

DOE/NETL's R&D Response to Emerging Coal By-Product and Water Issues

Clean Coal and Power Conference

in conjunction with

2nd Joint U.S.-People's Republic of China Conference on Clean Energy

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NETL Plays Key Role in Fossil Energy Supply, Delivery, and Use Technologies

Electric Power Using Coal



Coal Production



Environmental Control



V21 Next Generation



Carbon Sequestration

Clean Liquid Fuels



Exploration & Production



Refining & Delivery



Alternative Fuels



Future Fuels

Natural Gas



Exploration & Production



Pipelines & Storage



Fuel Cells



Combustion Turbines



Photo of hydrogen fueled car: Warren Gretz, NREL

Innovations for Existing Plants Program

- **Goal**

- Enhance environmental performance of existing fleet of coal power plants and advanced power systems

- **Objectives**

- Develop low-cost, integrated, non-complex technology to control emissions/releases (air, water, and solids) to the environment
- Provide high-quality scientific and technical information on environmental issues for use in future regulatory and policy decision making, e.g., Clear Skies Initiative



Program Components

- **Mercury control technology**
- **Air quality research**
- **Coal by-products characterization and market development**
- **Water management**
- **NOx control technology**
- **PM/Acid gas control technology**

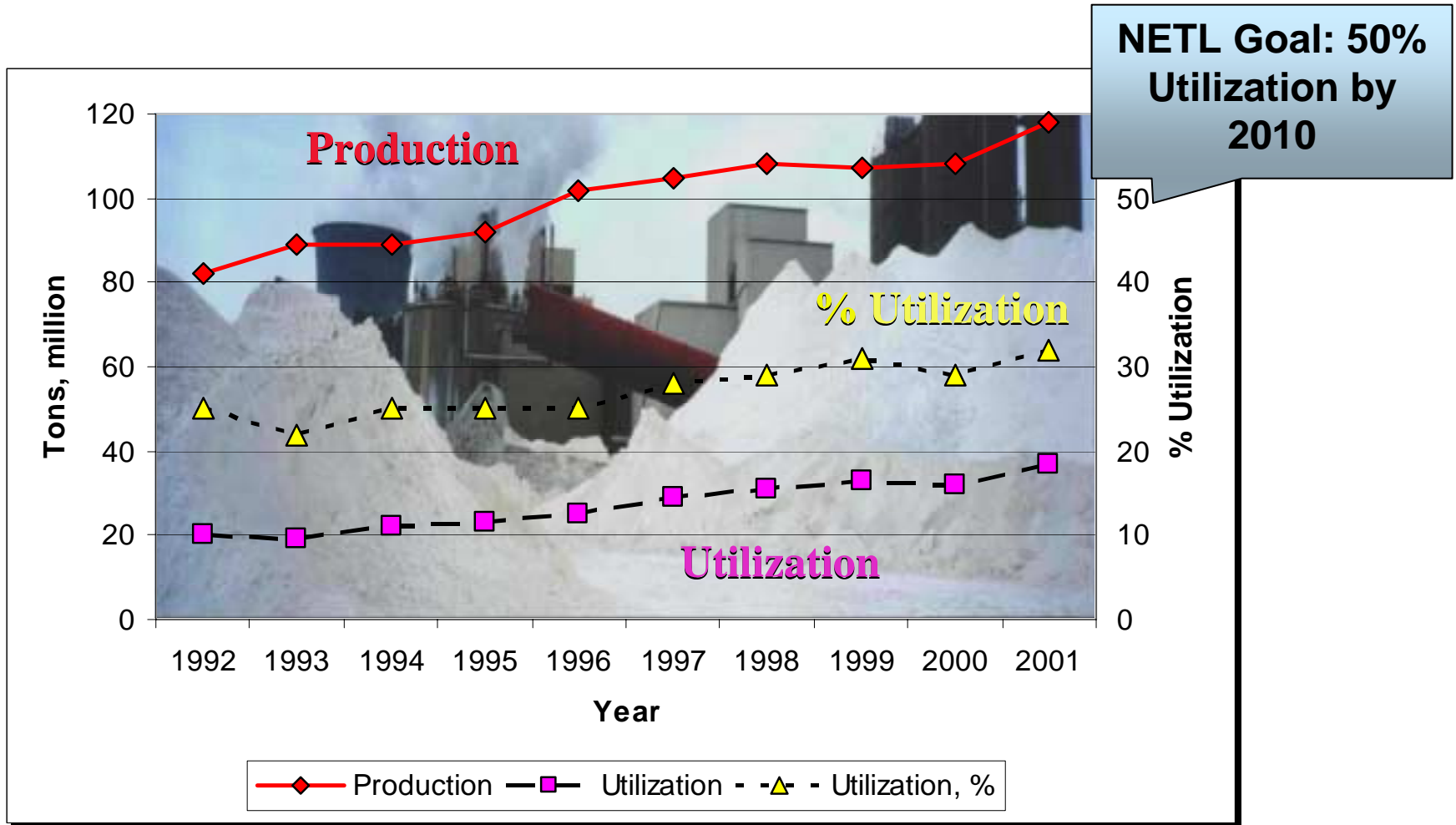


Coal Utilization By-Products (CUBs)



U.S. Coal Utilization By-Products

Historical Production and Utilization



Source: ACAA and USGS



Multiple Benefits of Using CUBs

- **Environmental**

- Reduced greenhouse gas emissions
- Reduced land disposal requirements

- **Economic**

- Avoid disposal costs
- Revenue from sale of by-products
- Tax incentives (e.g., Montana)

- **Performance**

- Enhance physical and chemical characteristics, e.g., increased strength, improved workability



Challenges to Increased CUB Utilization

- **Future air pollution regulations, e.g., Clear Skies, Mercury MACT**
 - Increase volume of coal utilization products
 - Change characteristics (i.e., quality) of products
- **Future solid waste regulations under RCRA**
 - Limit use applications
 - Regulate coal utilization products as hazardous?
- **Public perception**



NETL External Projects Addressing the Environmental Characterization of CUBs

- **Fate of mercury from control technology field demonstrations**
 - ADA-ES and Reaction Engineering
 - B&W and McDermott Technology
- **Trace element leaching from CUB disposal and utilization applications**
 - CONSOL Energy
 - University of North Dakota Energy & Environmental Research Center (UNDEERC)
 - Electric Power Research Institute (EPRI)
- **Fate of mercury in synthetic gypsum used for wallboard production**
 - US Gypsum



NETL Mercury Control Technology Field Demonstrations



- Activated carbon injection field tests at four power plants
- ADA –ES and Reaction Engineering analysis of ash by-products
- Mercury in leachate below 0.01 $\mu\text{g/L}$ measurement detection limit in most samples

- Wet FGD reagent field tests at two plants
- B&W and McDermott Technology analysis of FGD by-products
- No significant mercury in FGD liquids
- Minimal mercury volatilization from heated FGD solids



Fate of Mercury in Synthetic Gypsum Used for Wallboard Production

- **Team:**
 - U.S. Gypsum (prime), URS, EPRI (co-funding), and Shaw Environmental
- **Objectives:**
 - Provide information about fate of mercury in synthetic gypsum produced by FGD systems on coal-fired boilers
 - Measure mercury concentrations in solid, liquid, and gaseous streams



USG Wallboard Plant, Aliquippa, PA

Combustion Byproducts Recycling Consortium (CBRC)

- **Focus on regional and national priorities**
- **Analyses of trace metal leaching from CUB disposal and utilization applications**
 - Fly ash and FGD material disposal sites
 - Agricultural soil amendment
 - Surface and underground mine reclaim
 - Construction project soil stabilization and structural fill
- **Effects of wet FGD mercury control on gypsum wall board manufacture**
- **Effects of ammonia on fly ash due to NOx SCR**



Coal Combustion Products Partnership (C²P²)



- Environmental Protection Agency (EPA) Deputy Administrator announced C²P² on October 10, 2002
- DOE/NETL will partner with EPA, American Coal Ash Association, Utility Solid Waste Activities Group, and Department of Transportation
- Encourage increased beneficial use of coal combustion products (e.g., fly ash, scrubber solids)



Power Plant-Water R&D Activities



Three Things Power Plants Require



1) Access to transmission lines



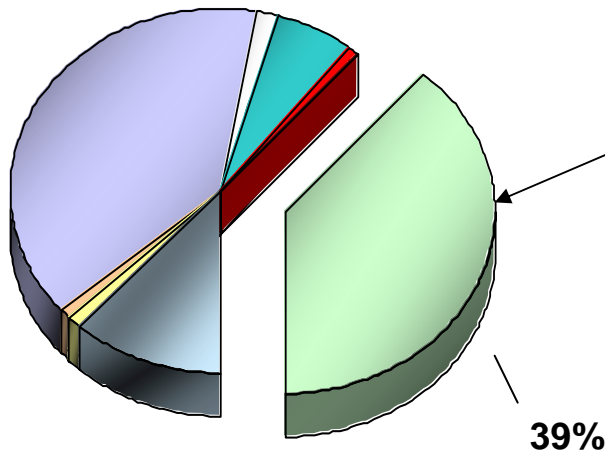
2) Available fuel, e.g., coal or natural gas



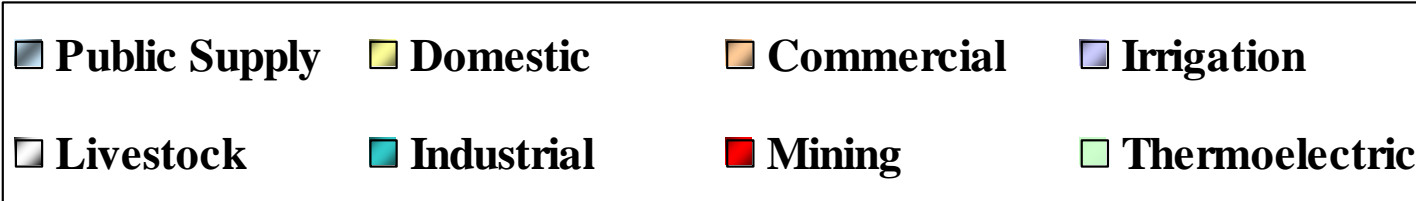
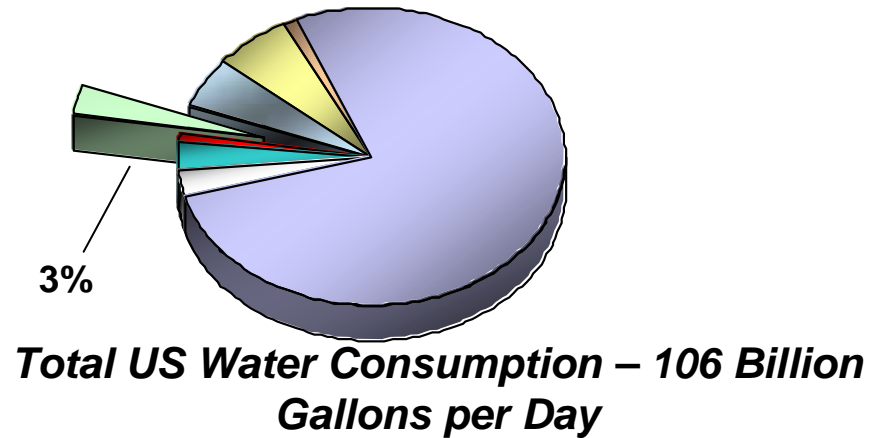
3) Water

U.S. Fresh Water Use and Consumption

Total US Fresh Water Withdrawal – 341 Billion Gallons per Day



Thermoelectric Power Plants
Average 25 gal/kWh



Water and Energy Inextricably Linked

- **Each kilowatt-hour of electricity requires on average about 25 gallons of water to produce.**
- **Therefore, we may indirectly use as much water turning on lights and running appliances as we use in taking showers and watering lawns.**

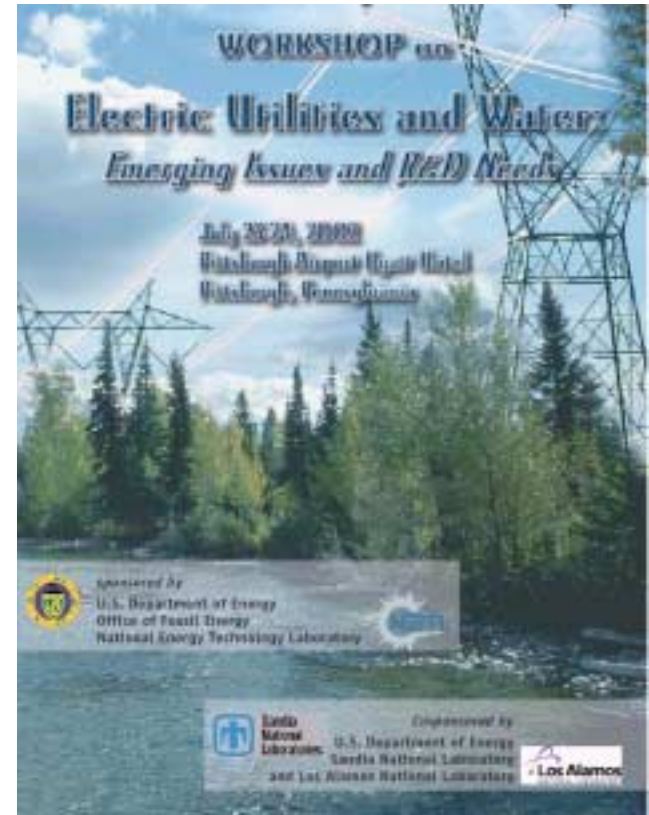
Power Plants and Water Inextricably Linked

- **Georgia Power Loses Bid to Draw Water from Chattahoochee**
 - *Miami Herald*, February 2002
- **Duke Power Warns Towns in Charlotte, N.C., Area to Cut Water Use**
 - *The Charlotte Observer*, NC, August 2002
- **Official: Plants Would Use Too Much Water**
 - *The Idaho Statesman*, July 2002
- **Utilities Warn of Power Crunch if Flows Are Cut**
 - *Greenwire*, July 2003



Workshop on Electric Utilities and Water

- July 2002 two-day workshop addressing emerging water/energy R&D needs
- Second in a series of workshops sponsored by NETL, LANL, and Sandia
- Meeting of government, utility industry, academia, and regulatory representatives



Workshop proceedings available at www.netl.doe.gov/coalpower/environment



‘Innovative Water Management Technologies and Concepts for Coal-Fired Electric Utility Boilers’

- Targeted competitive solicitation closed February 14, 2003
- Four topic areas:
 - Non-Traditional Sources of Process and Cooling Water
 - Innovative Cooling Technology
 - Advanced Cooling Water Intake Technology
 - Advanced Pollutant Measurement and Treatment Technology
- Five projects selected



Strategies for Cooling Electric Generating Facilities Utilizing Mine Water

- West Virginia Water Research Institute
- Evaluate use of mine water as a source of cooling water
- Investigate feasibility of using underground mines as a heat sink for cooling



Discharge from underground coal mine

Use of Produced Water in Recirculated Cooling Systems at Power Generation Facilities



San Juan Generating Station

- EPRI in partnership with Public Service of New Mexico
- Evaluate use of oil/gas produced water as source of cooling water for PNM's San Juan Generating Station
- Part of NetZero initiative to reduce water use in New Mexico



Water Extraction from Coal-Fired Power Plant Flue Gas



- **Energy & Environmental Research Center and Siemens Westinghouse Power Corporation**
- **Develop and test a desiccant-based dehumidification process recover water from exhaust gas of fossil fuel-fired power plants**

Fate of As, Se, and Hg in a Passive Integrated System for Treatment of Fossil Plant Wastewater

- TVA and EPRI
- Evaluate passive wastewater treatment system at TVA's Paradise Fossil Plant
- Removes nitrogen, arsenic, selenium, mercury, and methylated mercury from fly-ash impoundments



Paradise Fossil Plant

Environmentally Safe Control of Zebra Mussel Fouling



Zebra Mussels

- Rochester Gas & Electric partnership with NY State Education Department
- Evaluate innovative methods to control bio-fouling of cooling water intake systems that incorporates selective toxins from a naturally-occurring bacterium

Coal Drying to Reduce Water Consumed in Pulverized Coal Power Plants



***Great River Energy's Coal
Creek Station, North Dakota***

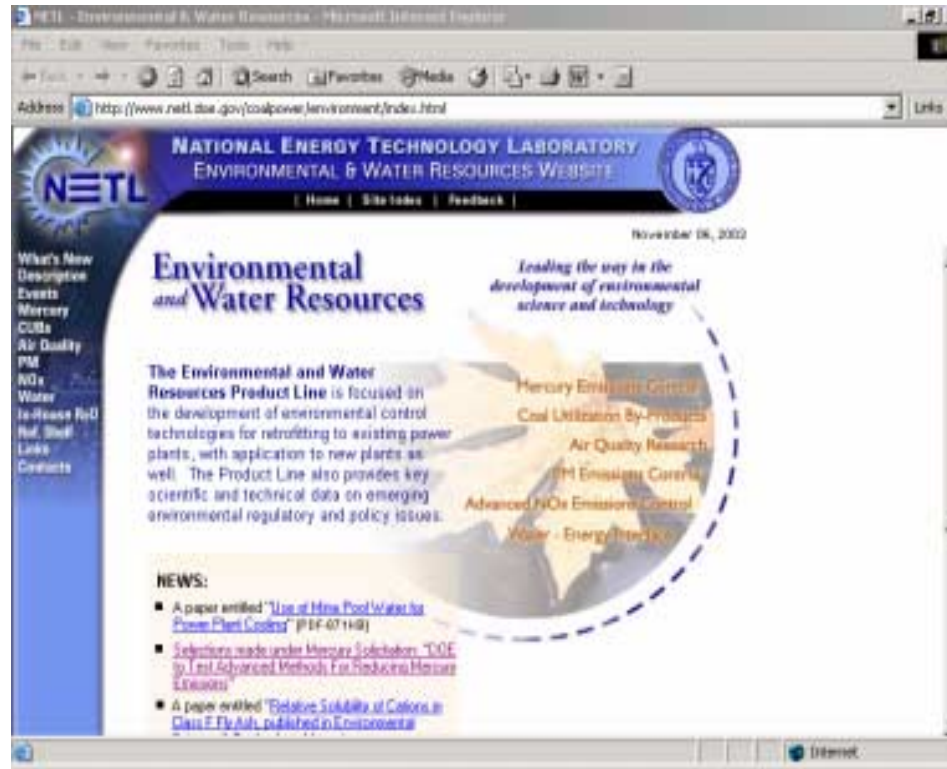
- Lehigh University and Great River Energy
- Low temperature drying of subbituminous and lignite coals through recovery of low grade waste heat
- Previous work demonstrates coal drying can reduce cooling tower makeup water requirements

Summary

- **Future regulations and issues of public perception related to solid byproducts and freshwater resources will challenge power plant design and operation**
- **DOE/NETL will continue to partner with industry, academia, and other key stakeholders to carry out research directed at CUB use and disposal and water management**
- **This research will help maintain coal's strategic role in providing U.S. with secure, reliable, affordable, and environmentally sound energy**



NETL Environmental and Water Resources (*Innovations for Existing Plants Program*)



To find out more about DOE-NETL's Hg R&D activities visit us at:
www.netl.doe.gov/coalpower/environment

