

Coal Combustion Products -- Challenges to Increased Utilization

EUCI's Coal Combustion Product Optimization Conference



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Outline

- **What are coal combustion products and how can they be utilized**
- **Technical and regulatory drivers that could challenge future utilization**
- **DOE's research program**
- **Summary**



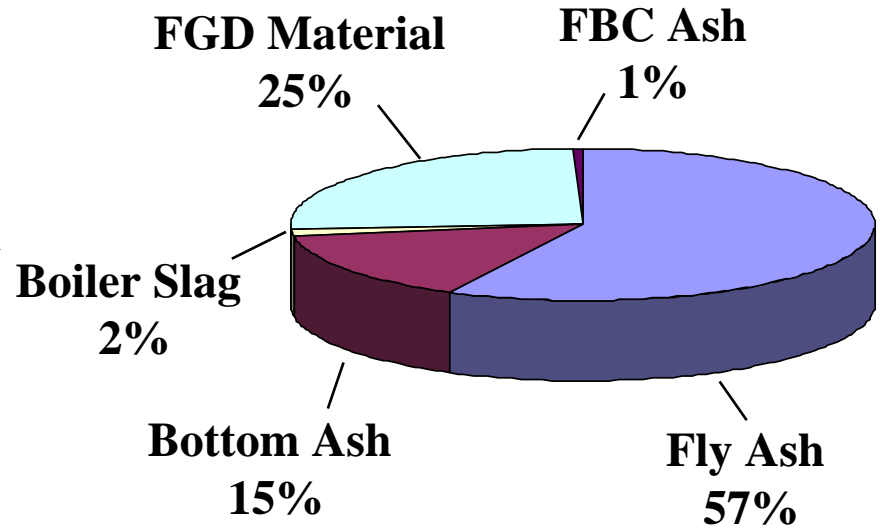
What are Coal Combustion Products?

- Coal Combustion Products (a.k.a. CUB, CCB, CCW, FFCW, CCR ...)
- DOE/NETL uses the term ***Coal Utilization Byproducts (CUB)*** to define the solid byproducts from the utilization of coal including:
 - Combustion
 - Gasification
 - Hybrid systems

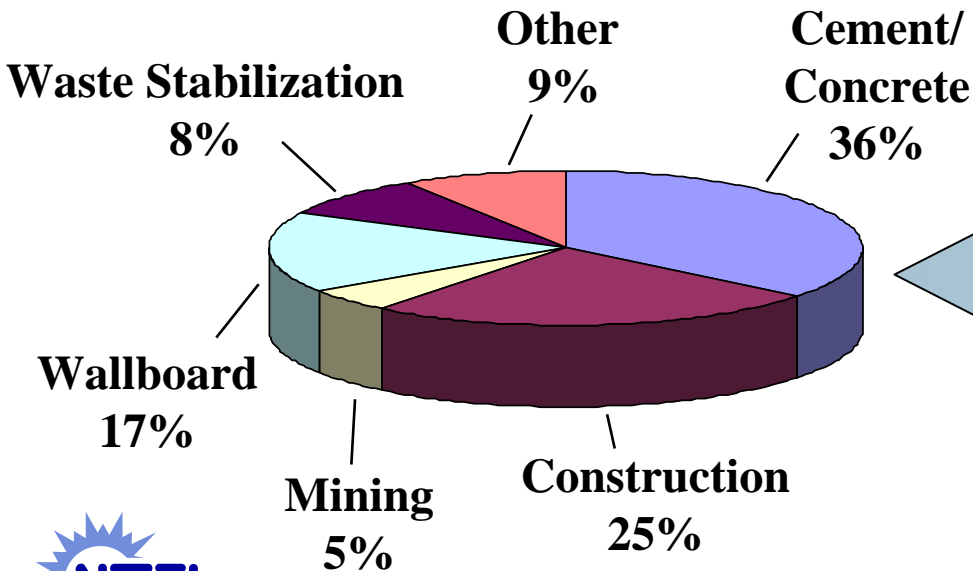


Current Production and Utilization

Production
122 million tons



Utilization (38%)
46 million tons



Source: ACAA 2003 CUB Survey

Many Uses for Coal Combustion Products

- Drywall
- Portland cement
- Flowable fill
- Bowling balls
- Wall paints
- Carpeting
- Synthetic tiles
- AMD control
- Soil amendments



Multiple Benefits of Using Fly Ash in Concrete

- ***Environmental***

- Reduced greenhouse gas emissions
- Reduced land disposal requirements

- ***Economic***

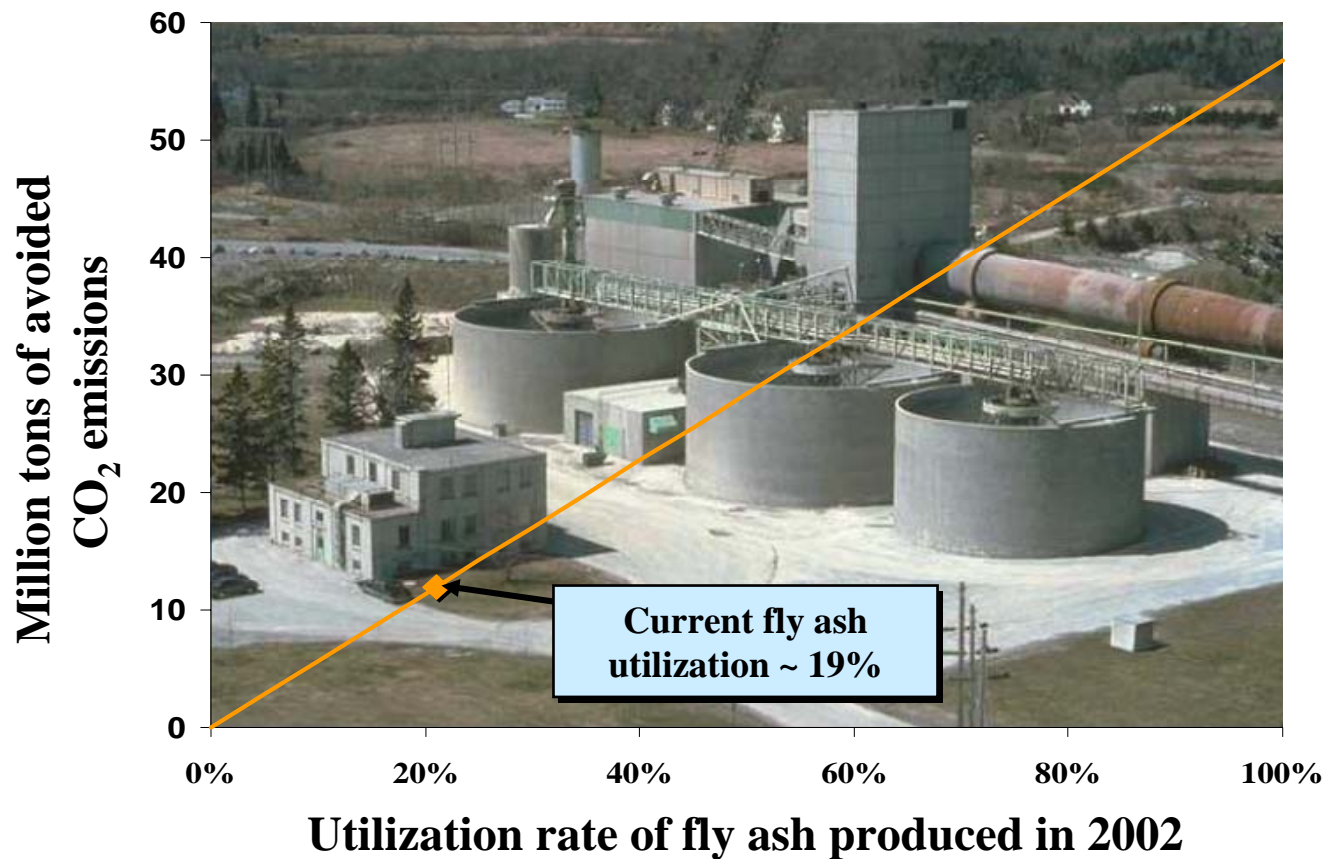
- Avoid disposal costs
- Revenue from sale of by-products
- Tax incentives

- ***Performance***

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



Potential To Reduce Greenhouse Gases



1 ton of fly ash used in cement manufacturing provides for approximately 0.8 tons of avoided CO₂ emissions

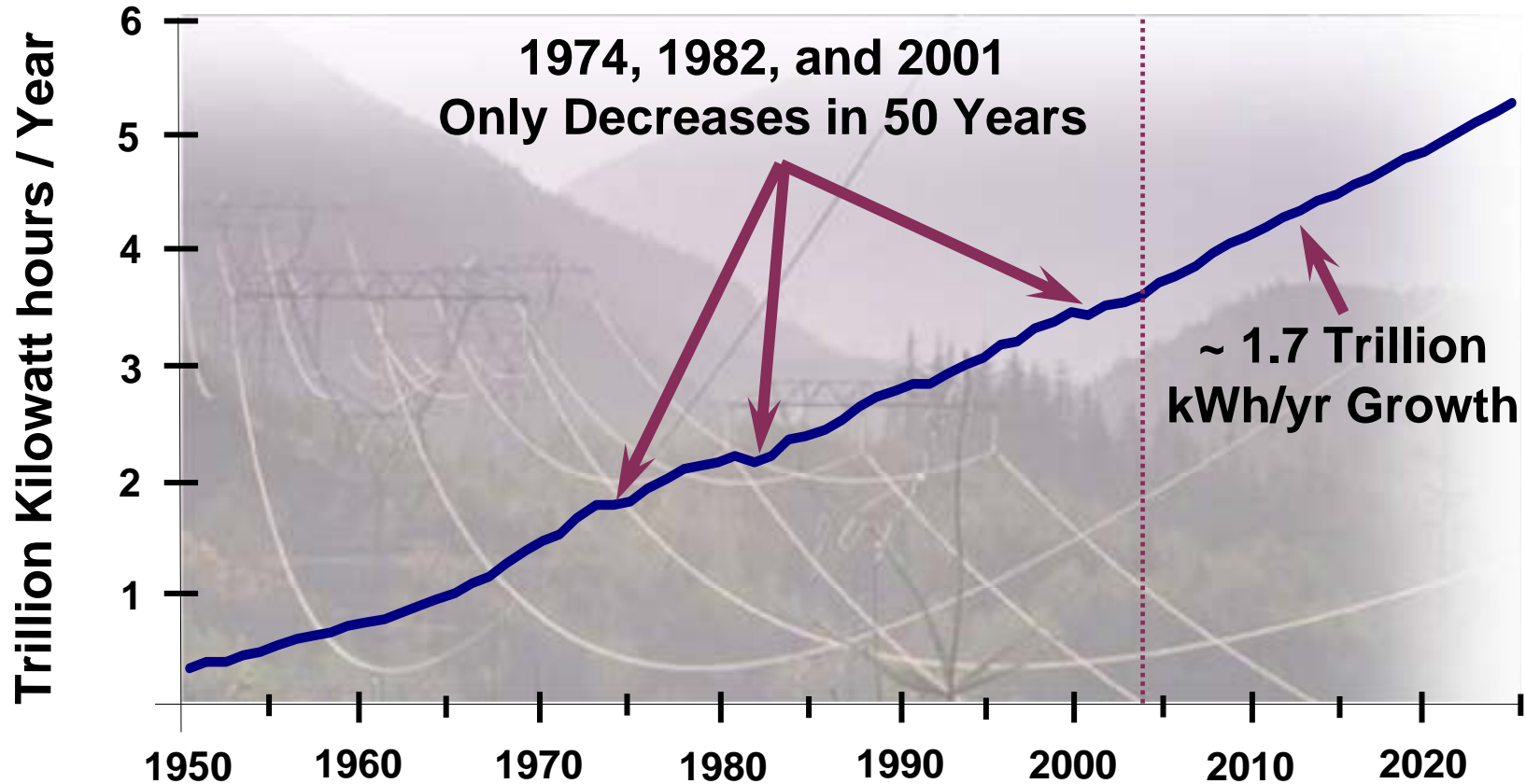


CUB Provisions in the Energy Policy Act of 2005

- **Title I – Section 108 Amendment to Solid Waste Disposal Act**
 - *Requires increased use of recovered mineral component in federally funded projects involving procurement of cement or concrete.*
- **Title IV – Section 421 Amendment of the Energy Policy Act of 1992**
 - Provides DOE funding for deployment of advanced air pollution control technologies for existing coal-based power plants
 - *Priority given to projects designed to allow the use of the waste byproducts or other byproducts of the equipment.*



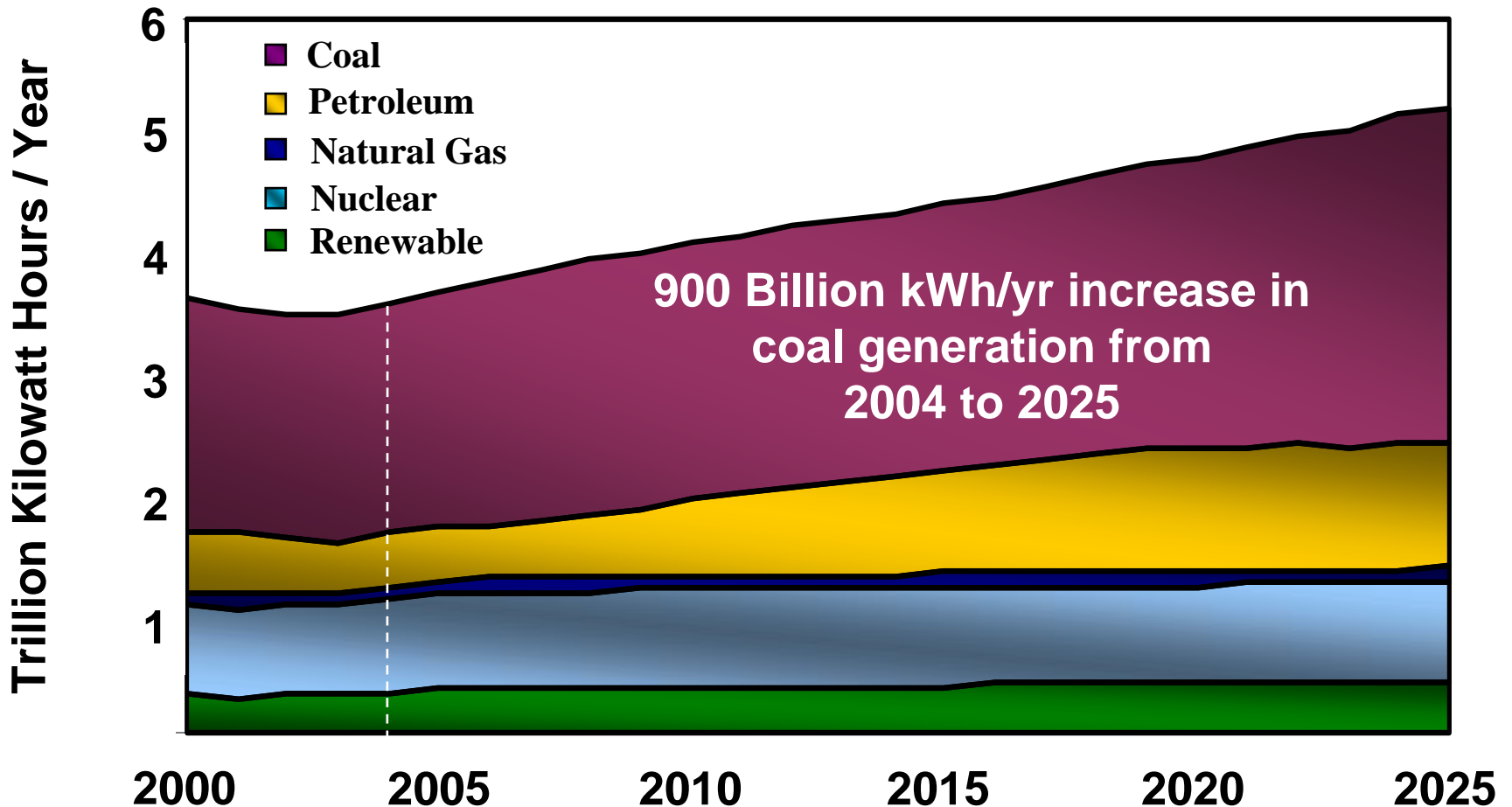
Growth of U.S. Electricity Market



Source: EIA Annual Energy Review 2005 Annual Energy Outlook



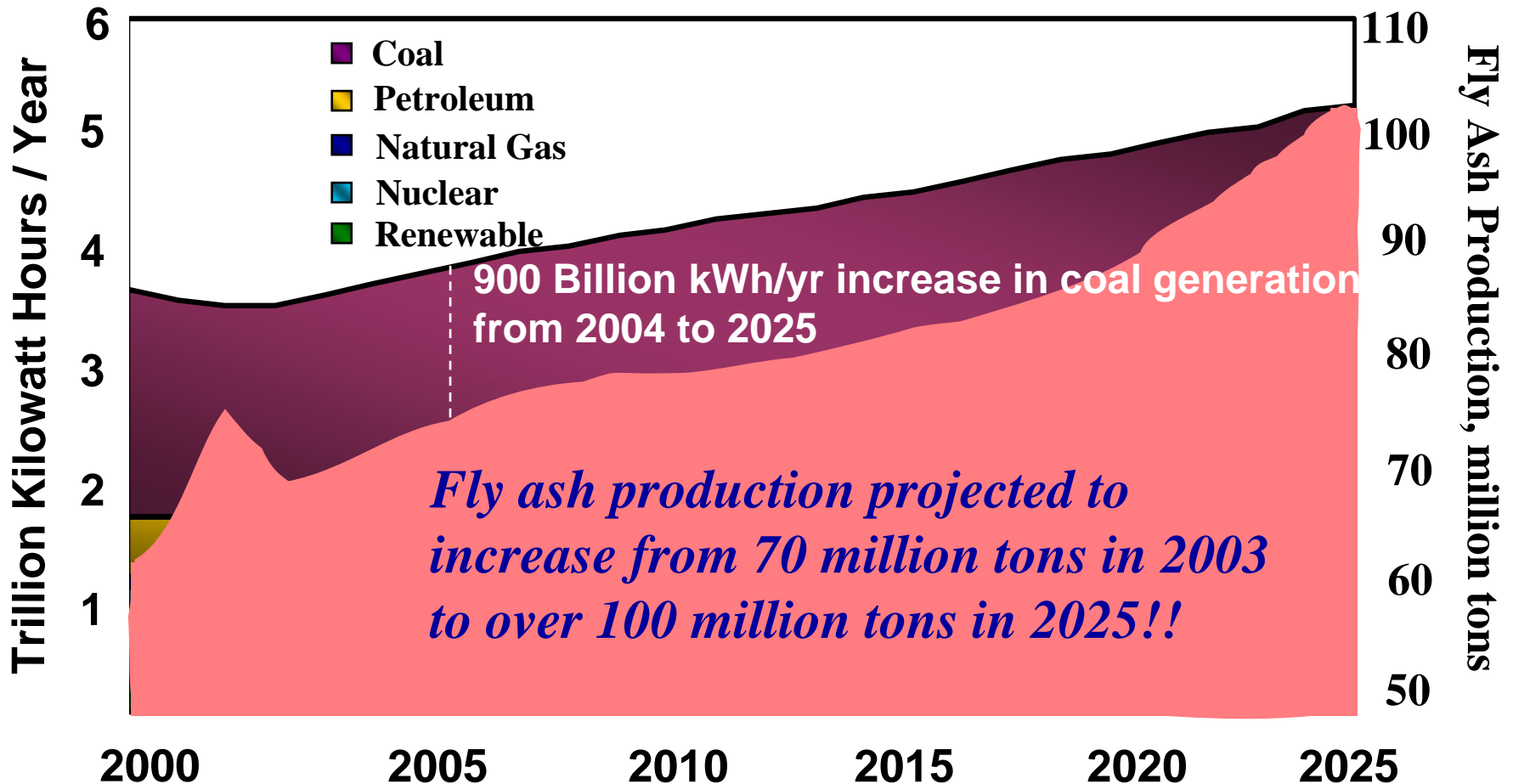
Fuel Mix for Electricity Growth



Source: EIA Annual Energy Review 2005 Annual Energy Outlook



Fuel Mix for Electricity Growth



Fly ash production projected to increase from 70 million tons in 2003 to over 100 million tons in 2025!!

900 Billion kWh/yr increase in coal generation from 2004 to 2025



Source: EIA Annual Energy Review 2005 Annual Energy Outlook

Coal-Fired Power Plants Facing New EPA Emission Regulations

• Clean Air Interstate Rule (CAIR)

- Announced March 10, 2005
- Implementation via two phase Eastern regional cap & trade program
- Phase I (2009/2010)
 - 1.5 million ton NO_x cap in 2009 (53% reduction)
 - 3.6 million ton SO₂ cap in 2010 (45% reduction)
- Phase II (2015)
 - 1.3 million ton NO_x cap (61% reduction)
 - 2.5 million ton SO₂ cap (73% reduction)

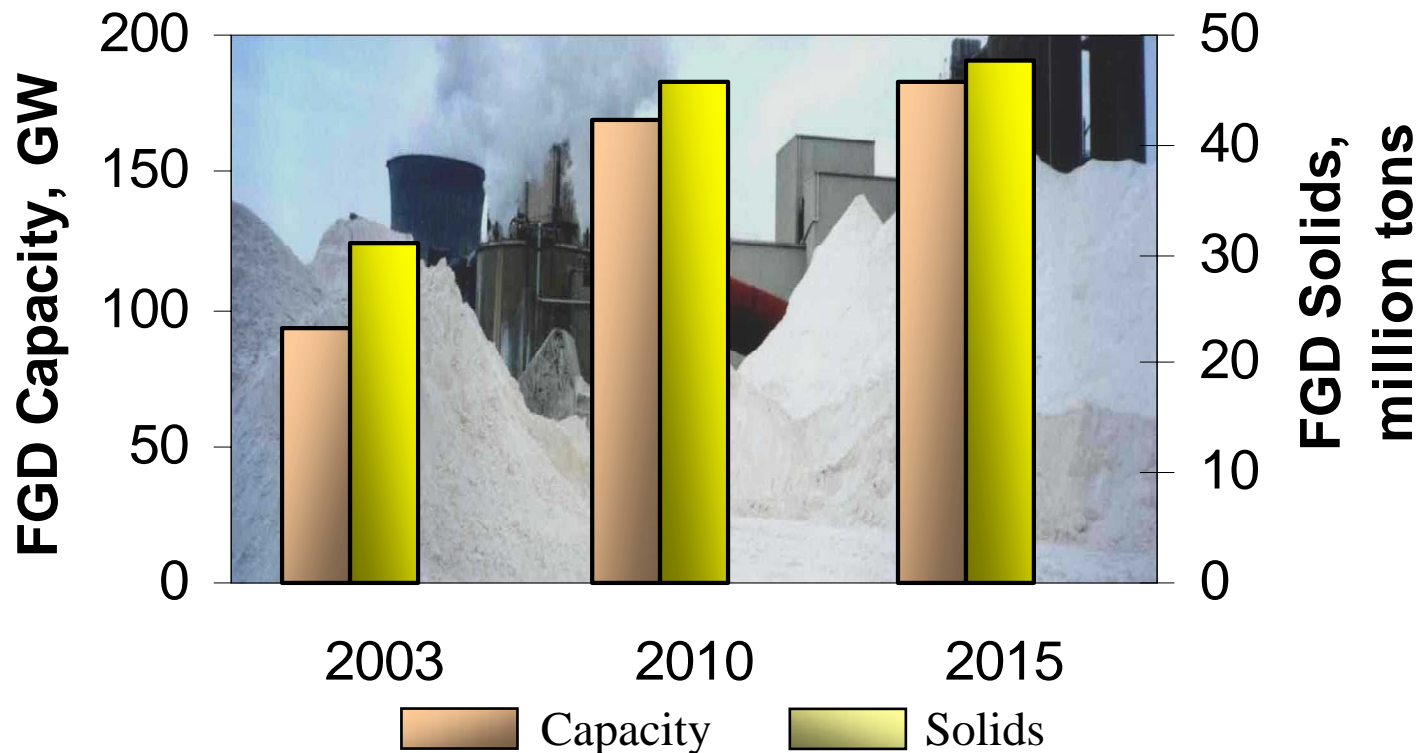
• Clean Air Mercury Rule (CAMR)

- Announced March 15, 2005
- Implementation via two phase nation-wide cap & trade program
- Phase I (2010)
 - 38 ton mercury cap (21% reduction)
- Phase II (2018)
 - 15 ton mercury cap (69% reduction)



Note: Percentage reductions from 2003 baseline emission levels.

Estimate of Future U.S. FGD Capacity and Solids Production

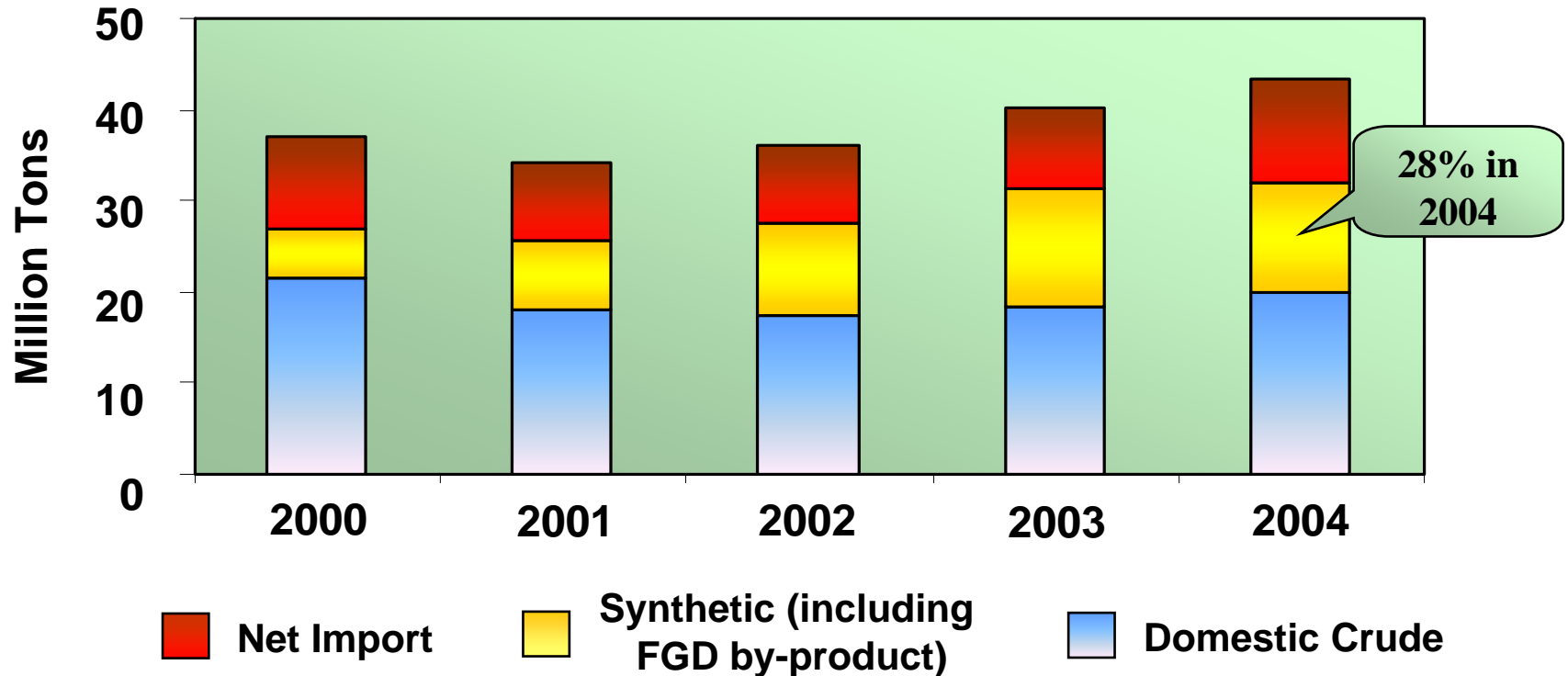


Total U.S. FGD solids production is projected to increase from 31 to 48 million tons between 2003 and 2015.

*Source: FGD Capacity per EPA IPM projections for CAIR..
FGD Solids per DOE/NETL internal analysis.*

Potential U.S. Market for Synthetic FGD Gypsum

U.S. Sources of Gypsum



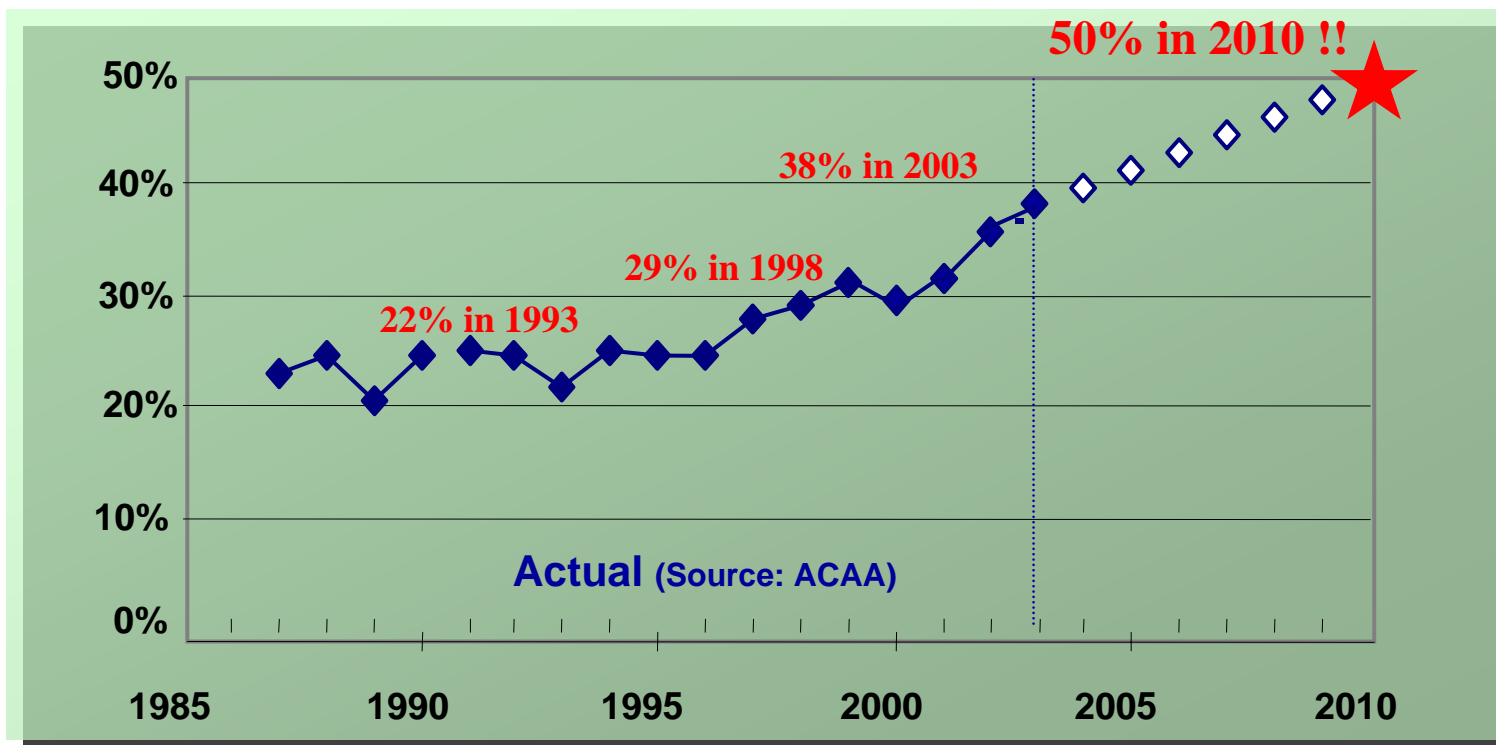
In 2003, 88% of total U.S. gypsum consumption was used in manufacture of wallboard and other plaster products.

Source: USGS 2005 Commodity Report



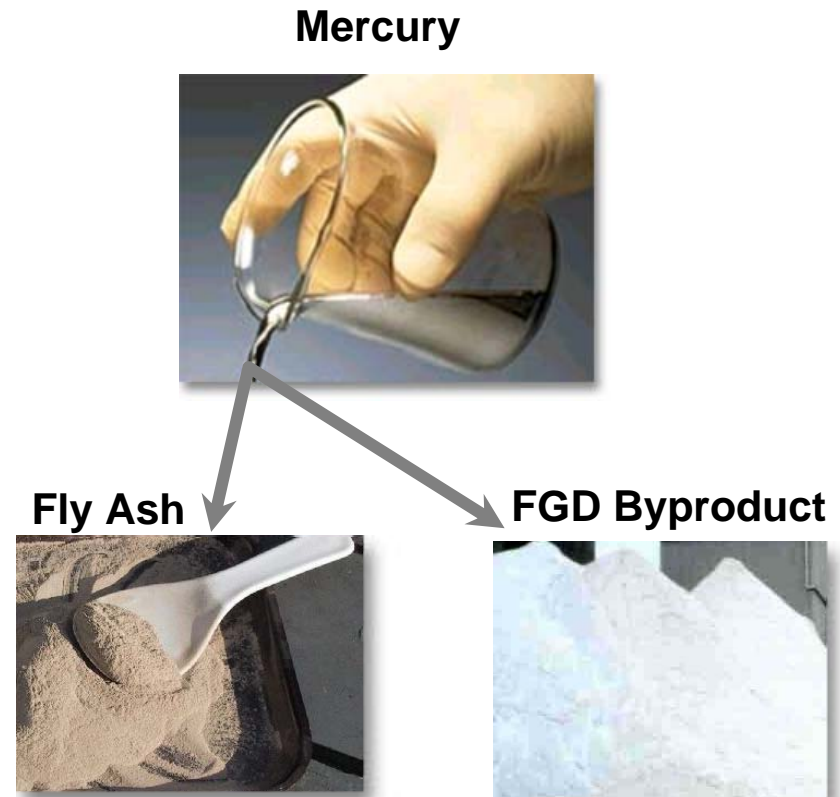
DOE/NETL's Coal Utilization By-Products Research Program

- Goal is to increase CUB beneficial use to 50% by 2010
- Working with key stakeholders such as ACAA, EPRI, and EPA



Mercury Control and Coal Byproducts

- Almost all mercury control technologies increase mercury concentration in byproducts
- Ultimate fate?
- Perceptual impacts?
- Regulatory impacts?

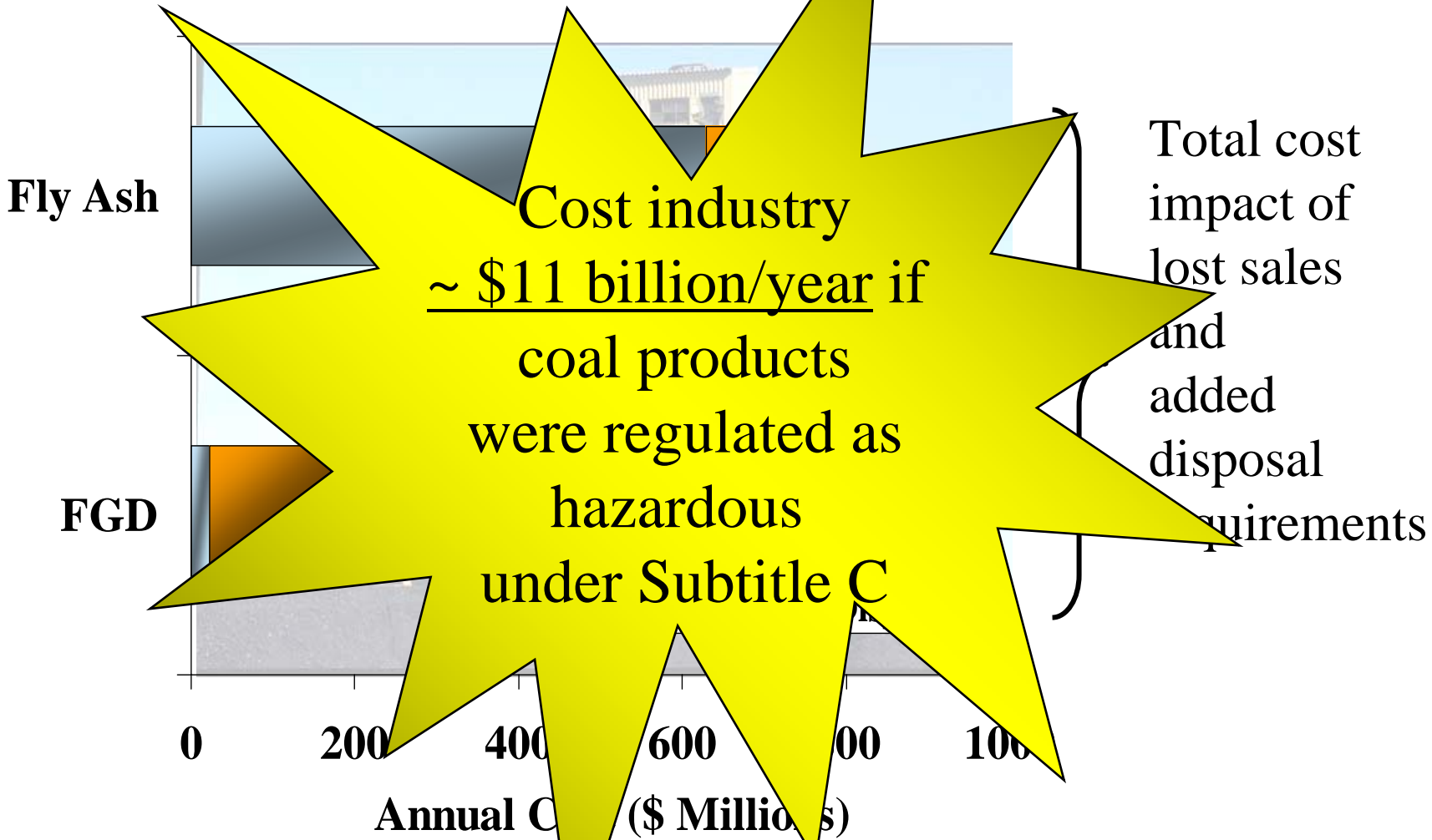


Regulation of CUB Disposal and Utilization

- **EPA regulates CUBs under the Resource Conservation and Recovery Act (RCRA)**
- **EPA's May 2000 regulatory determination**
 - Maintain Subtitle C (hazardous waste) exemption and not require regulation under Subtitle D (non-hazardous waste) for beneficial use applications
 - However, EPA plans to develop regulations under Subtitle D for CUB disposal and mine placement applications
- **CUB disposal rules**
 - Regulatory development schedule unknown
- **CUB mine placement rules**
 - EPA issue of proposed rule pending National Academy of Science study scheduled for publication by December 2005



Potential Cost Implication of Restrictions on Coal Byproduct Use



Key Challenges to CUB Use

- Projected increases in electricity demand will result in greater coal use and concomitant byproduct production
- Installation of additional FGD to meet CAIR will increase volume of scrubber solids
- Installation of additional advanced combustion technology and SCR to meet CAIR could increase UBC and NH_3 in fly ash
- Use of AC injection for Hg control could negatively impact fly ash utilization due to increased carbon content
- Transfer of Hg from flue gas to fly ash and scrubber solids will likely lead to increased scrutiny of CUB use and disposal



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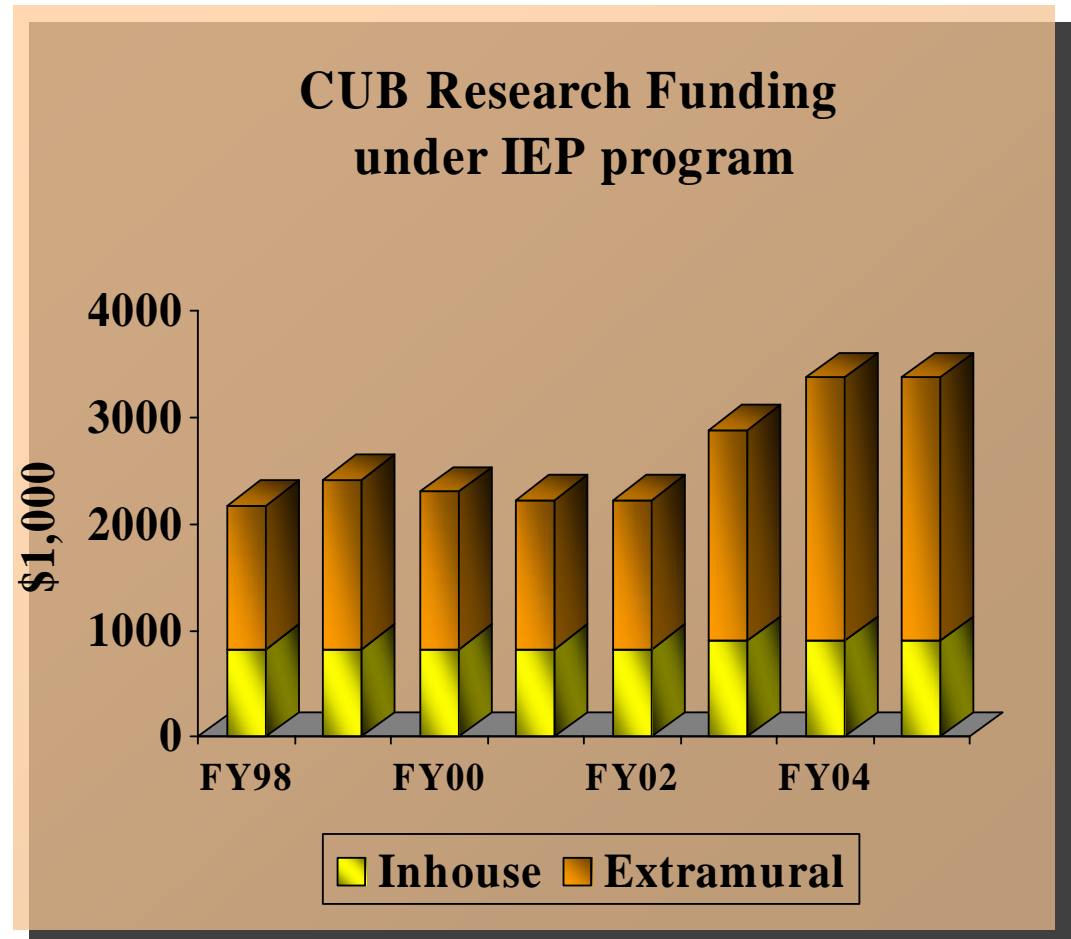


- **One of DOE's 17 national labs**
- **Government owned / operated**
- **Sites in:**
 - Pennsylvania
 - West Virginia
 - Oklahoma
 - Alaska
- **More than 1,100 federal and support contractor employees**



DOE/NETL CUB Research Funding

- Over \$22 million in DOE/NETL funded CUB in-house and extramural research from FY98 – FY05
- An additional \$22 million for coal byproducts under DOE's clean coal demonstration program



DOE/NETL CUB R&D Projects

- **NETL-funded extramural R&D projects**
- **NETL-sponsored consortia**
 - Combustion Byproducts Recycling Consortium (CBRC) administered by the University of West Virginia
 - Coal Ash Resources Research Consortium (CARRC) administered by the University of North Dakota EERC
- **NETL In-house (OSTA-Environmental Sciences Division)**



Combustion By-Products Recycling Consortium (CBRC)

- Administered through West Virginia University's National Mine Land Reclamation Center
- Divided into three geographic regions:
 - Western
 - Midwestern
 - Eastern
- Focus on regional and national priorities
- To date, over \$3 million in DOE/NETL funding and \$2.5 million in cost sharing



DOE/NETL CUB Research Projects

Project Title	Lead Organization
CUB Analysis from ACI Mercury Control Field Testing	ADA-ES and Reaction Engineering
CUB Analysis from Wet FGD Reagent Hg Field Testing	Babcock & Wilcox
Characterization of Coal Combustion By-Products for the Re-Evolution of Hg into Ecosystems	CONSOL Energy
Hg and Air Toxics Element Impacts of Coal Combustion By-product Disposal and Utilization	UNDEERC
Effect of Hg Controls on Wallboard Manufacture	CBRC and TVA
Fate of Hg in Synthetic Gypsum Used for Wallboard Production	USGypsum
CUB Batch Characterization and Interlaboratory Comparison	NETL In-house
Hg and Metals Stability in CUBs	NETL In-house
Hg Capture and Potential Release from FGD Products	NETL In-house



Fate of Mercury in Synthetic Gypsum Used for Wallboard Production

- U.S. Gypsum (prime), URS, EPRI (co-funding), and Shaw Environmental
- Assess fate of mercury in synthetic gypsum produced by coal-fired boiler FGD systems:
- Measure mercury concentrations in solid, liquid, and gaseous streams



USG Plant



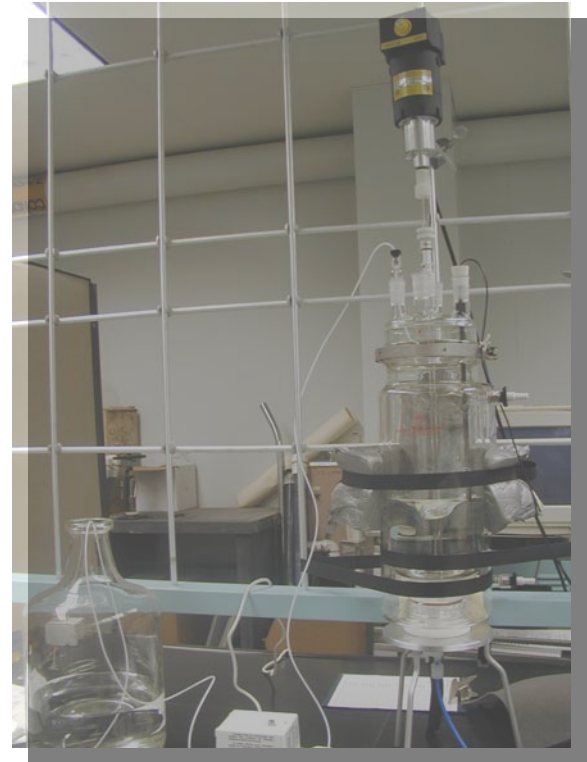
USG Plant

NETL In-House R&D

Partitioning of Mercury During Laboratory FGD-Slurry Settling Studies

Preliminary Results:

- All Hg remains in iron-rich residues after leaching experiments
- Both Hg and Fe preferentially report to top layers during settling experiments
- Hg content of FGD gypsum appears to correlate with Fe content



Continuous stirred tank reactor

DOE Clean Coal Power Initiative Demonstrations

Processing Plant to Reclaim Ash Pond CUBs for Portland Cement Substitute

- University of Kentucky-CAER to demonstrate hydraulic classification and froth flotation for making pozzolan & other products at 2,200 MW Ghent Station in Kentucky
- \$8.9 million project (\$4.4M DOE)



Potential Product Uses



Birchwood Plant

Processing Plant to Manufacture Aggregate from Spray Dryer Ash

- Universal Aggregates demonstrating aggregate manufacturing technology using spray dryer ash at Mirant's 250 MW Birchwood Plant in Virginia
- \$19.6 million project (\$7.2M DOE)



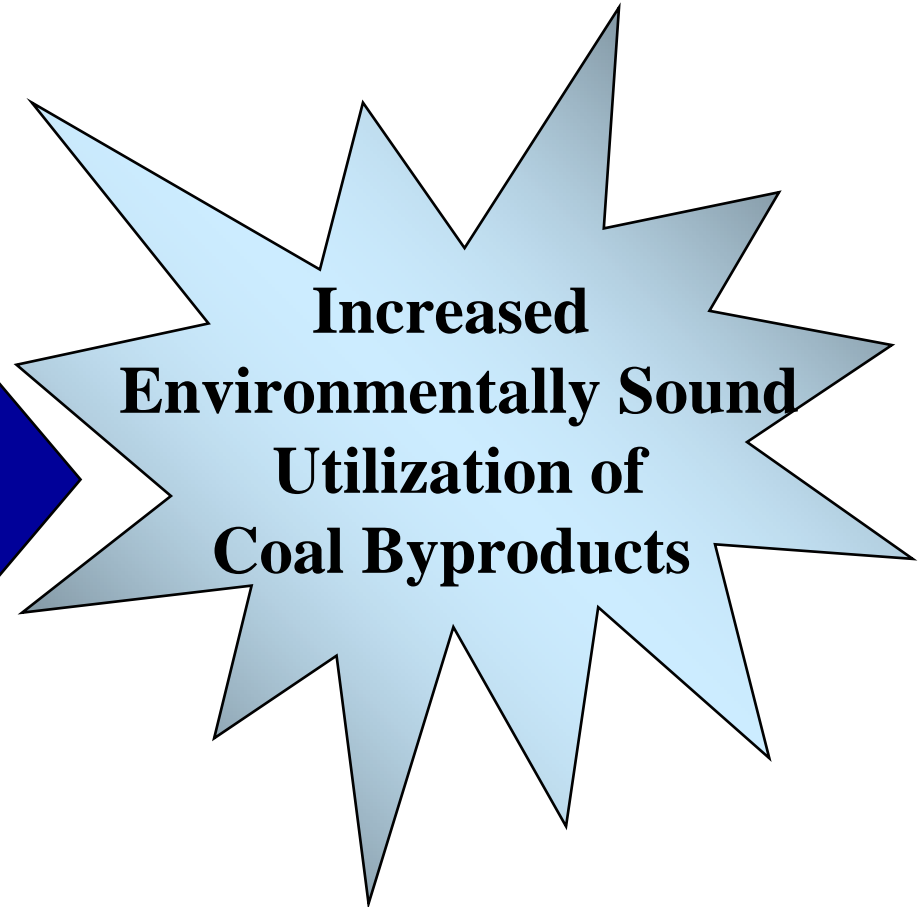
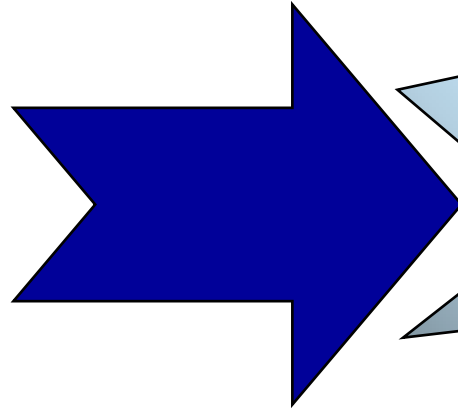
Summary

- **Future electricity demands in parallel with tighter controls on emissions of Hg, NO_x, and SO₂ from coal-fired power plants will increase CUB production and/or affect their characteristics**
- **Pressures to further regulate/restrict the use and disposal of CUBs will likely continue**
- **DOE/NETL and others will need to continue to aggressively support CUB research**



Partnership Key to Success

- C²P²
- Industry & Academia
- DOE/NETL
- ACAA
- USWAG
- EPA



Working Together We Can Reach Our Goals!

