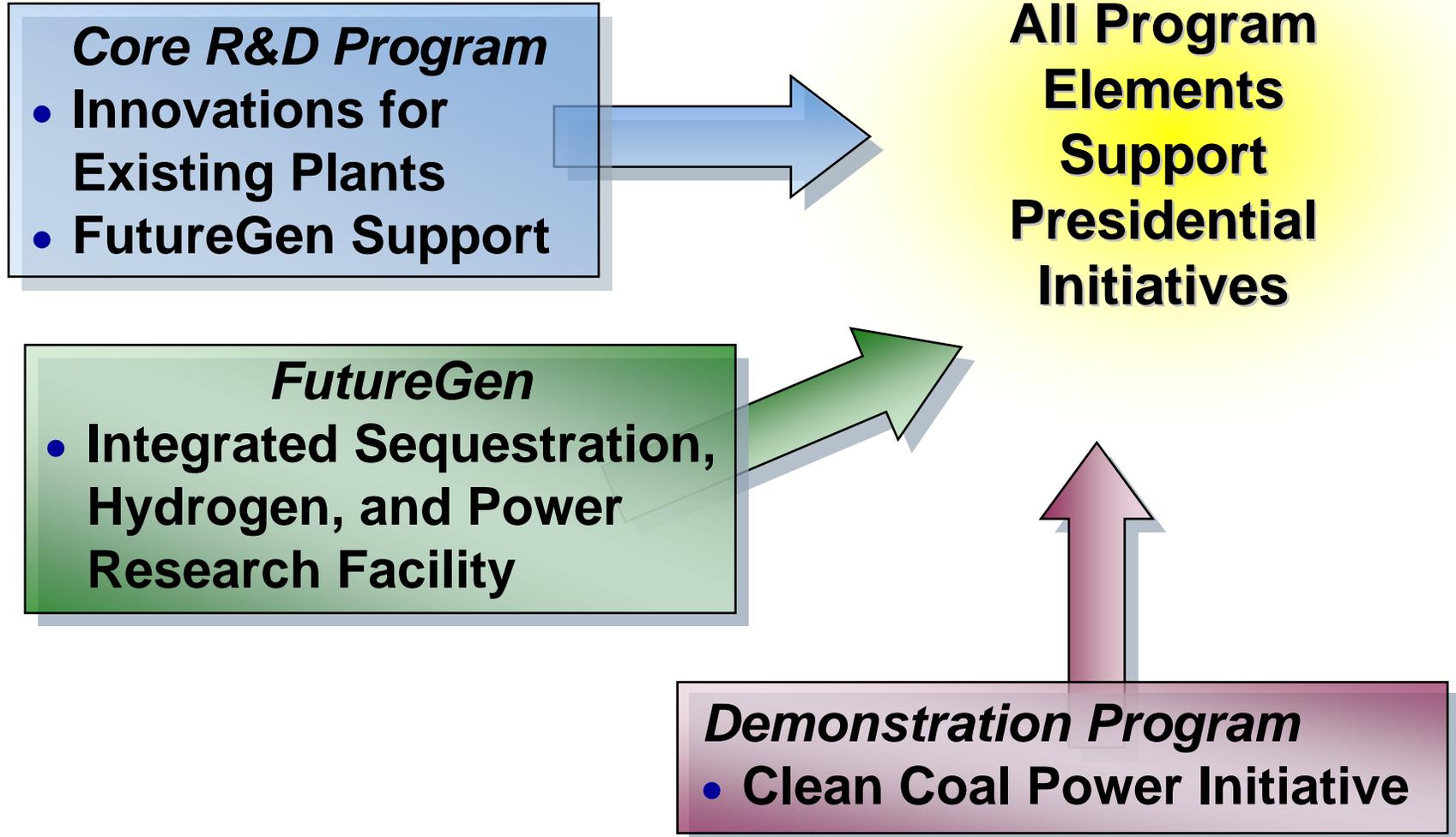


# National Energy Policy

- Increasing America's domestic energy supplies
- Protecting America's environment
- Ensuring a comprehensive delivery system
- Enhancing national energy security

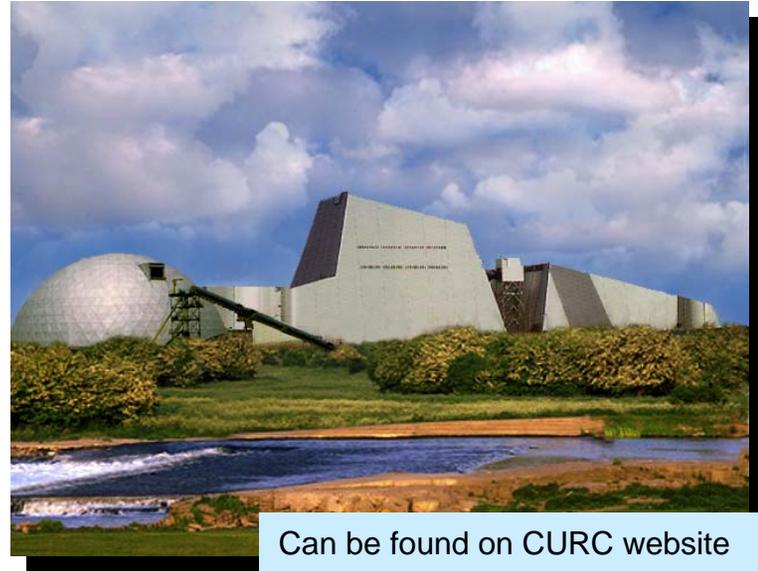


# Elements of Coal & Power Program



# Clean Coal Technology Roadmap Addresses Near- and Long-range Needs

- **Short-term: existing fleet**
  - Cost-effective environmental control technologies to comply with current and emerging regulations
- **Long-term: future energy plants**
  - Near-zero emissions power and clean fuels plants with CO<sub>2</sub> management capability



Can be found on CURC website

[www.coal.org](http://www.coal.org)

and NETL

[www.netl.doe.gov/  
coalpower](http://www.netl.doe.gov/coalpower)



# Coal Power Program Roadmap

## *New Plant Performance Targets*

*(Represents best integrated plant technology capability)*

	<b>Reference Plant</b>	<b>2010</b>	<b>2020 Vision 21</b>
<b>Air Emissions</b>	<b>98% SO<sub>2</sub> removal</b>	<b>99%</b>	<b>&gt;99%</b>
	<b>0.15 lb/10<sup>6</sup> Btu NO<sub>x</sub></b>	<b>0.05 lb/10<sup>6</sup> Btu</b>	<b>&lt;0.01 lb/10<sup>6</sup> Btu</b>
	<b>0.01 lb/10<sup>6</sup> Btu Particulate Matter</b>	<b>0.005 lb/10<sup>6</sup> Btu</b>	<b>0.002 lb/10<sup>6</sup> Btu</b>
	<b>Mercury (Hg)</b>	<b>90% removal</b>	<b>95% removal</b>
<b>By-Product Utilization</b>	<b>30%</b>	<b>50%</b>	<b>near 100%</b>
<b>Plant Efficiency (HHV)</b>	<b>40%</b>	<b>45-50%</b>	<b>50-60%</b>



# Coal Power Program Roadmap

## *New Plant Performance Targets<sup>1</sup>*

*(Represents best integrated plant technology capability)*

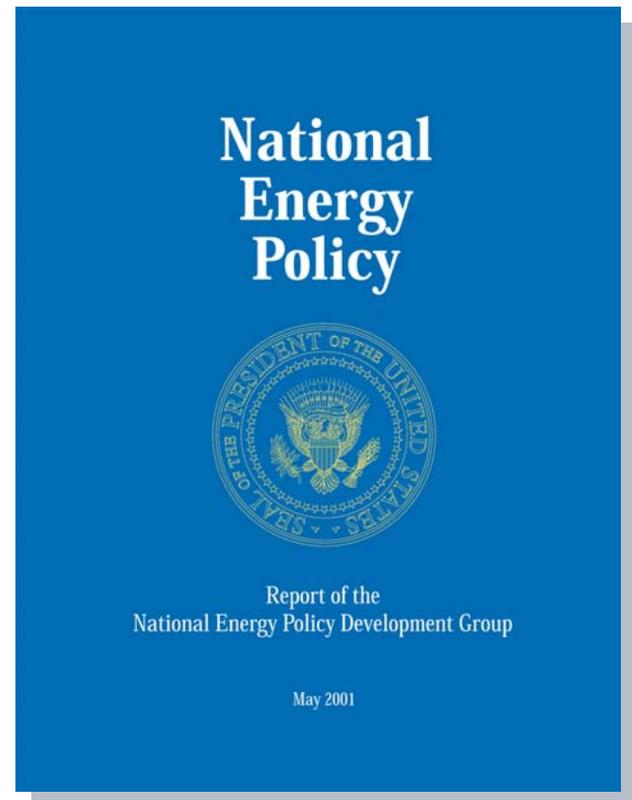
	<b>Reference Plant</b>	<b>2010</b>	<b>2020 Vision 21</b>
<b>Availability<sup>(3)</sup></b>	<b>&gt;80%</b>	<b>&gt;85%</b>	<b>≥90%</b>
<b>Plant Capital Cost<sup>(2)</sup></b> <b>\$/kW</b>	<b>1000 – 1300</b>	<b>900 – 1000</b>	<b>800 – 900</b>
<b>Cost of Electricity<sup>(4)</sup></b> <b>¢/kWh</b>	<b>3.5</b>	<b>3.0 - 3.2</b>	<b>&lt;3.0</b>

- (1) Targets are w/o carbon capture and sequestration and reflect current cooling tower technology for water use
- (2) Range reflects performance projected for different plant technologies that will achieve environmental performance and energy cost targets
- (3) Percent of time capable of generating power (ref. North American Electric Reliability Council)
- (4) Bus-bar cost-of-electricity in today's dollars; Reference plant based on \$1000/kW capital cost, \$1.20/10<sup>6</sup> Btu coal cost

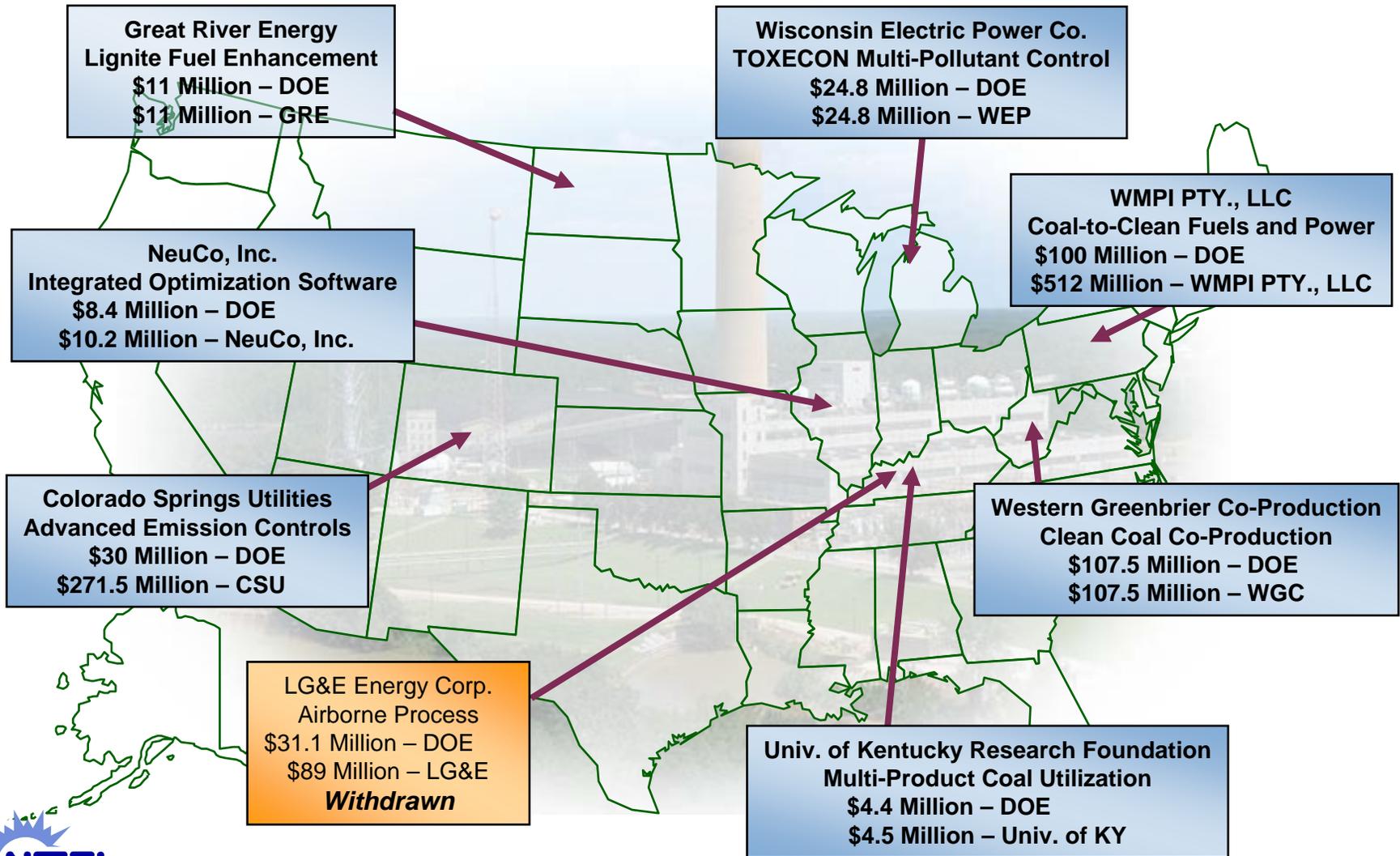


# Clean Coal Power Initiative

- Implemented NEP recommendation to increase investment in clean coal technology
- **\$2 billion over 10 years starting in FY 02**
  - Anticipates series of competitive solicitations
  - Industry cost share of at least 50%
  - Builds off CCT and PPII demonstration efforts

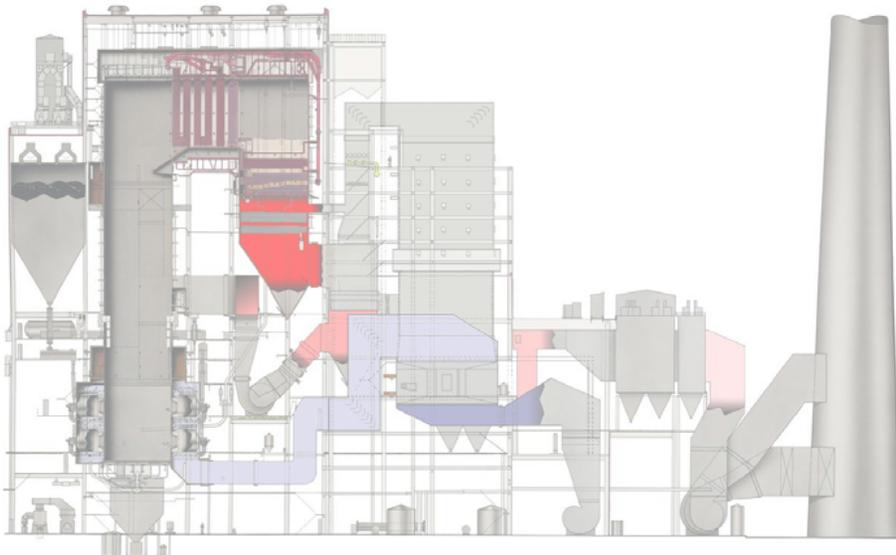


# Clean Coal Power Initiative (CCPI) – Round 1 Projects



# NeuCo, Inc.

- Integrated optimization software on three 600 MW units reduces emissions, increases efficiency, and increases reliability.
- Five optimization modules: cyclone combustion, soot blowing, SCR operations, thermal performance, and profit optimization.
- Higher efficiencies help to meet Climate Change goals.
- Total project funding: \$18.6 million (DOE share: \$8.4 million).



Dynegy Midwest Generation's Baldwin Energy Complex



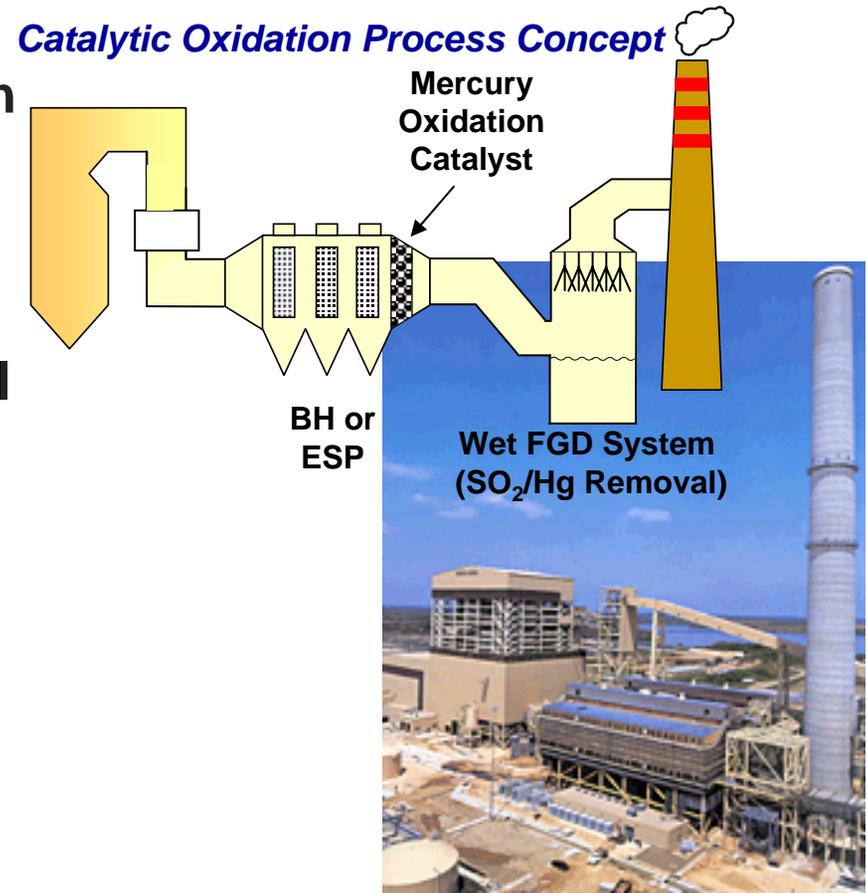
**A CCPI Round 1 Project**



# Mercury Control R&D

## *Catalytic Mercury Oxidation for Low-Rank Coals*

- URS, CPS, EPRI & NETL conducting pilot scale tests with catalysts to oxidize elemental mercury to a form that can be scrubbed in WFGD
- Commercial concept is to install a 4-inch catalyst depth at PCD outlet to achieve +80% Hg<sup>0</sup> oxidation to ensure +90% Hg capture in WFGD
- Testing at J.K. Spruce Plant
  - 546 MW T-fired boiler
  - Fires PRB & PRB/Pet Coke



*CPS's J.K. Spruce Plant  
Bexar County , Texas*



Equipped with BH and WFGD

# Tentative Priority Technologies

## *Future CCPI Rounds*

- **Emission control**
  - Mercury
  - NO<sub>x</sub>

- **Advanced Power Technologies**
  - Improved efficiency/lower capital cost
  - Sequestration friendly
- **Sequestration**

**Round 2**

**Round 3**

**Round 4**

**Technologies  
for Clear  
Skies  
Compliance**

**Technologies  
For Zero-  
Carbon  
Emission  
Plants**

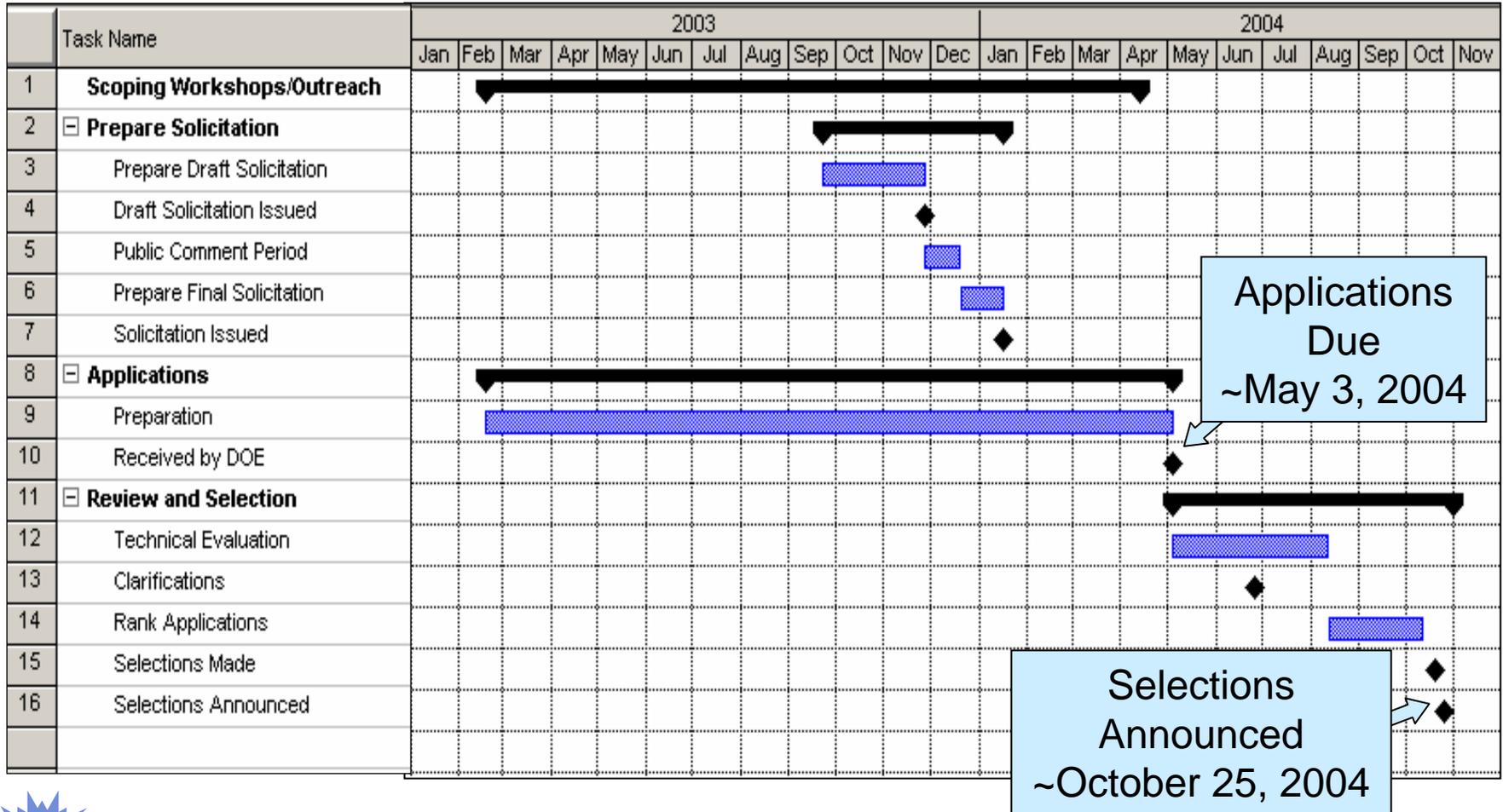
**Program  
Goals**



# CCPI Round 2 Schedule

## *Path to Selection*

*(Dates Approximate)*



# Carbon Sequestration Program Structure

## Core R&D

Capture of CO<sub>2</sub>

Sequestration

- Direct CO<sub>2</sub> storage
- Enhanced natural sinks

Break-through Concepts

Measurement, Monitoring & Verification

Non-CO<sub>2</sub> GHG Mitigation



Carbon Sequestration Leadership Forum

## Infrastructure

### 7 Regional Partnerships

- Engage regional, state, local governments
- Determine regional sequestration benefits
- Baseline region for sources and sinks
- Establish monitoring and verification protocols
- Address regulatory, environmental, & outreach issues
- Test sequestration technology at small scale

*Initiated FY 2003*

## Integration

### FutureGen

- First-of-kind integrated project
- Verify large-scale operation
- Highlight best technology options
- Verify performance & permanence
- Develop accurate cost/performance data
- International showcase

*Initial Funding in FY 2004*



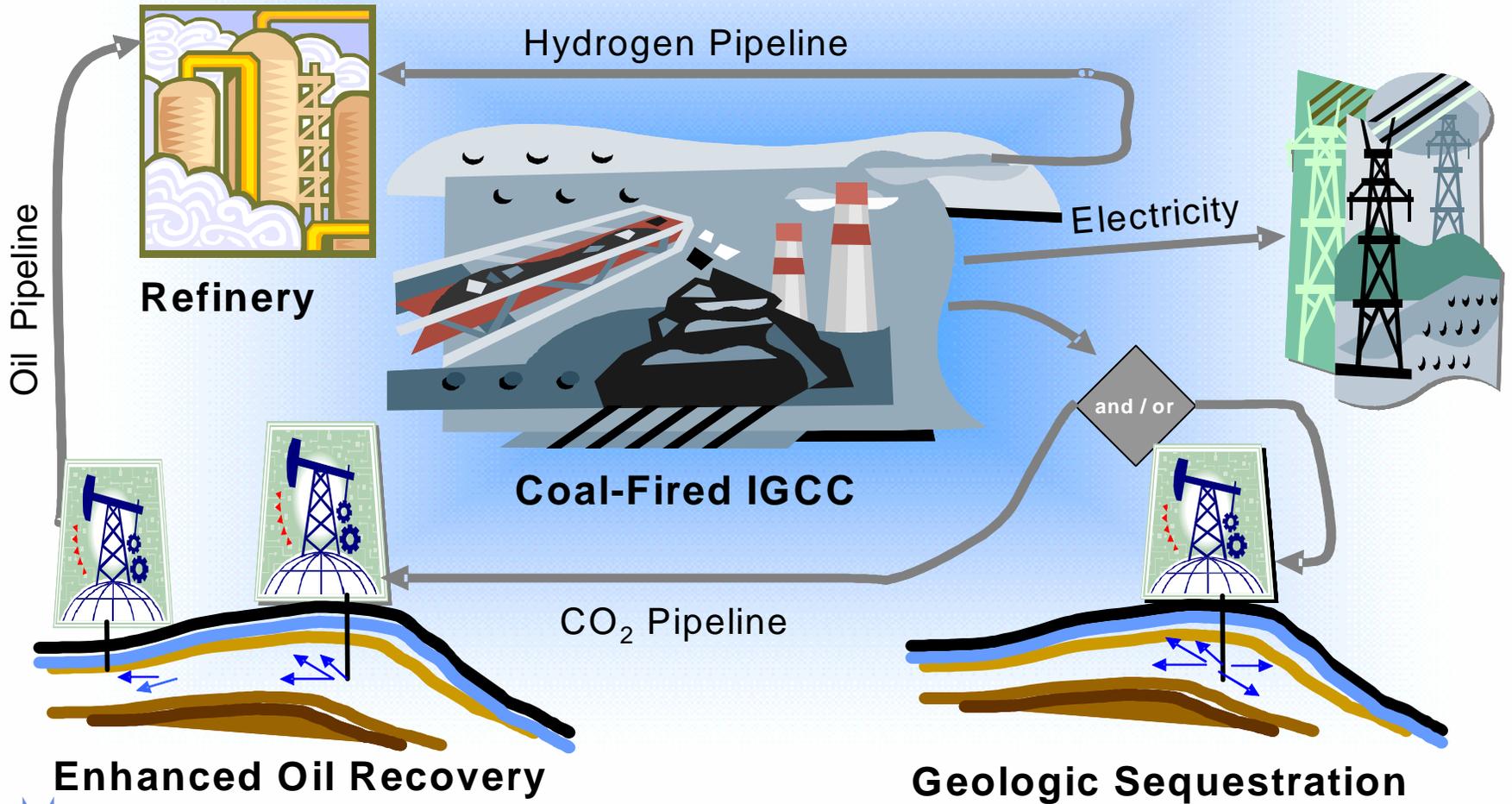
# FutureGen: A Presidential Initiative

**One-billion-dollar, 10-year demonstration project to create world's first coal-based, zero-emission electricity and hydrogen plant**  
*President Bush, February 27, 2003*

- Produce electricity and hydrogen from coal using advanced technology
- Emit virtually no air pollutants
- Capture and permanently sequester CO<sub>2</sub>

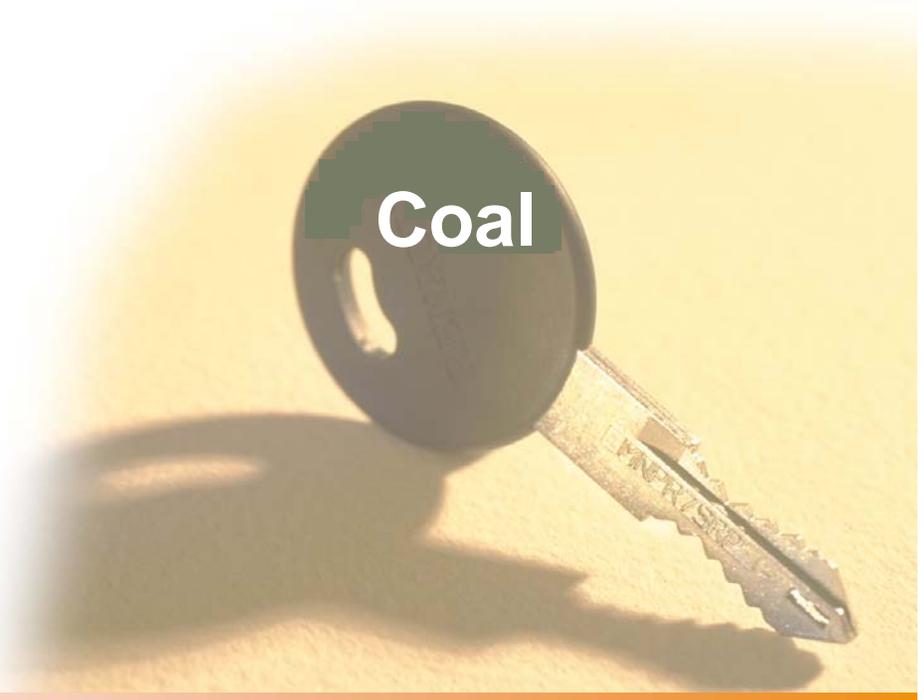


# FutureGen Concept



# Closing Comments

- **Coal must play a key role to secure a healthy economy**
  - Is recognized in Presidential-level initiatives; Clear Skies, Climate Change, FutureGen, Hydrogen, Sequestration
  - Coal can play an important role in a potential future carbon-constrained world
- **Regulatory uncertainty improving (e.g. NSR)**
- **CCT Roadmap charts challenging but doable path forward**
  - Best ideas needed
  - Sustain Federal and private sector investments



# Visit Our NETL Website

[www.netl.doe.gov](http://www.netl.doe.gov)

# Visit Our OCES Website

[www.netl.doe.gov/coalpower/](http://www.netl.doe.gov/coalpower/)

**NATIONAL ENERGY TECHNOLOGY LABORATORY**  
United States Department of Energy

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February 08, 2003

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**TOP NEWS STORIES**



**DOE Names Winners of Clean Coal Competition**  
\$1.3 Billion of Projects Aimed at Clear Skies, Climate Change & Coal Waste Cleanup

The Department of Energy has named the first winners in President Bush's Clean Coal Power Initiative. The eight projects are valued at more than \$1.3 billion and include new technologies to reduce air pollutants, boost power plant efficiencies, and extract energy from coal waste piles. [Read More!](#)

**Experimental Fiber Optic Cables To Warn of Potential Pipeline Damage Tests Begin of an "Early Warning" System To Prevent Damage to Natural Gas Pipelines**

Technicians in a joint DOE-industry project have deployed fiber optic cables over a mile of an active gas pipeline in the first test of a new system to detect encroaching construction activity. [Read More!](#)

**Gas Upgrading R&D "Success Story"**

A new gas upgrading technology funded by DOE and the Gas Technology Institute moves to market. [Link To GTI Announcement](#)

**NEW! DOE AWARDS NEW CONTRACTS TO IMPROVE POWER PLANTS BY:**

**Recycling Coal Combustion Ash**

A cooperative agreement with Universal Aggregates, LLC calls for a manufacturing plant at the Birchwood Power Facility in King George, Virginia, to turn coal ash into aggregate. [Read More!](#)

**Integrating Lower Cost NOx Controls**

A unique combination of high-tech combustion modifications and sophisticated control systems will be tested on a Kansas coal plant to show how new technology can reduce air emissions and save money. [Read More!](#)

[Visit the Homeland Security Energy Infrastructure Website!](#)

**SPECIAL ANNOUNCEMENTS**

- [Powder River Coal Can Be Rich Source of Natural Gas](#) (PDF)
- [Abraham Announces Plans to Expand Sequestration Program](#)
  - [Regional Carbon Sequestration Partnerships Solicitation](#)

**BUSINESS SECTORS**

- Strategic Center for Natural Gas
- Coal and Env. Systems
- Climate Change Policy Support
- National Petroleum Technology Office
- Env. Technologies & Business Excellence
- Homeland Security Energy Infrastructure

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**NATIONAL ENERGY TECHNOLOGY LABORATORY**  
OFFICE OF COAL & ENVIRONMENTAL SYSTEMS

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**Office of Coal & Environmental Systems**

Playing a central planning and coordination role in ensuring that coal is sustained as an abundant, affordable, and acceptable resource for satisfying our country's need for energy, now and well into the future.

Welcome to NETL's [Office of Coal and Environmental Systems](#) webpage. From promoting gasification and combustion technologies, to funding and fostering carbon sequestration and advanced research, we take the steps necessary to ensure coal is sustained as a clean and affordable energy supply.

Through this website, we hope to answer your questions about using coal as a reliable, stable, and sustainable source for electric power. We will share with you the technologies in place now to make this a reality, and the planning, funding, and development efforts to make tomorrow's technologies a reality, today.

[Tracking New Coal-Fired Power Plants](#) (PDF-445KB)

Advanced Research  
Carbon Sequestration  
Clean Coal Power Initiative (CCPI)  
Combustion Technologies  
Environmental & Water Resources  
Gasification Technologies  
Mining Industry of the Future  
Vision 21

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