

# Upcoming Priorities for DOE's Innovations for Existing Power Plants R&D Program



*Institute of Clean Air  
Companies (ICAC)  
Annual Meeting*

*May 1, 2008  
Stuart, Florida*

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US Department of Energy  
National Energy Technology Laboratory



# National Energy Technology Laboratory

- **Only DOE national lab dedicated to fossil energy**
  - Fossil fuels provide 85% of U.S. energy supply
- **One lab, five locations, one management structure**
- **1,200 Federal and support-contractor employees**
- **Research spans fundamental science to technology demonstrations**



*Alaska*



*Oklahoma*



*Oregon*



*Pennsylvania*



*West Virginia*



# Innovations for Existing Plants Program

## *Change in Program Focus*

- **FY07 R&D Activities**

- Mercury control
- Water management
- Coal utilization by-products
- NO<sub>x</sub> control



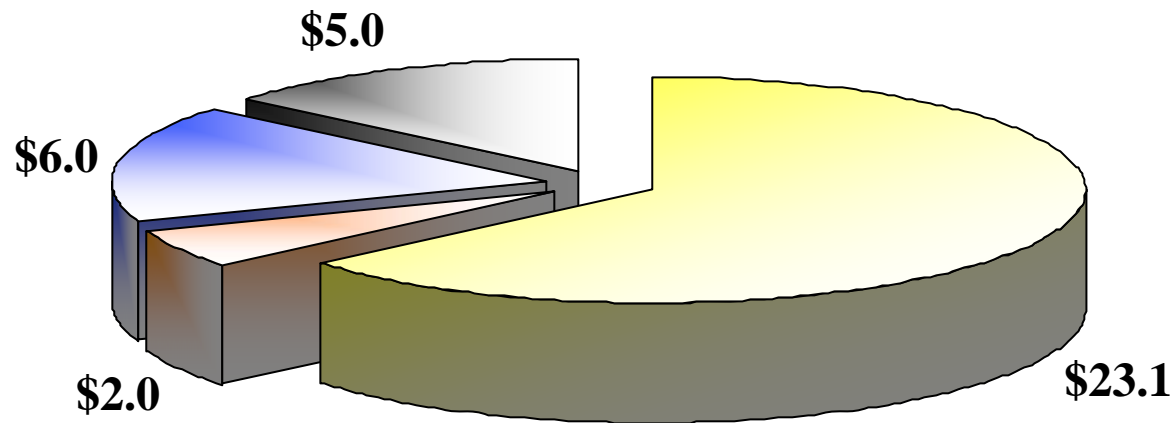
- **FY08 R&D Activities**

- *CO<sub>2</sub> control & compression*
- *Water management*

IEP Funding	
FY2007	FY2008
~\$15 M	~\$36.1 M



# FY08 IEP Funding Breakout (\$M)



■ CO2 Capture ■ CO2 Compression ■ Water ■ ORD



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# Mercury



# From Concept to Commercial Reality

## *NETL's Mercury Control R&D Activity*

### ***Sorbent injection***

- Untreated activated carbon injection (ACI)
- Chemically-treated/brominated ACI
- TOXECON™
- TOXECON II™
- “Ash-friendly” & non-carbon sorbents

### ***Hg<sup>0</sup> oxidation enhancements***

- Aqueous chemical additives
- Fixed-bed catalysts



### ***IEP Program's near-term goal:***

*To develop control technologies (available for commercial demonstration by year-end 2007 for all coal ranks) that can achieve 50 to 70% Hg capture at costs 25 to 50% less than the baseline (1999) estimate of \$60,000/lb Hg removed*



# Mission Accomplished?

## *Deployment of Mercury Control Technologies...*

- **Over 44 GW of coal-fired capacity have ordered full-scale ACI systems for Hg control**
  - New plants account for more than 11 GW
  - ~33 GW are ACI retrofits (~10% of total U.S. coal-fired capacity)
  - 8 ACI systems operational (~2,750 MW)
- **100 Coal-fired Units (includes 2 Canadian Facilities)**
  - 69 Subbituminous Units (28 GW)
  - 16 Bituminous Units (6.5 GW)
  - 5 Lignite Units (5 GW)
  - 9 Coal Blend Units (4.5 GW)

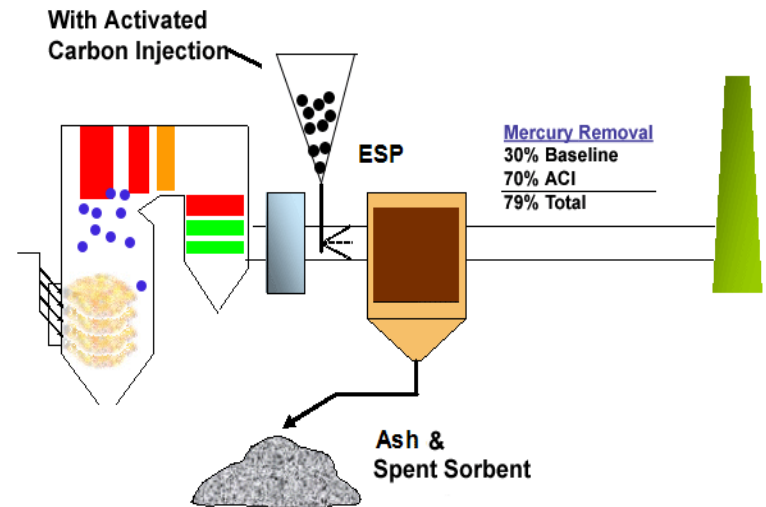


Source: *Institute of Clean Air Companies*  
Updated April 21, 2008

# ...But Technical/Performance/Regulatory Issues Remain

*February 8, 2008, the U.S. DC Circuit Court of Appeals issued a decision to vacate CAMR*

- Acid gas/SO<sub>3</sub> interference
- Coal utilization by-product (CUB) impacts
- Mercury re-emissions across FGD scrubbers
- Increased particulate loading (NSR)
- High temperature mercury capture
- Baghouse impacts



*Activated carbon injection*

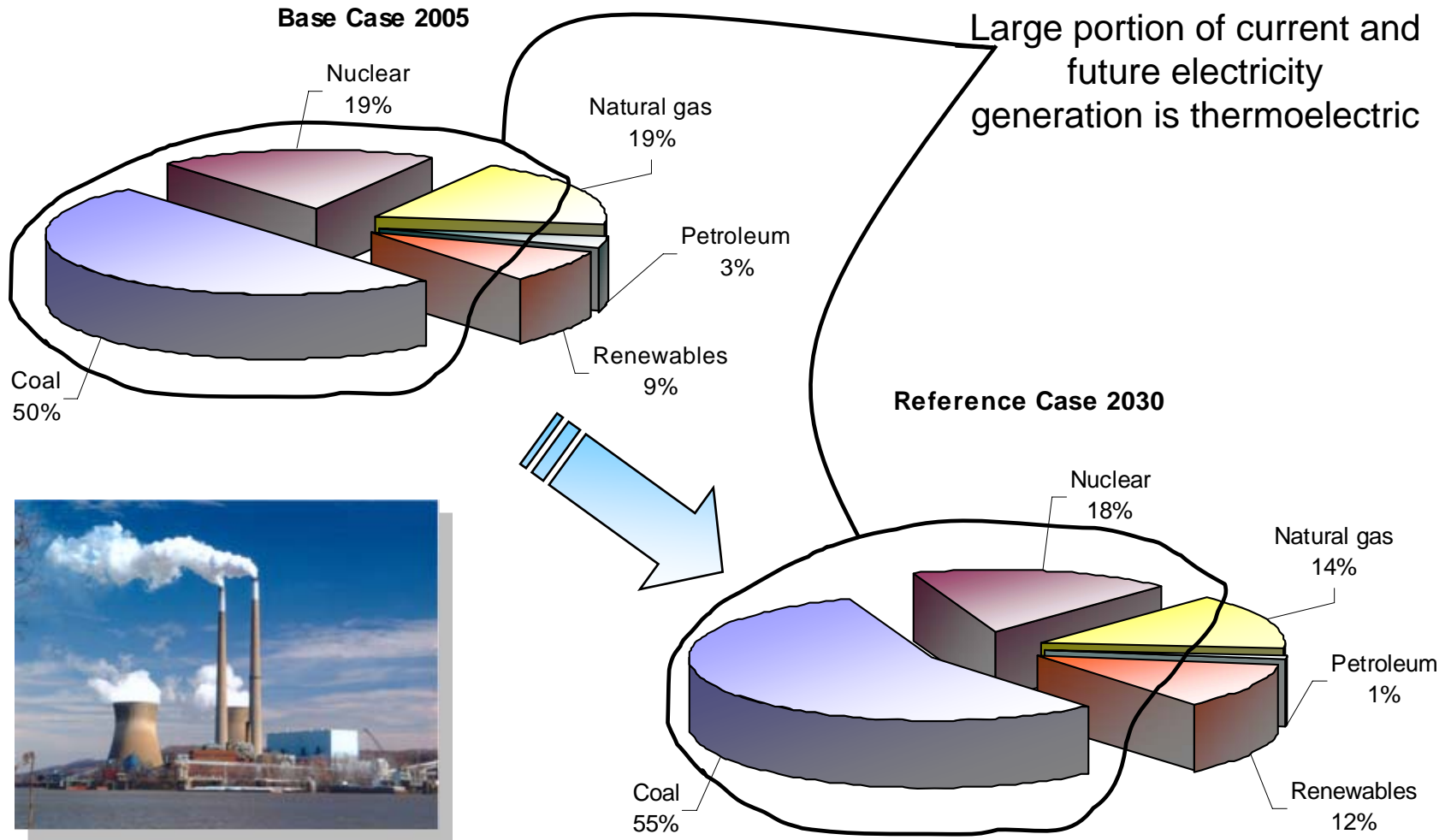


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# Water



# U.S. Electricity Generation by Fuel Type



# Water/Energy-Related Articles

## *Impacts on Power Plant Siting and Operation*

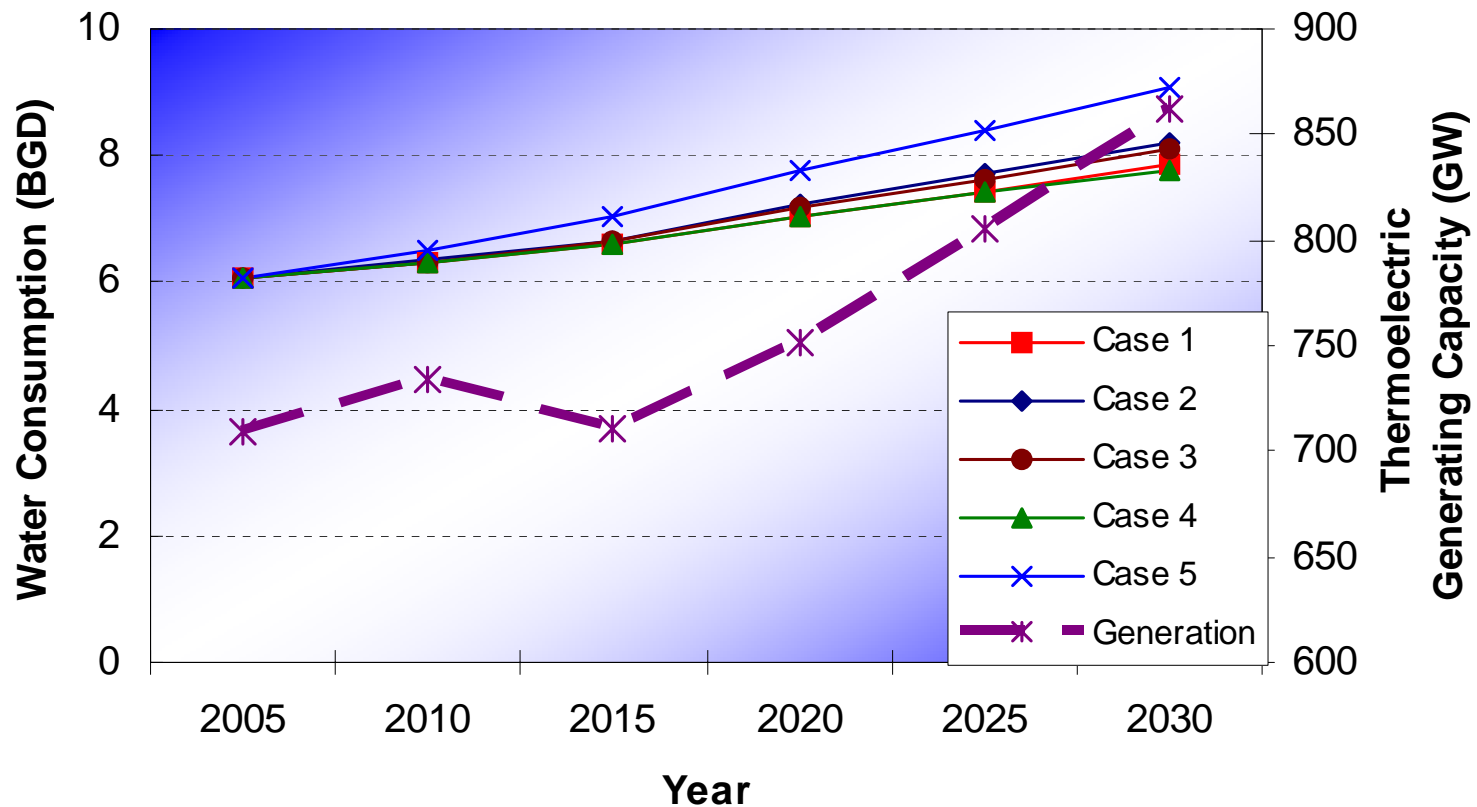
- **Drought Could Force Nuke-Plant Shutdowns**
  - [The Associated Press](#), January 2008
- **Sinking Water and Rising Tensions**
  - [EnergyBiz Insider](#), December 2007
- **Stricter Standards Apply to Coal Plant, Judge Rules; Activists Want Cooling Towers for Oak Creek**
  - [Milwaukee Journal Sentinel](#), November 2007
- **Journal-Constitution Opposes Coal-Based Plant, Citing Water Shortage**
  - [The Atlanta Journal-Constitution](#), October 2007
- **Maryland County Denies Cooling Water to Proposed power plant**
  - [E-Water News Weekly](#), October 2007
- **Water Woes Loom as Thirsty Generators Face Climate Change**
  - [Greenwire](#), September 2007



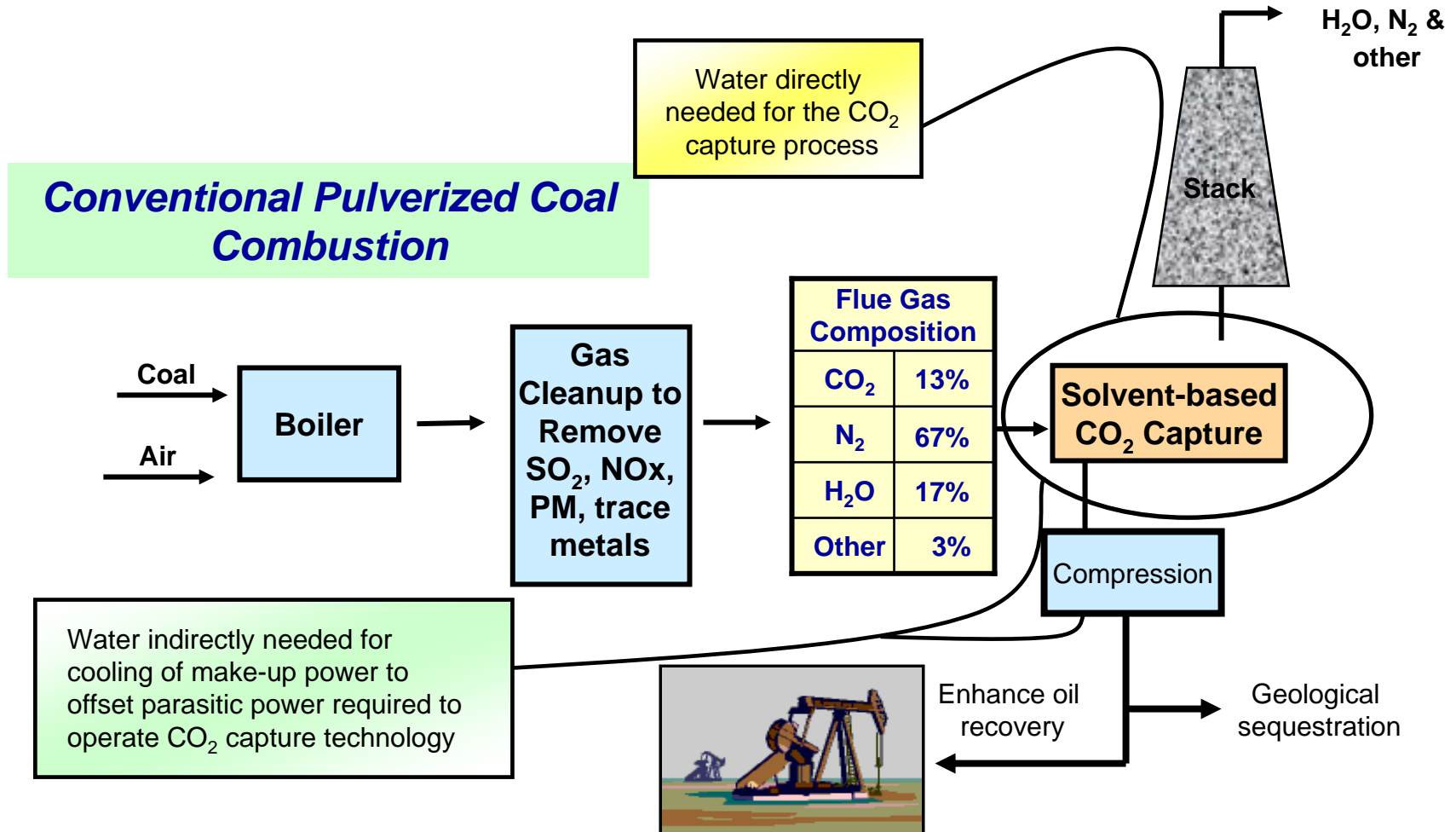
*May 2006 Issue of  
Power Magazine*



# Average Daily National Freshwater Consumption for Thermoelectric Power Generation



# Water and CO<sub>2</sub> Capture

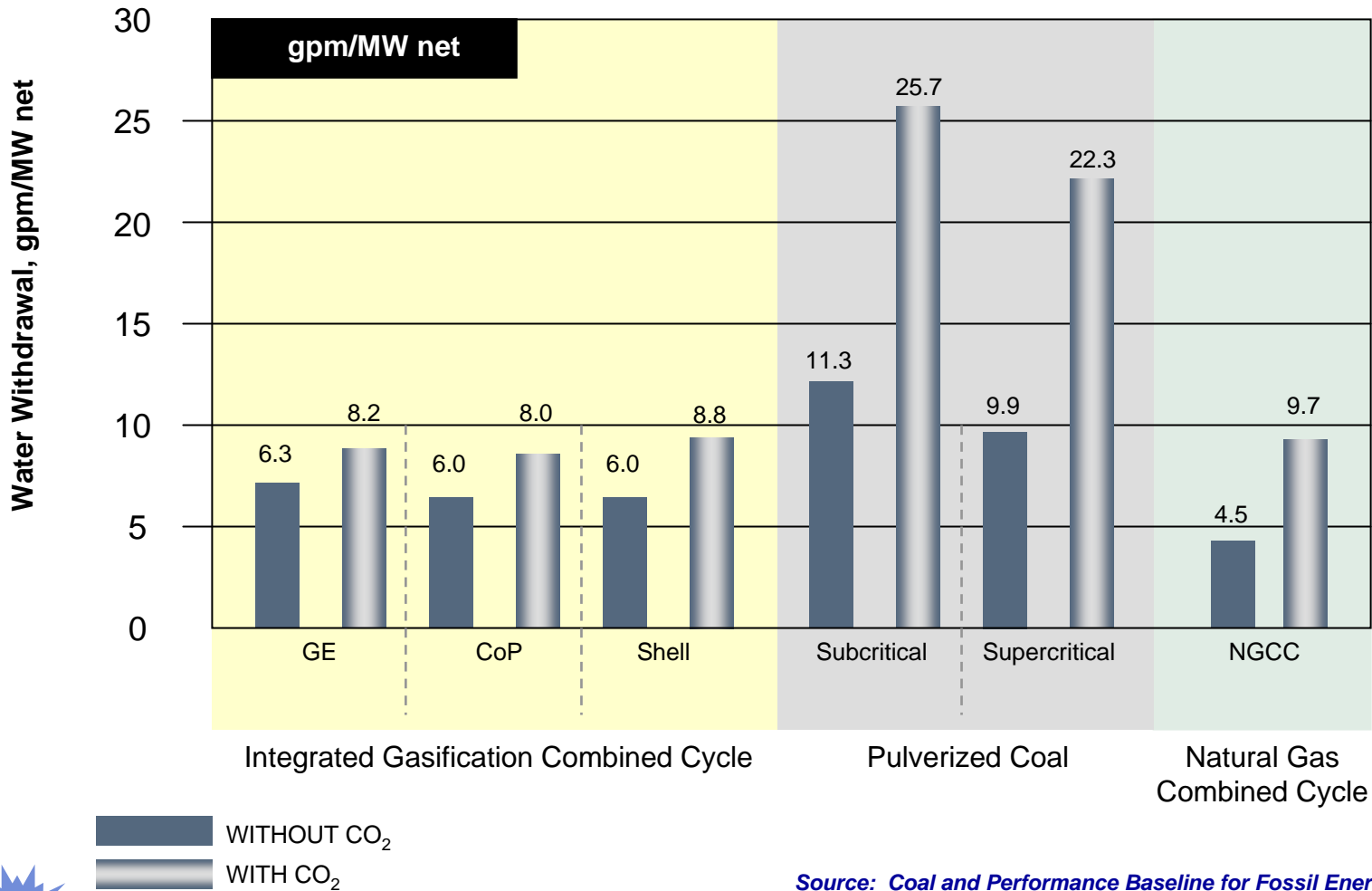


Source: NETL "2007 Pulverized Coal Oxyfuel Combustion Power Plants" August 2007 Final Report.

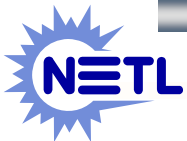


# Power Plant Water Withdrawal Requirements

*with and without CO<sub>2</sub> capture*

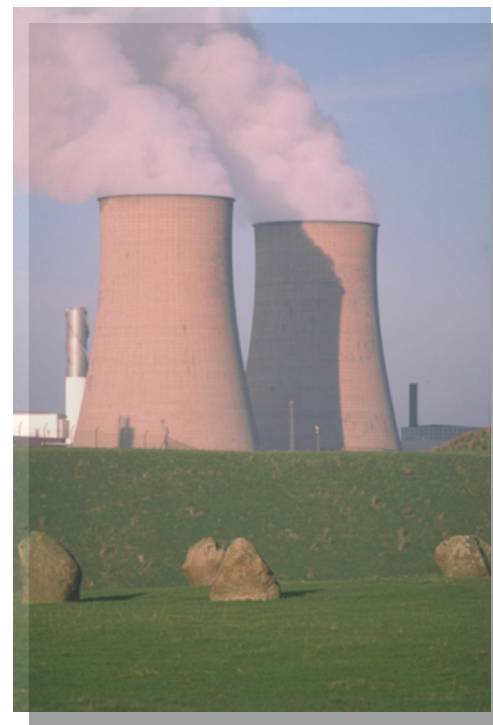


Source: Coal and Performance Baseline for Fossil Energy Power Plants, Volume 1: Bituminous Coal and Natural Gas to Electricity; NETL, May 2007



# FY08 Power Plant Water Management Solicitation

- *Funding Opportunity Announcement [DE-PS26-08NT00233-00](#)*
- *“R&D of Advanced Technologies and Concepts for Minimization of Freshwater Withdrawal and Consumption in Coal-Based Thermoelectric Power Plants”*
  - Advanced Cooling Technology
  - Innovative Water Reuse and Recovery
  - Non-traditional Sources of Process and Cooling Water
- ~ \$9-\$15 million total funding available
- *Project awards by end of September 2008*



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# CO<sub>2</sub> Capture

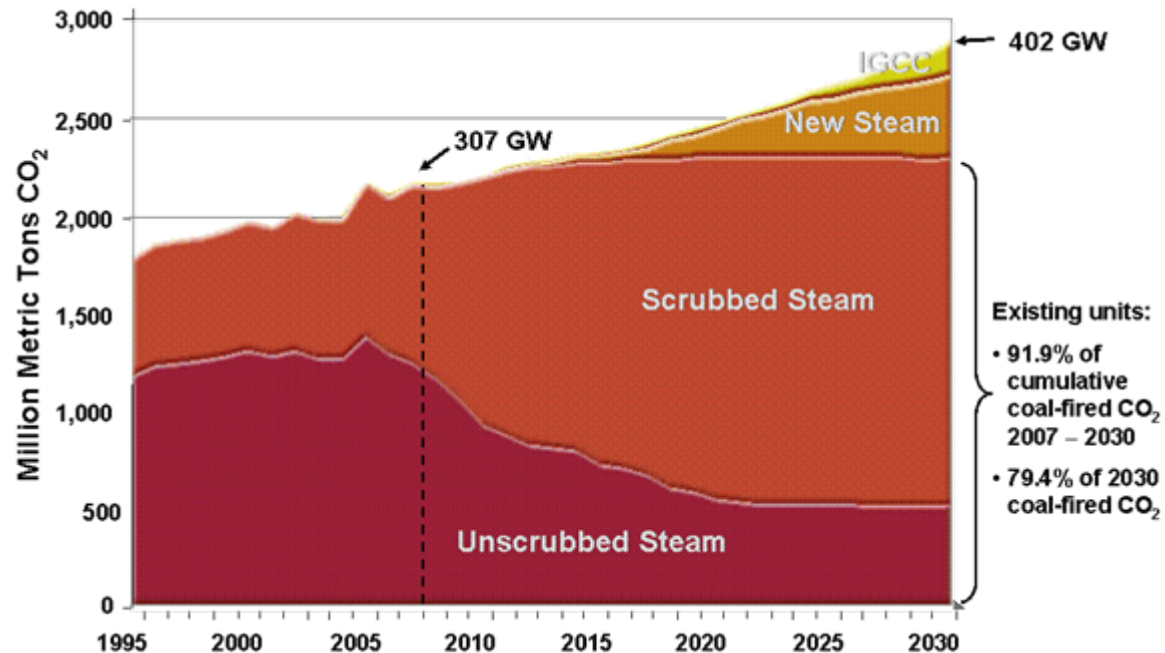




# New Initiative – CO<sub>2</sub> Capture for Existing Plants

- Coal-fired power plants will continue to dominate CO<sub>2</sub> emissions from fossil fuel power generation
- In FY08, Innovations for Existing Plants Program transitioned to CO<sub>2</sub> capture technology R&D
- Issued FOA focused on post-combustion and oxy-combustion capture technologies for existing plants

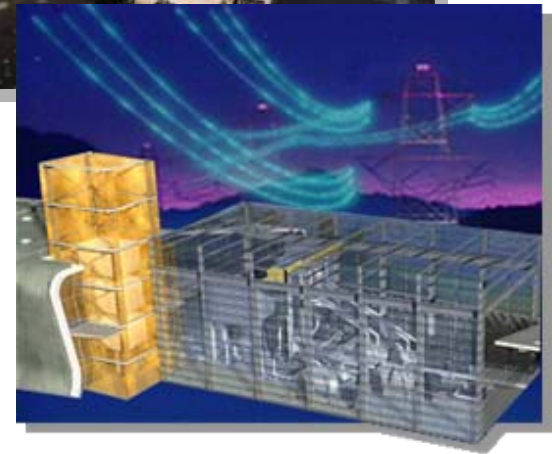
*Projected CO<sub>2</sub> Emissions from Fossil Fuel Power Generation*



Source: EIA, Annual Energy Outlook 2008 Revised Early Release, March 2008

# IEP CO<sub>2</sub> Emissions Control R&D Activities

- Post-Combustion CO<sub>2</sub> Control
- Oxy-Combustion CO<sub>2</sub> Control
  - Chemical looping
- CO<sub>2</sub> Compression
- CO<sub>2</sub> Beneficial Use
- In-house R&D
- Systems Analysis



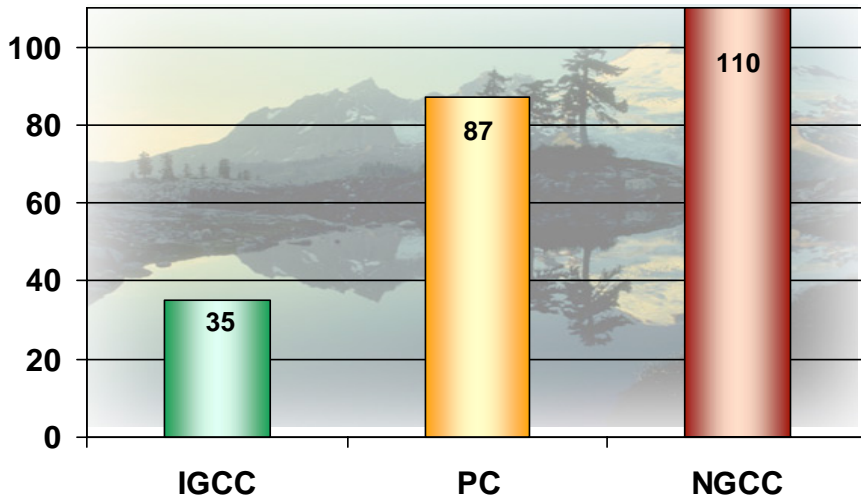
# CO<sub>2</sub> Capture Is Expensive !

- 5–30% parasitic energy loss
- 35–110% increase in capital cost
- 30–80% increase in cost of electricity

Currently refining cost target for PC plants considering potential improvements in:

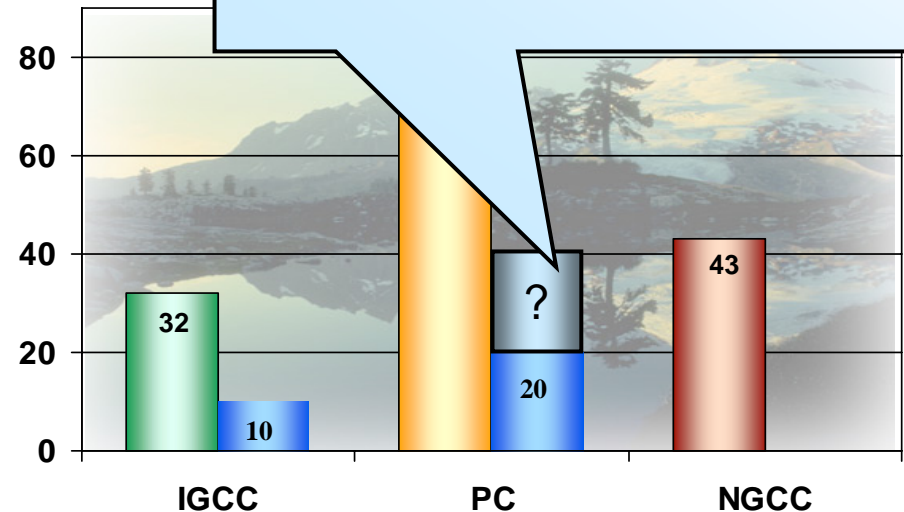
- Capital cost
- Fixed operating cost
- Variable operating cost
- Energy cost
- Transport, storage & monitoring costs

**Effect of CO<sub>2</sub> Capture on Capital Cost**  
(% Increase Resulting From CO<sub>2</sub> Capture)



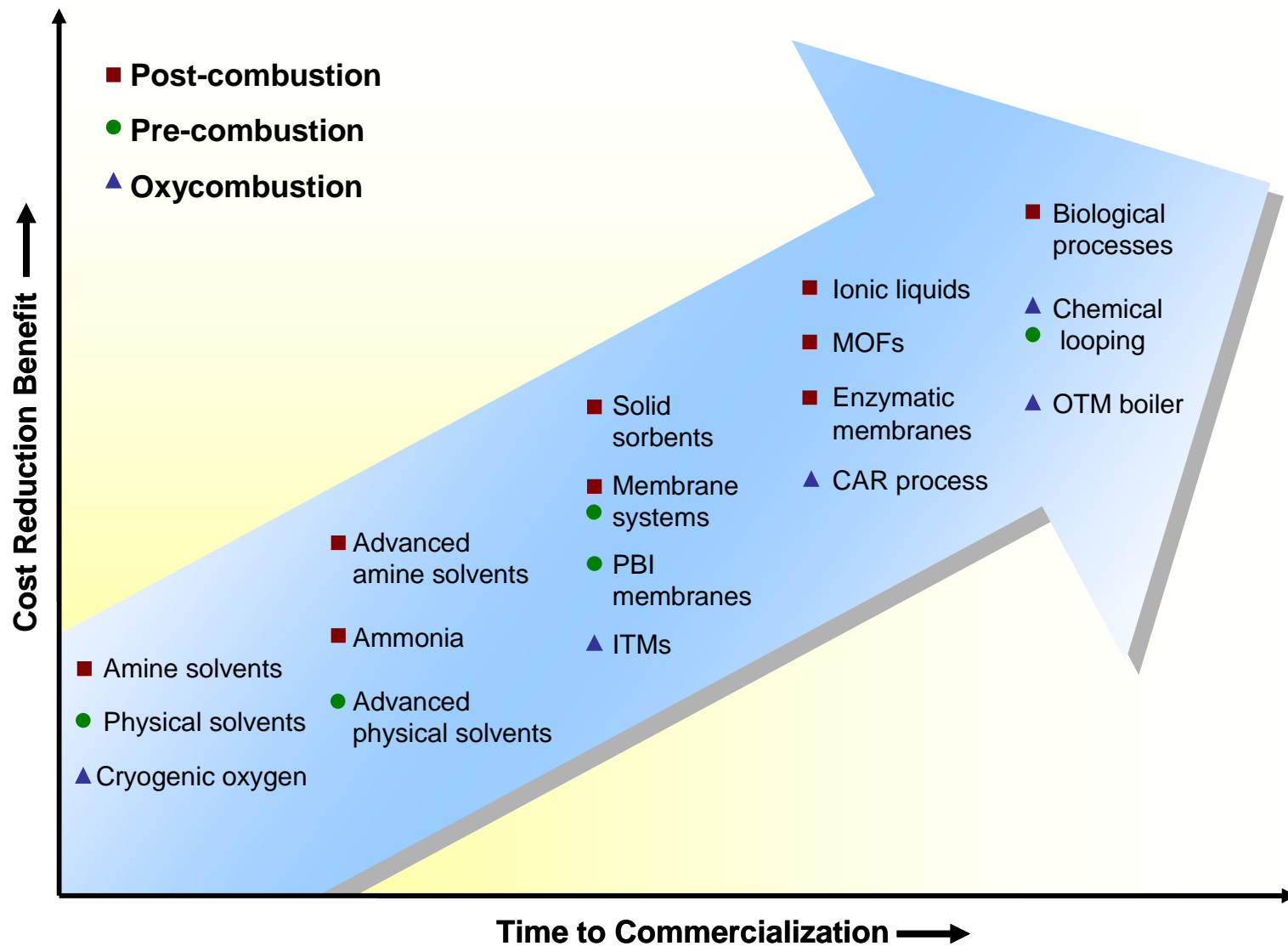
Note: CO<sub>2</sub> capture costs based on use of Selexol process for IGCC and MEA for PC and NGCC.

**Effect of CO<sub>2</sub> Capture on Electricity Cost**  
(% Increase in Electricity Cost)



Source: *Cost and Performance Baseline for Fossil Energy Power Plants study, Volume 1: Bituminous Coal and Natural Gas to Electricity*; NETL, May 2007.

# Technology Advances Are Starting to Emerge



# Current U.S. CO<sub>2</sub> Capture Technology Developments

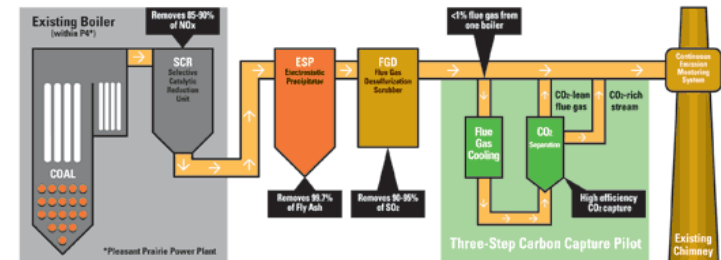
- ALSTOM testing chilled ammonia at 1.7 MW pilot-scale at We Energies' Pleasant Prairie Power Plant
- Powerspan testing aqueous ammonia at ~ 1 MW pilot-scale at First Energy's Burger Power Station
- B&W and Air Liquide testing oxy-combustion at 30 MW scale at B&W's Clean Energy Development Facility



*R.E. Burger Power Station  
in Shadyside, Ohio*



*B&W's CEDF  
in Barberton, Ohio*



*Diagram of Chilled Ammonia Process*



# FY08 CO<sub>2</sub> Capture Solicitation

- *Funding Opportunity Announcement [DE-PS26-08NT00134](#)*
- *"Carbon Dioxide Capture and Separation Technology Development For Application To Existing Pulverized Coal-Fired Power Plants."*
  - Post-Combustion Capture
  - Oxy-Combustion
  - Chemical Looping
- ~ \$30 million total funding available
  - 5 to 15 projects @ \$150k to \$5M each
- *Applications were due April 10, 2008*
- *Project awards by end of September 2008*



# Key Takeaways

- **DOE/NETL's Innovations for Existing Plants Program now focusing on CO<sub>2</sub> capture and compression and water**
- **Hg control technology developed under IEP Program is commercially available**
- **Current CO<sub>2</sub> capture technology projected to negatively impact both power plant costs and performance**
- **Critical need for continued research and development of advanced CO<sub>2</sub> capture and water management technologies**



# To Find Out More About NETL's IEP R&D:



The screenshot shows the NETL website interface. At the top, there is a navigation bar with "National Energy Technology Laboratory" on the left, "Site Map" in the center, and a search box with a "GO" button on the right. Below this is a banner image of an industrial facility at night with the NETL logo and the tagline "THE ONLY U.S. NATIONAL LABORATORY DEVOTED TO FOSSIL ENERGY TECHNOLOGY".

The main content area is divided into three columns. The left column is a navigation menu with categories: ABOUT NETL, KEY ISSUES & MANDATES, ONSITE RESEARCH, TECHNOLOGIES (highlighted), ENERGY ANALYSES, SOLICITATIONS & BUSINESS, CAREERS & FELLOWSHIPS, NEWSROOM, and CONTACT NETL. Under "TECHNOLOGIES", sub-items include Oil & Natural Gas Supply, Coal & Power Systems (with sub-items: Clean Coal Demonstrations, Innovations for Existing Plants, Gasification, Turbines, Fuel Cells, FutureGen, Adv. Research/Combustion, and Contacts), Carbon Sequestration, Hydrogen & Clean Fuels, and Technology Transfer.

The middle column displays the breadcrumb trail: Home > Technologies > Coal & Power Systems > Innovations for Existing Plants. Below this is the section header "Coal and Power Systems Innovations for Existing Plants". A list of funding opportunities is shown, including two announcements from DE-PS26-08NT00233 and DE-PS26-08NT00134. A welcome message follows, stating that the IEP program is an integral part of NETL's Coal and Power Systems RD&D portfolio. To the right of the text is an image of two cooling towers at sunset. Below the image is a list of links: CO<sub>2</sub> Emissions Control, Water-Energy Interface, Mercury Emissions Control, Coal Utilization By-Products, Advanced NOx Emissions Control, Air Quality Research, and PM Emissions Control.

The right column is titled "NEWS & FEATURES // All >" and contains a list of recent news items, such as "An Update on DOE/NETL's Mercury Control Technology Field Testing Program, Jan 2008" and "Further Investigation of the Impact of Sulfur Trioxide on Activated Carbon Injection Performance, Nov. 2007". Below this is an "EVENTS CALENDAR // All >" section with an entry for the "DOE/NETL Seventh Annual Conference on Carbon Capture & Sequestration" in Pittsburgh, PA, from May 5-8, 2008. At the bottom of the right column is a "PUBLICATIONS & PROJECTS // All >" section with an entry for "Water: A Critical Resource in the Thermoelectric Power Industry" (PDF-426KB).

<http://www.netl.doe.gov/technologies/coalpower/ewr/index.html>

