

JEA Large-Scale CFB Combustion Demonstration Project

Benefits Presentation



Clean Coal Technology Project

A Fuel-Flexible, Low Emissions, Large-Scale Circulating Fluidized Bed (CFB) Combustion Demonstration Project

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National Energy Technology Laboratory



Outline

- **Executive Summary**
- **Project Information**
 - Plant, fuel, and location
 - Cost, and schedule
 - Team members
 - A CFB Process
 - SO₂ control process
 - NO_x control process
 - JEA schematic
 - Unique contribution



Outline (continued)

- **Estimated Benefits**
 - Approach
 - Market penetration assumptions
 - Emissions comparison by fuel
 - Actual emissions compared to similarly sized plants
 - Regional
 - National
 - Pollutant reductions from commercialization
- **Conclusions**



Executive Summary

- This project demonstrates technical and economic viability of a low temperature, atmospheric pressure, 297.5 MWe coal-fired circulating fluidized bed (ACFB) combustion boiler
- Project has received *Power* magazine's 2002 Power Plant Award, and was nominated for *Power Engineering* magazine's 2003 Power Plant of the Year Award
- ACFB offers superior cost and performance compared to conventional pulverized coal-fired (PC) plants
- Fly ash and bed ash blended by-product classified by Florida Department of Environmental Protection as (DEP) "industrial by-product" allowing it to be used beneficially



Executive Summary (continued)

- Equivalent availability was 72.8% for 2003 and 58.7% for 2004
- The ACFB system uses various types of coal and petroleum coke/coal blends to provide fuel options
- Stack emissions data (CY2004)
 - NO_x emissions: 0.08 lb/Million Btu
 - SO₂ emissions: 0.17 lb/Million Btu
 - PM emissions: 0.005 lb/Million Btu



Panoramic view of JEA site



Project Information

Plant, Fuel, and Location

- This project demonstrates technical and economic viability of a 297.5 MWe coal-fired atmospheric circulating fluidized bed (ACFB) combustion boiler
- Fuel:
 - Pittsburgh #8 bituminous coal
 - 50/50 blend of petroleum coke and Pittsburgh #8 bituminous coal
 - Illinois #6 bituminous coal
 - 80/20 blend petroleum coke and Pittsburgh #8 bituminous coal
- Location: Jacksonville, FL



Project Information (continued)

Cost and Schedule

- **Project cost: \$321.4 million;
DOE share \$74.7 million**
- **Schedule:**
 - 2000 Project Start
 - 2000 to 2003 Construction
 - 2003 to 2004 Operation
 - 2005 Completion



Project Information (continued)

Team Members

- **JEA (Jacksonville, FL)**
 - Prime contractor
 - Project administration, performance testing, and reporting
- **Foster Wheeler Energy Corporation (Clinton, NJ)**
 - Technology supplier: design and supply of ACFBs
 - Engineering, procurement and construction contractor of boiler island (ACFB, scrubbers, fabric filters, stack, and fuel and limestone preparation facilities)



Project Information (continued)

ACFB Process

- **Coal fuel blends, along with primary air and a solid sorbent (limestone) are introduced to lower part of combustor, where initial combustion occurs**
- **As fuel particles decrease in size, due to combustion, they are carried higher in combustor, where secondary air is introduced**
- **As particles continue to shrink, fuel, along with some of the sorbent is carried out of combustor, collected in a cyclone separator, and recycled to lower portion of combustor**
- **Steam is generated in tubes placed along the walls of combustor and superheated in tube bundles placed downstream of particle separator**



Project Information (continued)

SO₂ Control Process

- **Design emission rate for SO₂ is 0.15 lb/Million Btu**
- **Primary removal of sulfur is achieved by reaction with limestone sorbent in ACFB**
- **Additional SO₂ removal is achieved by a downstream polishing scrubber using a spray dryer absorber**
- **Stack emissions for various fuels include**
 - 100% Pittsburgh #8 bituminous coal: 0.104 lb/Million Btu
 - 50/50 blend of petroleum coke and Pittsburgh #8 bituminous coal: 0.101 lb/Million Btu
 - 100% Illinois #6 bituminous coal: 0.094 lb/Million Btu
 - 80/20 blend of petroleum coke and Pittsburgh #8 bituminous coal: 0.064 lb/Million Btu



Project Information (continued)

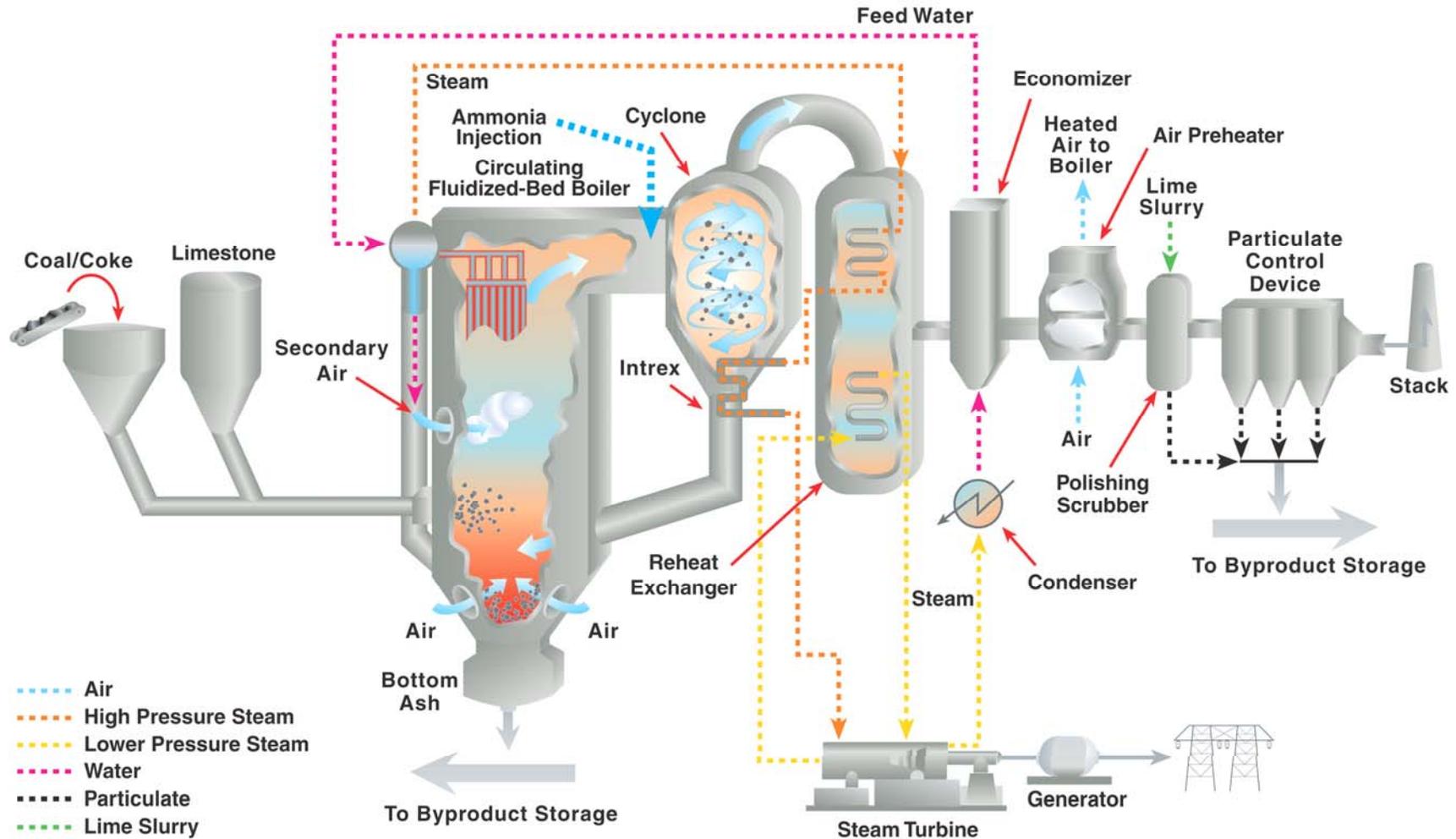
NO_x Control Process

- Design emission rate for NO_x is 0.09 lb/Million Btu, which is achieved by maintaining low furnace temperatures in 1500 to 1700°F range
- Efficient heat transfer between the fluid bed and water walls maintains temperature range
- NO_x control is augmented with an SNCR system using reaction with aqueous ammonia
- Stack NO_x emissions for various fuels
 - 100% Pittsburgh #8 bituminous coal: 0.078 lb/Million Btu
 - 50/50 blend of petroleum coke and Pittsburgh #8 bituminous coal: 0.070 lb/Million Btu
 - 100% Illinois #6 bituminous coal: 0.095 lb/Million Btu
 - 80/20 blend of petroleum coke and Pittsburgh #8 bituminous coal: 0.01 lb/Million Btu



Project Information (continued)

JEA Large-Scale CFB Schematic



Project Information (continued)

Unique Contribution

- **Superior cost and performance compared to conventional pulverized coal-fired (PC) plants**
 - ACFB's outperform PC plants by meeting stringent environmental requirements without installation of selective catalytic reduction (SCR) and large wet flue-gas desulfurization (FGD) units
 - Affords efficiency gain
 - Reduces capital costs
 - Lower operating costs relative to PC plants
- **ACFB provides a high degree of fuel flexibility including many types of coals, renewables, and wastes (petcoke)**
 - Using petcoke as a low-cost, high-energy fuel relieves a solid waste management problem for refineries



Estimated Benefits

Approach

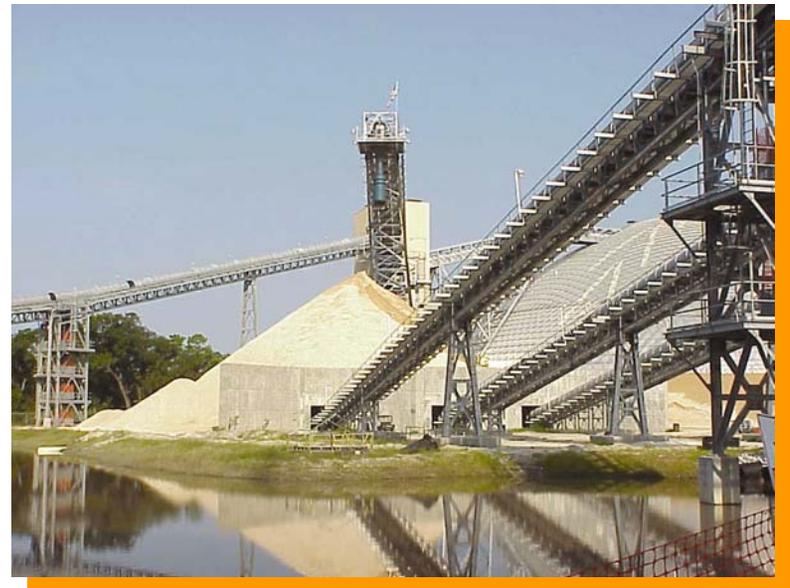
- Compare actual emissions by fuel type to illustrate fuel flexibility
- Compare actual emissions to those of comparable sized PC plants to show emission control advantage
- **Commercialization Benefits**
 - Estimate market penetration
 - Quantify emissions differences between existing power plants and ACFB technology being demonstrated (pollutant emissions, tons/year)



Estimated Benefits (continued)

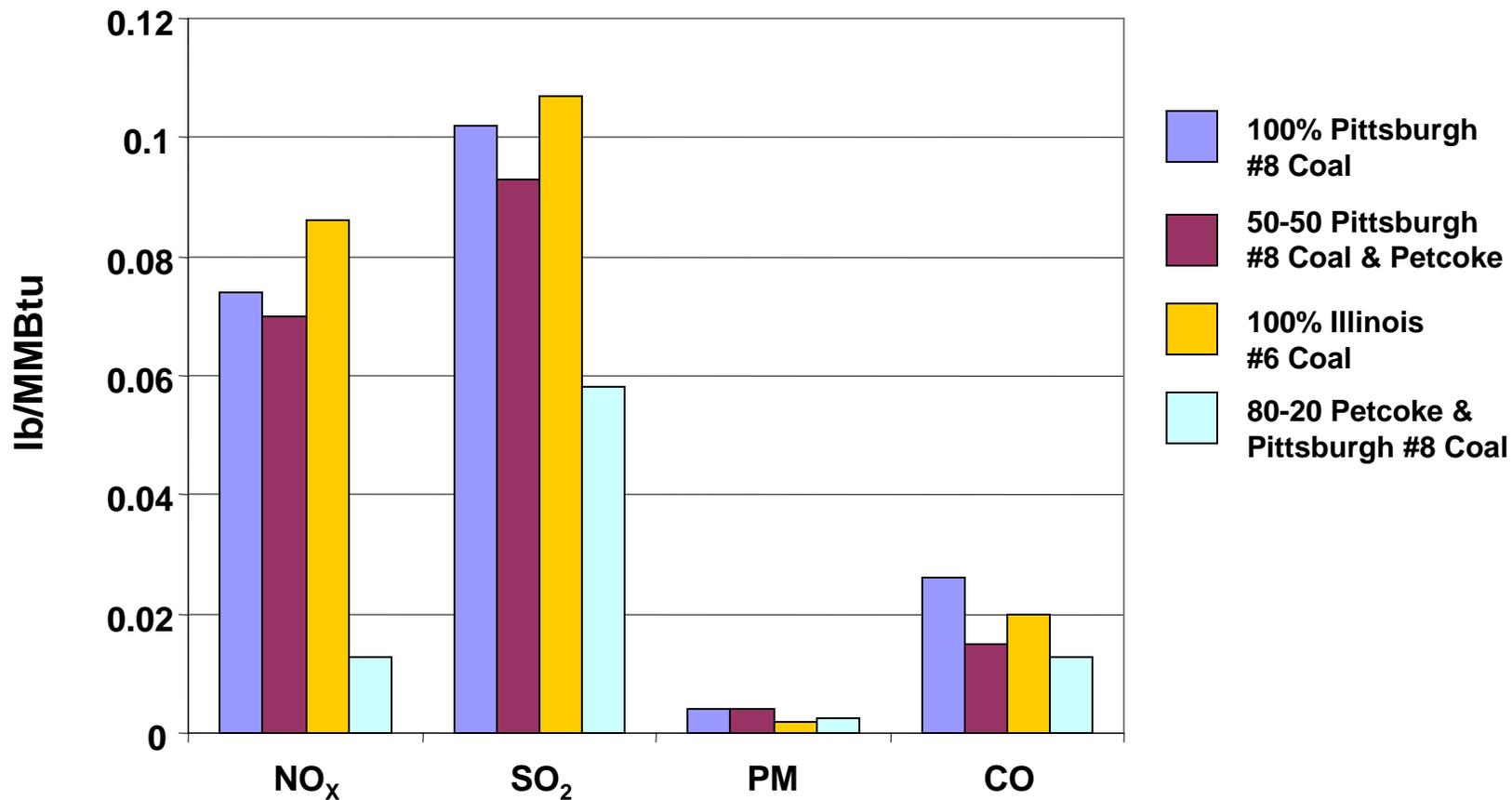
Market Penetration Assumptions

- **JEA's ACFB benefits are based on combined capacity of units constructed**
- **Assume JEA market penetration to be a nominal combined capacity of 5 GWe**



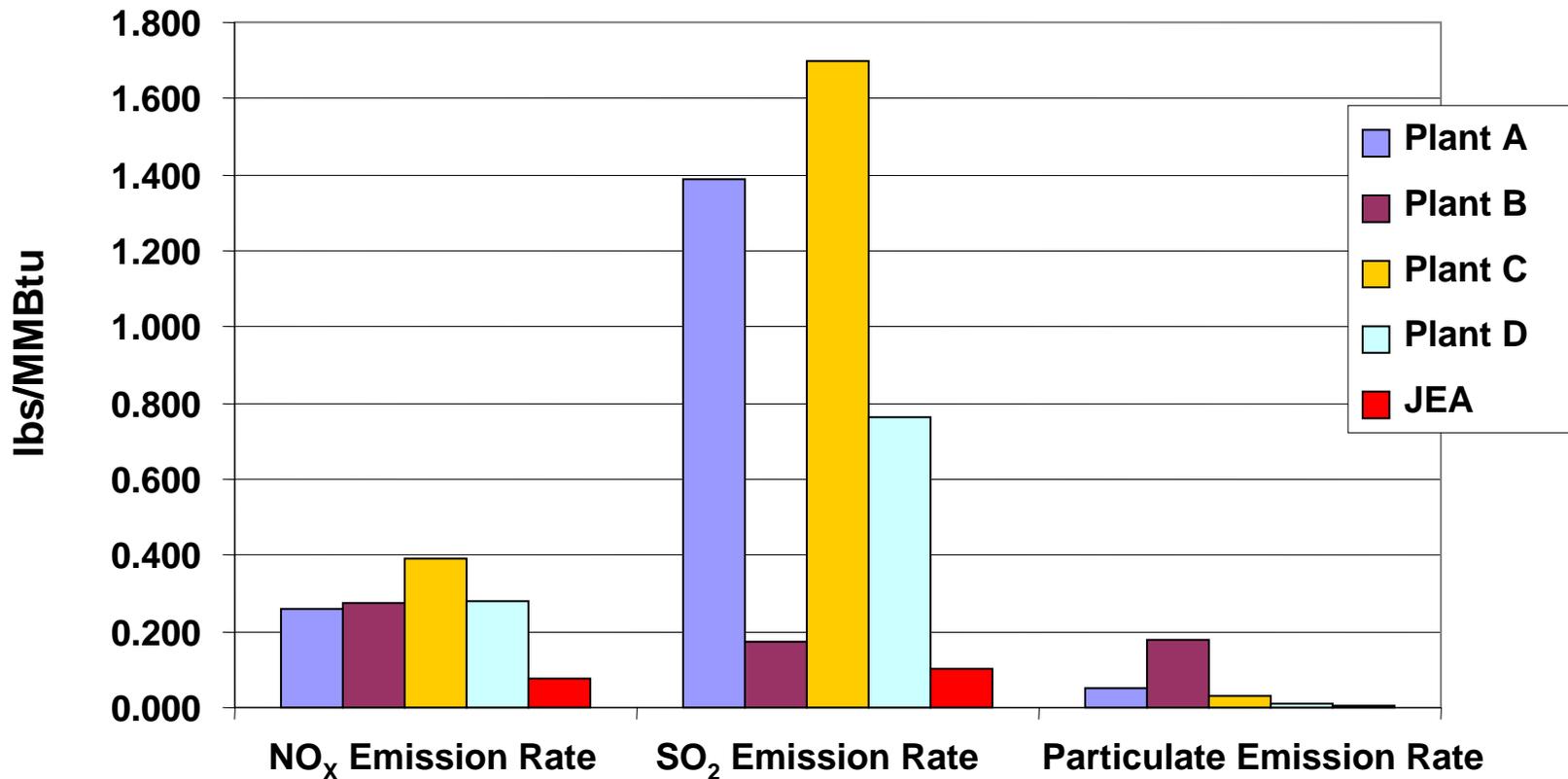
Estimated Benefits (continued)

Emissions Comparison by Fuel



Estimated Benefits (continued)

Actual Emissions Compared to Similarly Sized Plants¹



¹ NETL Coal Powered Database-Plant Size 298-300 MWe,
 Bituminous Coal ² Emissions with Pittsburgh #8 Coal



Estimated Benefits (continued)

Regional

- **Fuel Flexibility**
 - Coals include Pittsburgh #8 and Illinois #6 bituminous coals
 - Petcoke and Petcoke/coal blends
- **Full load boiler efficiencies at approximately 90% for all tested fuels**
- **Stack emissions well below permit limits for SO₂, NO_x and CO**
- **Florida DEP classified JEA blended ash as an “industrial by-product” allowing use for beneficial purposes**
 - In 2004, 38,312 tons of JEA blended ash sold in Florida and Georgia combined



Benefits Presentation: JEA CCTDP.1 – N. Rekos, 322, 3/2007



Estimated Benefits (continued)

National



- **Offers superior environmental performance by meeting stringent emissions requirements without having to add post combustion controls**
- **Demonstrates high degree of fuel flexibility, including wastes such as petcoke**
- **Uses Nation's abundant coal resources thereby increasing our energy security**
- **Furthers environmental objectives for America by providing high-efficiency, low-cost, future generating capacity**



Estimated Benefits (continued)

Pollutant Reductions from Commercialization

Pollutant	Emission Reduction ¹ tons/year	Current emissions from all coal fired boilers in the United States ² , tons/year
NO _x	32,174	3,856,988
SO ₂	116,325	10,149,019
Hg	0.81	46.6
PM	8,537	21,434,859

¹ Basis: 5 GWe market penetration

² Source: NETL Coal Power Data Base



Conclusions

- **JEA's ACFB demonstrates**
 - This technology can be used in large utility boiler arena, an important market sector
 - Boiler efficiency exceeds design value
 - Fuel flexibility, using various coals, renewables, petcoke, and petcoke blends
 - Environmental benefits
 - Use of petcoke can mitigate solid waste management problem for refineries
 - Stack emissions are well below state permit limits for SO₂, NO_x, and CO
 - Blended fly ash can be used for beneficial purposes



**Visit the NETL web site for information on all
Power Plant Improvement Initiatives and
Clean Coal Power Initiative projects**

www.netl.doe.gov/technologies/coalpower/cctc

