

Ohio . . . A Leader in Clean Coal Research, Development & Deployment

CCTR Advisory Panel Meeting

November 17, 2005

Purdue University

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Ohio Coal Development Office
Ohio Air Quality Development Authority*

Coal--a Vital Part of Ohio's Economy

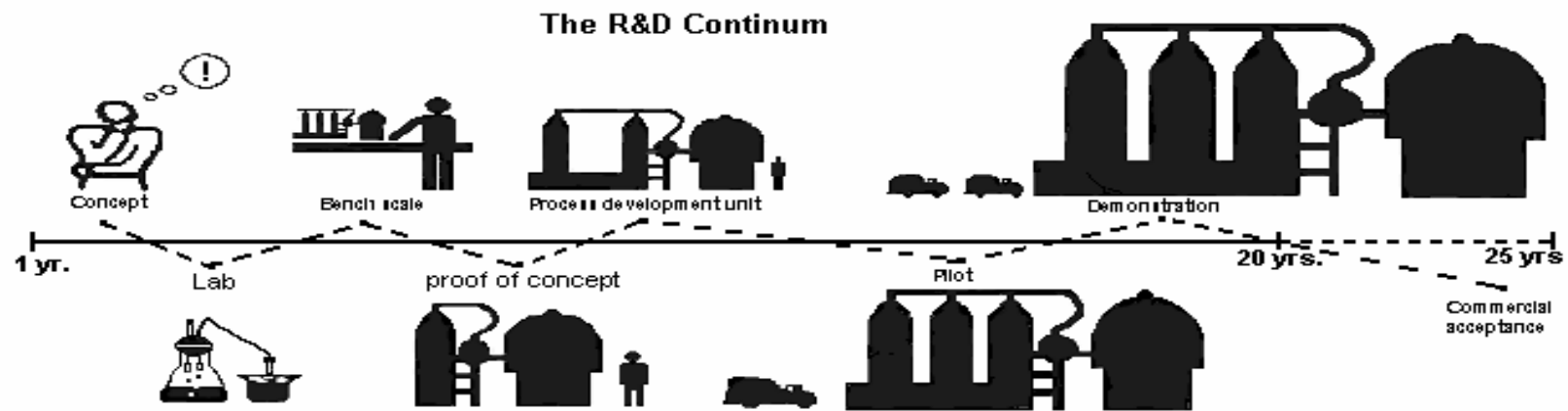
- Ohio -- 2nd-largest electrical generation capacity from coal; 4th-largest consumer of electricity
- 25.8 million tons of coal produced in 2001
- Over 80% delivered to instate u



Ohio Decided to be a Part of the Solution

- In 1984, created the Ohio Coal Development Office (OCDO)
- In 1985, electorate passed issue authorizing up to \$100 million in revolving debt in coal R&D bonds
- OCDO's purpose
 - To maintain Ohio's competitive edge by developing and deploying technologies that can use coal economically, within environmental limits while maintaining reasonable electricity costs and sustaining the jobs associated with coal's production and use.

The R & D Continuum



OCDO Projects

- Over 302 projects since 1984
- \$170.6 million in OCDO funds committed
- \$177.0 million leveraged from federal funds
- \$349.7 million leveraged from grantee and other sources
- **\$697.3 million in total project value**

Program Oversight and Technical Inputs

- 15-member Technical Advisory Committee reviews and recommends projects
- 8-member Ohio Air Quality Development Authority reviews and approves/rejects recommendations
- Approved projects put under legal agreement and overseen by OCDO staff

Other Inputs: Strategic Directions for Coal

- **Technology Roadmap**

Merged from USDOE, Coal Utilization Research Council, EPRI roadmaps

- **National Coal Council**

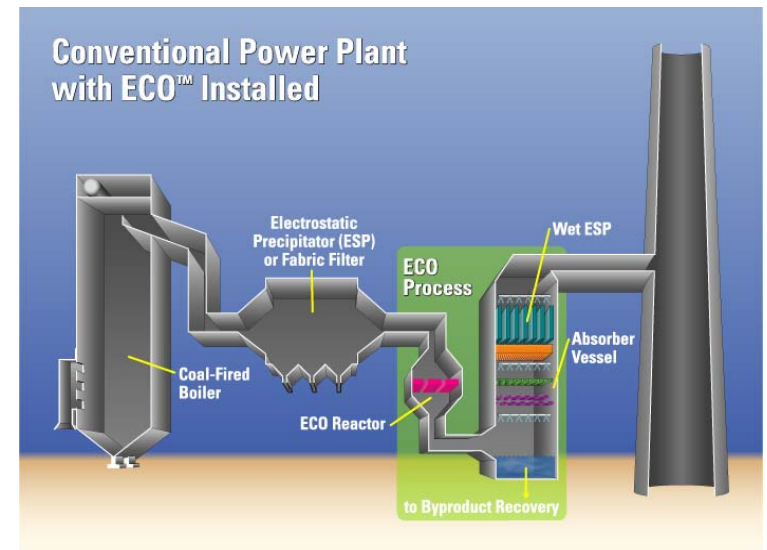


Following Are Some Examples of:

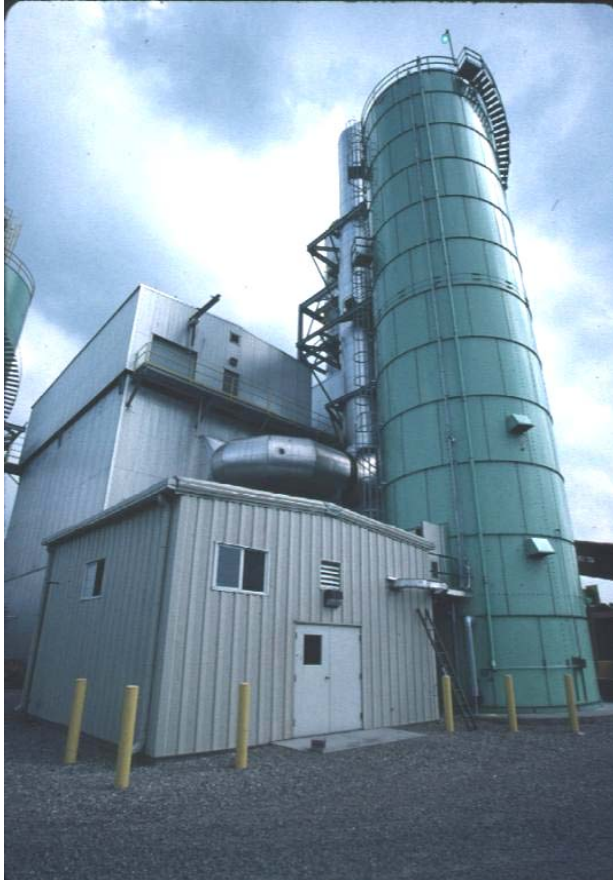
- Technologies at power plants
- Non-traditional applications
- Byproducts reuse
- Power plants of the future
- University research

Powerspan ECO Project

- 50 MW_e slipstream at FirstEnergy's Burger station
- System now undergoing long-term testing
- Capable of reducing NO_x and mercury emissions by 90% or more, SO₂ by 99% and fine particulates by over 95%
- If large NO_x reduction not needed, can install only the tower/WESP
- Process produces a valuable fertilizer product

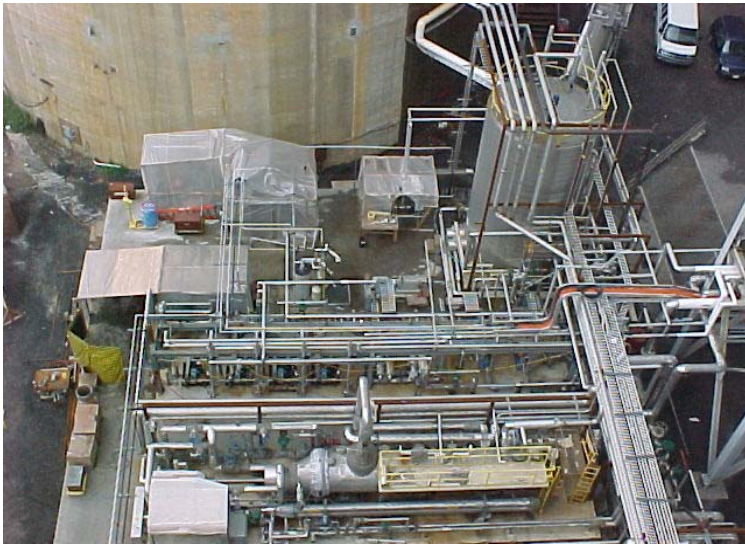


Gas Suspension Absorber



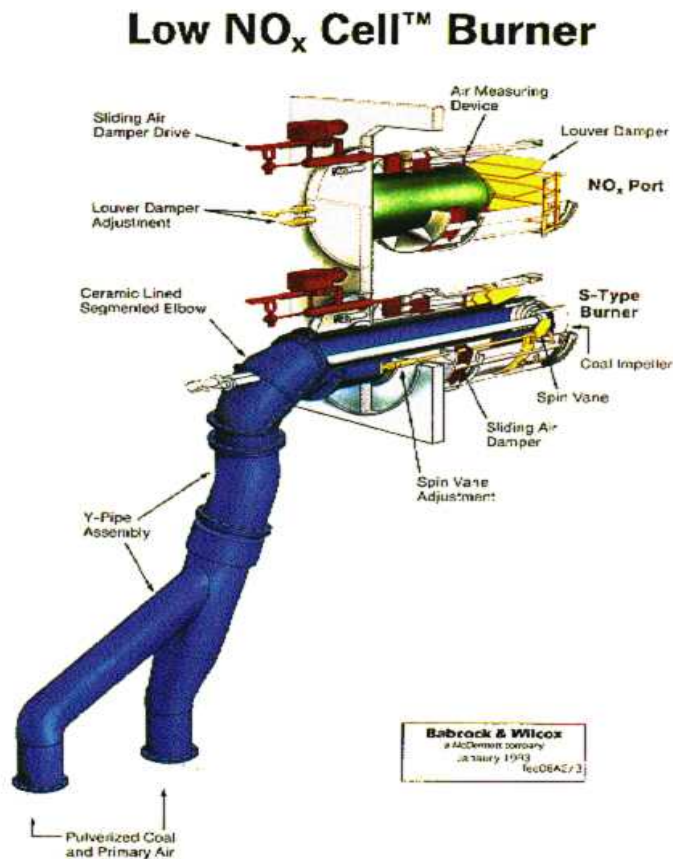
- Permanent installation, located at city of Hamilton Power Plant
- 50 MW_e installation of FLS miljø dry SO₂ scrubber
- Greater than 90% SO₂ removal
- Allows Hamilton to switch to less-expensive high-sulfur Ohio coal
- Enables the plant to meet MACT limits

AOD™ Demonstration



- Permanent installation at the 2600 MW_e AEP Gavin Station
- Uses safely stored and transported urea, rather than anhydrous or aqueous ammonia
- Hydrolyzes urea to produce ammonia for Gavin SCR (NO_x removal) system
- System since installed at other AEP SCR systems

Low-NO_x Cell Burners



- B&W demonstration and subsequent permanent installation at the Dayton Power & Light Stuart Station
- 605 MW_e unit 4
- Achieved a NO_x reduction of 55%
- Resulted in commercialization of low-NO_x replacement burners

Carbon Nanofibers from High-sulfur Coal



- Production requires a carbon source and a sulfur source— Ohio coal provides both
- Gasifier is used to provide feed to nanofiber production reactors
- Lower cost production than alternative methods

Carbon nanofiber uses

- Lightweight, high-strength composites
- High-strength, crack-free concrete and machinable concrete products

OCDO is a National Leader in Coal Combustion Product Development

- 30 projects from 1988 to the present
 - \$12.5 million from OCDO
 - \$27.6 million in total project value
- Charter member of USEPA's C²P², a consortium dedicated to coal byproduct reuse



Testing of CCP Pavement Sections



- Conducted by The Ohio State University and Ohio University at the Accelerated Load Testing Facility in Lancaster
- Full-scale pavement sections subjected to simulated wheel loads and environmental conditions
- 10 years of Interstate highway wear simulated in 4-6 months
- 36-month, \$1.74 million project, with half from OCDO

Utilization of Zimmer FGD Byproducts



- Carmeuse demonstrated the production of saleable gypsum and magnesium hydroxide from Zimmer FGD byproducts
- Helped lead to the usage of most of the plant's gypsum in wallboard manufacture
- Demonstrated that calcium sulfite applied to minelands inhibits acid drainage

Aluminum/Fly Ash Metal Matrix Composite Foams

- Aluminum foams made from Ohio coal fly ash
- Will demonstrate use of foams for truck and SUV frames
 - Improved passenger safety
 - Reduced weight saves gasoline
- Can save landfill of 2.4 million yards³ of fly ash
- Two-year, \$1.5 million effort led by Thompson Aluminum Casting and the Budd Company
- \$750,000 from OCDO



B&W Mercury Control Demonstration



- Began with testing at B&W's Advanced Emissions Control Development Program in Alliance, OH
- Goal of 90% mercury removal in systems with SO₂ scrubbers
- Simple and cost-effective retrofit technology
- Removal costs expected to be 25% to 50% of the cost with commercial activated carbon systems
- 79% Hg capture at the 55 MW_e Endicott Station; 51% Hg capture at the 1300 MW_e Zimmer Station

Consol Mercury Testing Across FGD Systems



- Consol conducted stack testing to determine mercury removal across FGD systems
- Testing showed that 84% to 90% of oxidized mercury was removed
- Overall mercury removal by the FGD systems was about 60%

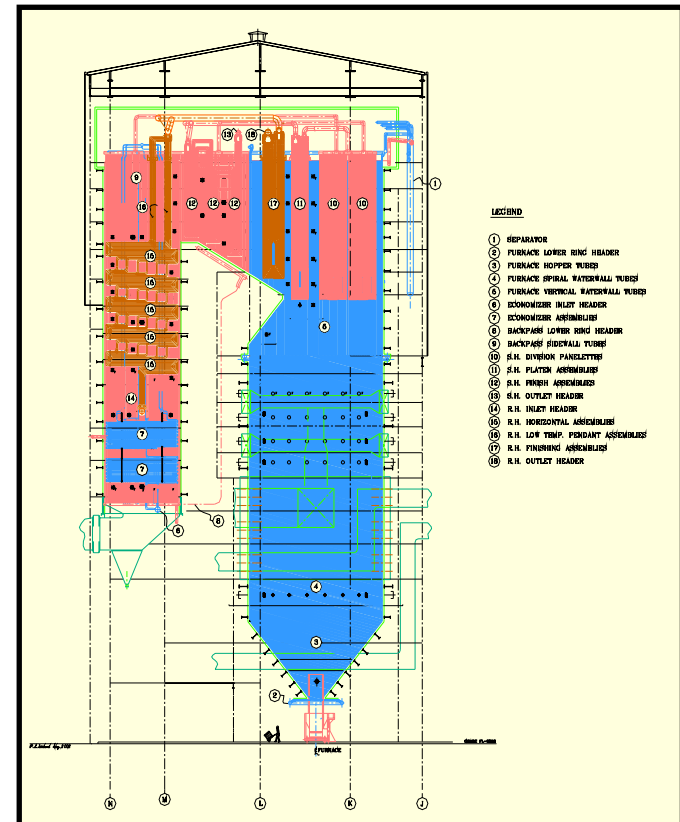
Sorbent Technologies Mercury Sorbents



- Has developed brominated, powdered activated carbon (B-PAC) sorbents
- In tests on OU steam plant, B-PAC sorbents removed 70% of Hg at 3 to 5 lb/MMacf
- Because of their greater activity B-PAC sorbents cost less than 20% of the cost of standard activated carbons

Ultrasupercritical Boiler Materials Project

- Identifying improved materials that can be used at steam temperatures to 1400 F and pressures to 5500 Conceptual psi
- design, 45.2% efficiency
- Partnership with DOE, EPRI, EIO, B&W, Alstom, Foster-Wheeler, Babcock Power, ORNL and others
- Complements and advances similar development programs in Europe and Japan



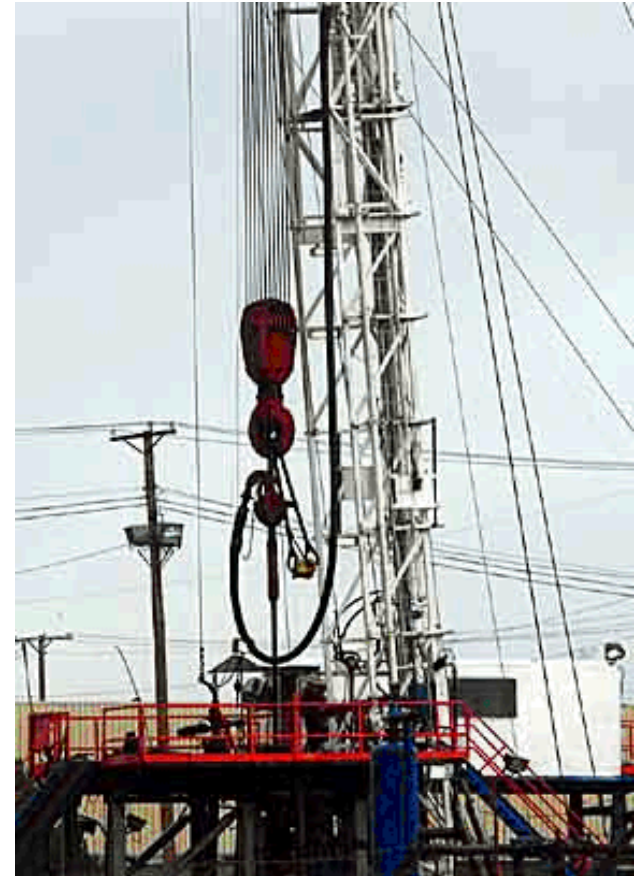
Evaluation of CO2 Retrofit Control



- Alstom Power, with sponsorship from DOE and OCDO, evaluated retrofit at Conesville Unit 5
- Study completed June, 2001
- Conclusions
 - No major technical barriers to CO2 control
 - CO2 reduced by 90-95%
 - Investment cost nearly equal to cost of new plant
 - Energy penalty would effectively reduce unit output to about 60% to 75% of rated capacity (requiring replacement capacity)
 - 5-8 acres required for new equipment

Demonstration of CO₂ Sequestration in Deep Geologic Formations

- Battelle project with support from OCDO, DOE and AEP
- Drill site is on Ohio River next to AEP Mountaineer plant
- Injection of CO₂ into sandstones approximately 8000 and 9000 feet below the surface
- Anticipated storage capacity out to 20-mile radius is up to 80 to 160 million tons of CO₂



Terrestrial CO₂ Sequestration at Reclaimed Mineland

- Project led by OSU and co-sponsored by OCDO, Los Alamos National Lab, and AEP
- Evaluating effects of post-reclamation land use and management on amount and permanence of CO₂ sequestered
- Assess the mechanisms of terrestrial (soil) sequestration
- Evaluate the effects of reclamation techniques on plant biomass production and residue decomposition

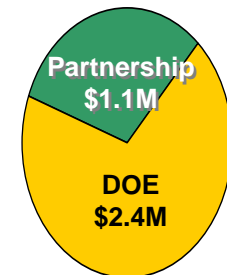
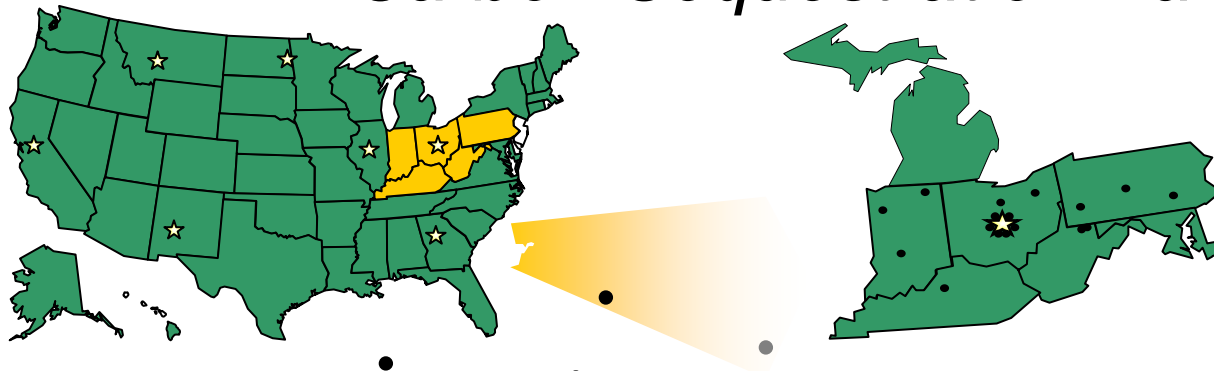


Use of FGD Gypsum to Enhance Soil Sequestration and No-Till Production



- OSU project, with support from OCDO, Ag Spectrum, Kohlpyr and Cinergy
- Gypsum can enhance clay soils, add essential nutrients (calcium and sulfur)
- No-tillage practices reduce expenses and enhance carbon storage capacity of soils
- Ultimate project goal is to increase no-till use and develop a large-volume application for FGD gypsum

Battelle Memorial Institute, *Midwest Regional Carbon Sequestration Partnership*



Description :

The Midwest Regional Carbon Sequestration Partnership, led by Battelle Memorial Institute, Columbus, OH, will identify greenhouse gas sources in its region - which covers Indiana, Ohio, Kentucky, West Virginia, Pennsylvania, and Ohio - and determine the technical feasibility and cost of capturing and sequestering these emissions in deep geologic formations and agricultural forests and degraded land systems. Existing regulations and policies will be examined to determine if they hinder the cost-effectiveness of CO₂ sequestration options, and ways of overcoming these barriers will be outlined. The partnership is comprised of various universities, geological surveys from the region, as well as Consol Energy.

Duration : 24 months

Partners:

**Battelle Memorial Institute
British Petroleum
Nordic
Arch Coal Inc.
American Electric Power
Cinergy
CONSOL Energy Inc.
First Energy
Wisconsin Energy Corporation
Indiana Geological Survey
Kentucky Geological Survey**

**Ohio Coal Development Office
Ohio Division of Geological Survey
Ohio Environmental Office
Pennsylvania Geological Survey
West Virginia Geological and Economic Survey
Ohio State University
Pennsylvania State University
Purdue University
West Virginia University
National Regulatory Research Institute
The Keystone Center**

Ohio Coal Research Consortium

- Coordinated coal research at Ohio universities since 1990
- Cutting-edge research
- Managed by Ohio University
- Current academic year
 - about 13 projects each year
 - \$1.6 million total project value
 - \$1.2 million from OCDO
 - Topics include capture of SO₂, NO_x, Hg trace emissions, CO₂ sequestration, hot gas cleanup, hydrogen from coal, fuel cells



OCDO Contact Information

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