The Benefits of Clean Coal Technology

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A Focus on Demonstration Projects

- Demonstration projects are critical to successful commercialization of the technology developed under the Fossil Energy R&D program.
- Estimates of the benefits to the nation from the Power Plant Improvement Initiative and the Clean Coal Power Initiative prove the value that can be realized from the application of advanced technology.

Outline

- **Approach used to calculate benefits.**
- **Quantitative estimates of the benefits of two Power Plant Improvement Initiative projects.**
  - Advance Hybrid Particulate Collector (Otter Tail Power)
  - Conversion of Spray Dryer Ash to Lightweight Aggregate Building Materials (Universal Aggregates)
- **Examples of the benefits anticipated from the eight Clean Coal Power Initiative projects selected for Round 1.**

Approach to Estimating Benefits

- **Forecast market penetration.**
- **Quantify differences between performance of conventional technology and the anticipated performance of the advanced technology being demonstrated.**
  - Pollutant emissions, tons per year
  - Fuel cost, constant dollars
  - Annual power generation, kWh
  - Capital and operating cost, constant dollars

Power Plant Improvement Initiative Projects

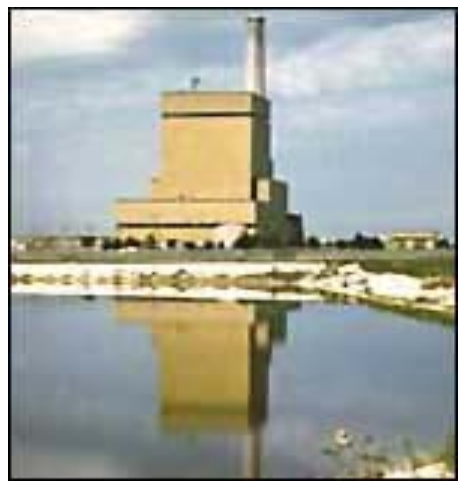
- **Advanced Hybrid Particulate Collector (AHPC) technology.**
  - Collecting better than 99.99% of particulate matter on a 450 MW_e cyclone boiler firing coal from Wyoming's Powder River Basin at Otter Tail Power's Big Stone Power Plant, Big Stone City, South Dakota.
- **Universal Aggregates process.**
  - Turning spray dryer fly ash from the 240 MW_e Birchwood Power Partners' Facility in King George County, Virginia, into useful products.

Big Stone Power Plant

Birchwood Power Facility

Advanced Hybrid Particulate Collector

- A highly efficient particulate control device with membrane filter bags interspersed with perforated electrostatic precipitator plates and electrodes in the same housing.
- Will reduce emissions of airborne particles to less than 0.007 pounds per million Btu – more than four times cleaner than required by current clean air laws.
- Forecast to be installed on 25 GW of existing coal-fired capacity.



Estimated Reductions in National Pollution Emissions from AHPC Commercialization

	AHPC Emission Reductions, tons/year	All Boiler Emissions, tons/year
Total Particulate Matter	**52,580**	**522,400**
PM_{10}	**35,670**	**360,900**
$PM_{2.5}$	**16,230**	**167,100**
SO_2	**202,700**	**10,770,000**

Note: PM_{10} and $PM_{2.5}$ emissions were estimated using generalized emissions factors.

Additional National Benefits from AHPC Commercialization

- AHPC technology could save up to $750 million in capital costs when compared to the installation of conventional fabric filter systems to achieve the same low particulate emissions on 25 GW_e of existing power plants.

Benefits of AHPC for Big Stone

	Total Particulate Emissions, tons/year
Before Retrofit	360
After Retrofit	130
Emissions Avoided	230

Total particulate emissions at the Big Stone power plant are estimated to decrease by at least 65% due to the installation of AHPC technology

Performance of AHPC at Big Stone

- Big Stone Plant had been forced to curtail operations to remain in compliance with its opacity limit of 20%. Opacity following installation of the AHPC is typically 1%.
- Recent emissions tests conducted at Big Stone show that the average collection efficiency of the AHPC system is 99.997%.
- Installation of the AHPC system at Big Stone provides much greater fuel flexibility to the plant operators.

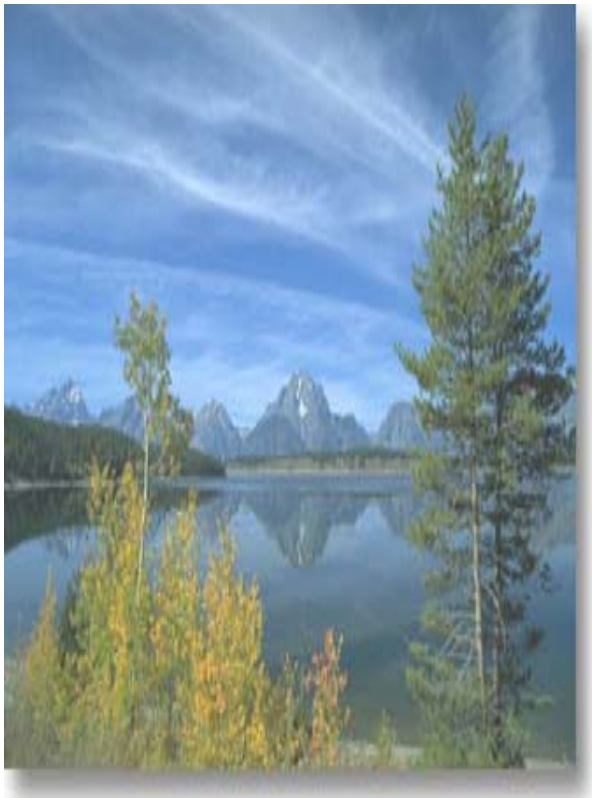
Universal Aggregates Process

- This new technology is designed to recycle the by-products from either wet or dry scrubbers, thereby lowering the costs of waste disposal while reducing the environmental drawbacks of landfilling.
- It will produce 167,000 tons per year of valuable lightweight aggregate that can be used to make a variety of construction materials, from masonry blocks and concrete to asphalt paving material.

Unique Contribution of the Universal Aggregates Process

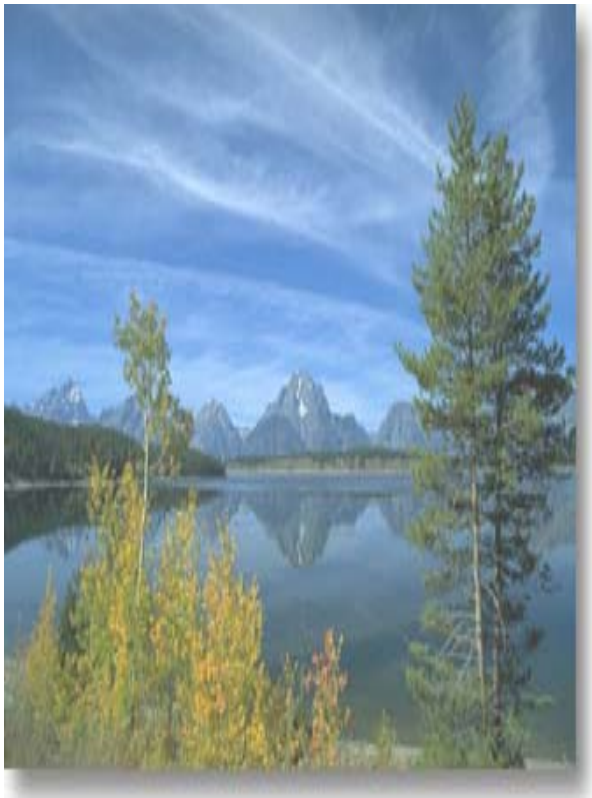
- The Universal Aggregates project at the Birchwood Power Partners' Facility is intended to demonstrate that a material with no current high-value use, spray dryer ash, can be turned into useful products.
- There are currently 21 units producing this difficult-to-use material.
- It is anticipated that, if proposed multi-pollutant control legislation is enacted, many more spray dryers will be installed to control SO_2 emissions.

Clean Coal Power Initiative Projects



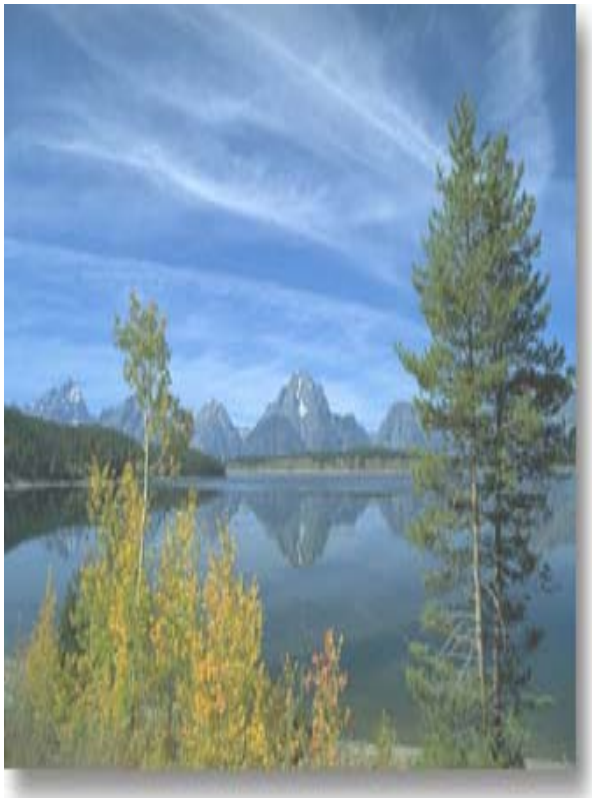
- **New Technology for Clear Skies**
  - Integration of Advanced Emissions Controls for Next Generation Circulating Fluid Bed Coal-Fired Generating Unit
  - TOXECON Retrofit for Mercury and Multi-Pollutant Control on Three 90-MW Coal-Fired Boilers
  - Commercial Demonstration of the Airborne Process

Clean Coal Power Initiative Projects (Continued)



- **Higher Efficiencies to Meet Climate Change Goals**
  - Demonstration of Integrated Optimization Software at the Baldwin Energy Complex
  - Advanced Multi-Product Coal Utilization By-Product Processing Plant
  - Increasing Power Plant Efficiency—Lignite Fuel Enhancement

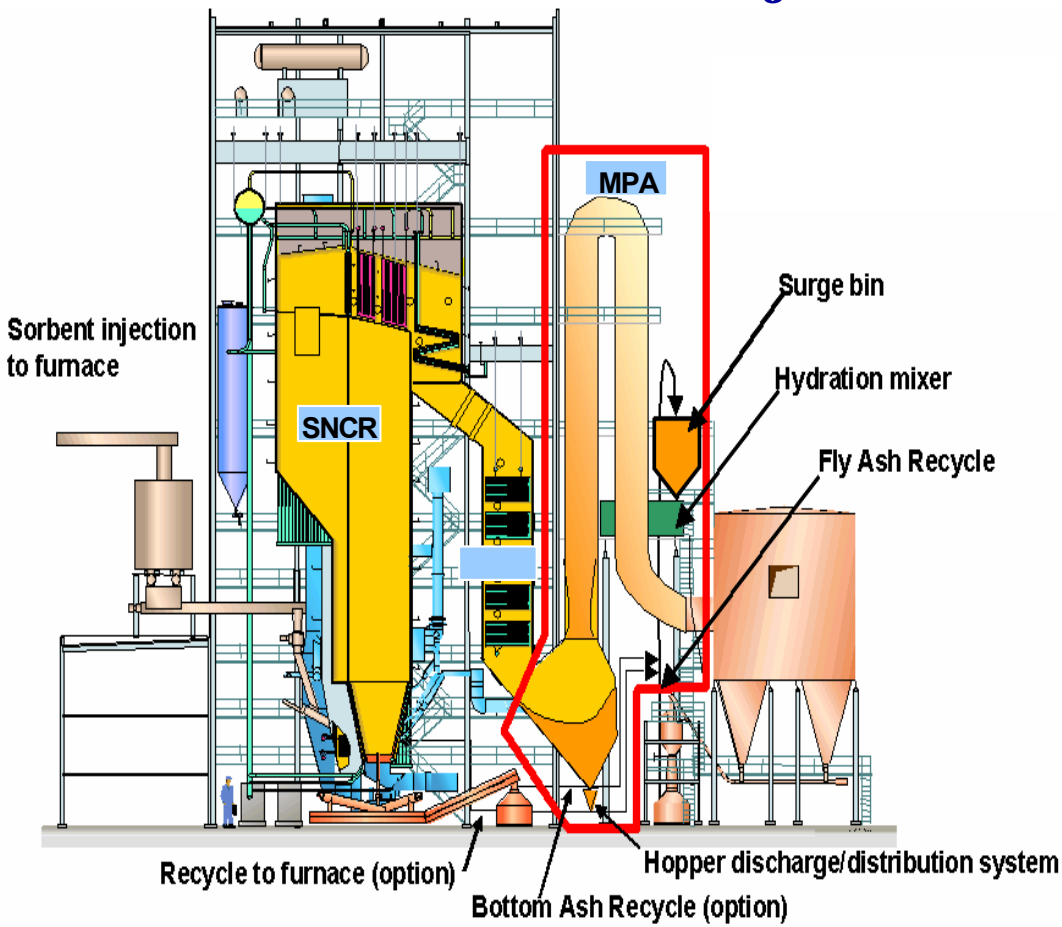
Clean Coal Power Initiative Projects (Continued)



- **Clean Energy from Coal Waste Piles**
  - Gilberton Coal-to-Clean Fuels and Power Project
  - Western Greenbrier Co-Production Demonstration Project

Example of the Benefits of a CCPI Project

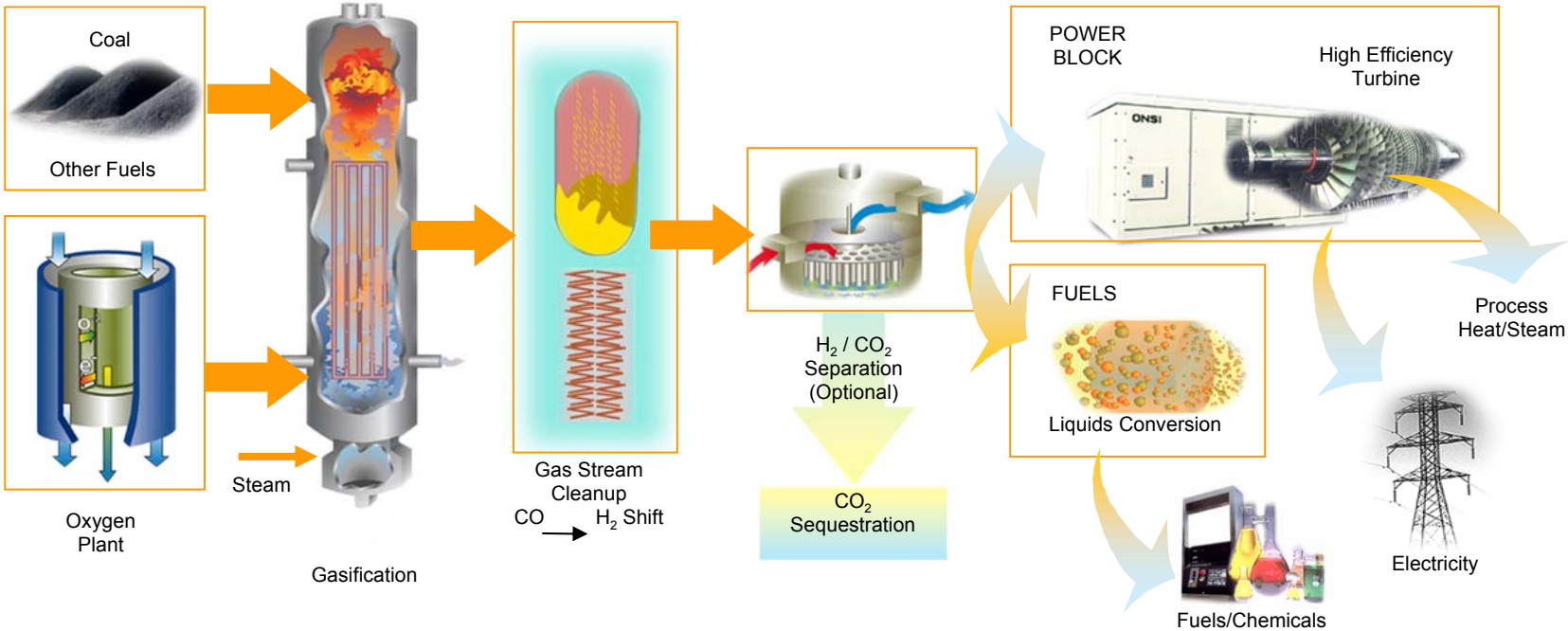
- **Commercialization of this technology in the state of Colorado would remove 20 to 30 million tons of…**
  - coal residue left by the steel industry
  - deadwood from the state's forests



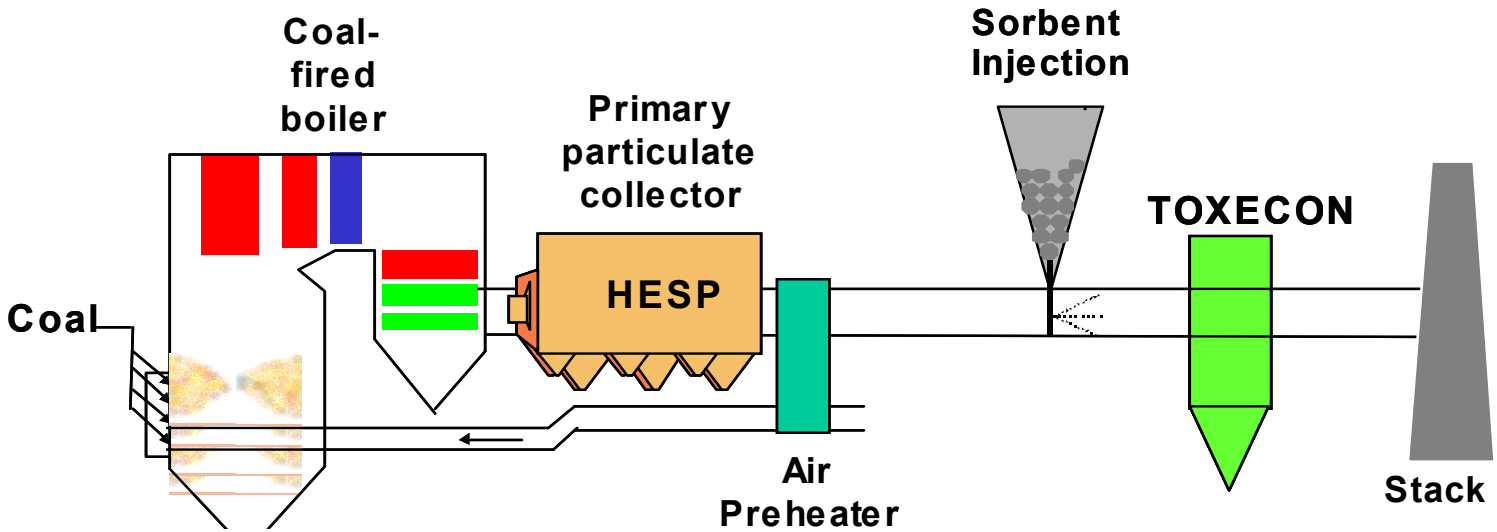
Integration of Advanced Emissions Controls for the Next Generation Circulating Fluid Bed Coal-Fired Generating Unit Project

Examples of Plant-Specific Benefits of CCPI Projects

- **This project is expected to process 1 million tons per year of coal waste (anthracite culm) into 1.8 million barrels per year of ultra-clean transportation fuel and 41 MW of electricity.**



Examples of Plant-Specific Benefits of CCPI Projects (Continued)



TOXECON Retrofit for Mercury and Multi-Pollutant Control Project

- **Anticipated emissions reductions at the Presque Isle Power Plant:**
  - 80 pounds of mercury per year
  - 1,145 tons of SO_2 per year
  - 428 tons of NO_x per year

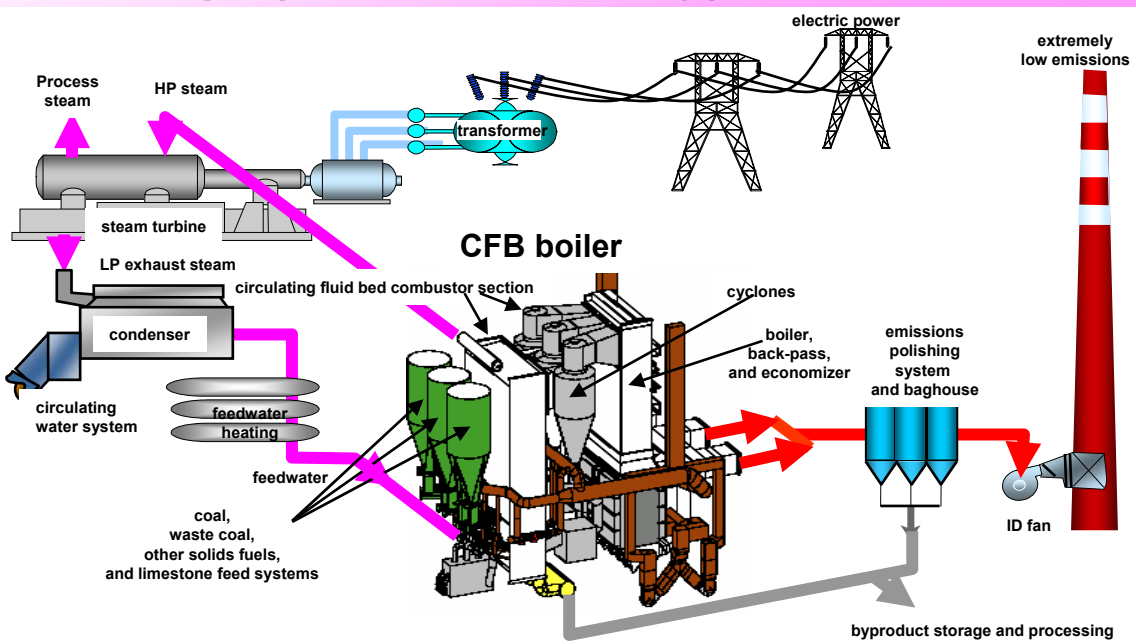
Examples of Plant-Specific Benefits of CCPI Projects (Continued)

- The Advanced Multi-Product Coal Utilization By-Product Processing Plant project is expected to produce 156,000 tons of pozzolan per year along with lightweight aggregate, polymer fill, and supplemental fuel.
- An equivalent amount of portland cement production would be displaced eliminating 156,000 tons of CO_2 emissions per year.

Examples of Plant-Specific Benefits of CCPI Projects (Continued)

- This project is expected to eliminate 1,610 tons per day of waste coal (gob) while producing electricity (75 MW), structural bricks (300 tons per day), hot water for district heating, steam for industrial use (480,000 pounds per day), and alkaline ash for remediating acid mine drainage (970 tons per day).

This novel power plant will serve as the "anchor tenant" in a new environmentally balanced industrial park.



Total Anticipated Clean Coal Power Initiative Benefits in 2020

Energy Savings, billion $ per year	Greenhouse Gas Reduction, mmtCe per year	Mercury Reduction, tons per year
44	71	13

Conclusions

- There are significant benefits to the nation that will be realized by the commercialization of technologies being demonstrated in the Power Plant Improvement and Clean Coal Power Initiatives.

Visit the NETL web site for information on all Clean Coal Power Initiative projects.

www.netl.doe.gov/coalpower/ccpi