FETC's Fluidized-Bed Combustion Program for 1998

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FETC's fluidized-bed combustion (FBC) Program is one of the cornerstones of its overall research and development (R&D) activities. Fluidized beds are used to convert coal and other solid fuels cleanly into electricity and steam and other useful consumer products. The strategy of our program aims at commercialization and/or improvement of cost-effective systems. The FBC Product Team hopes to have systems that reach 60-percent efficiency while helping solve environmental and energy problems. The scope of the FBC Program includes more than 35 projects in 17 states. The program is divided into five major project groups: repowering studies; R&D activities; pilot-plant demonstration activities; clean coal projects; and high-temperature, high-pressure filter R&D and other supporting R&D activities.

A major thrust in our program is the Power Systems Development Facility (PSDF) at Wilsonville, Alabama. Major participants are Southern Company Services, EPRI, Foster Wheeler, Westinghouse, and Peabody Coal. The current status of the pressurized fluidized-bed combustion (PFBC) portion of the PSDF includes construction completion and shakedown initiation.

The second key thrust in our program is site-specific repowering studies. FETC and Parsons Power personnel have worked with Carolina Power and Light (CP&L), Duke Energy, and New York Gas and Electric to investigate the implementation of advanced PFBC systems at specific utility plants. Utilities are being educated about the capabilities of advanced PFBC in tomorrow's deregulated electric power market. Currently, we have completed the CP&L study, are about 98 percent complete with the Duke study, and are just beginning the New York Gas and Electric investigation of the Greenwich plant. CP&L has stated that they will now include advanced PFBC repowering as an option in their future system planning. As part of this education process, a repowering workshop is planned for October 12 through October 14, 1998; 400 interested parties have been invited.

The third key thrust is hot gas filter support and testing at both FETC and at the PSDF. Participants include Coors, Westinghouse, Dupont, Lowsch, Oak Ridge National Laboratory, 3M, Schumacher, and Paul. To date, FETC has developed a candidate filter at 1,300 ` F for the Lakeland clean coal project; other alternatives also show promise.

Our final key thrust is at the University of Tennessee Space Institute where Westinghouse and Foster Wheeler are investigating the use of the multi-annular swirl burner (MASB) in the Lakeland Clean Coal Technology (CCT) project. Testing is scheduled for the fall of 1998.

The FBC Program interfaces with a number of other programs. The development of hot gas filters and systems; improved solids handling; and special gas turbine combustors for integrated gasification combined-cycle (IGCC), pressurized fluidized-bed combustion (PFBC), high-performance power systems (HIPPS), and other advanced applications are part of the FBC Program. The FBC Program interfaces with organizations such as the Coal Utilization Research Council, the Council of Industrial Boiler Owners, the American Boiler Manufacturers Association, Southern Company Services, American Electric Power, Carolina Power and Light, EPRI, Duke Power, Southern Indiana Gas and Electric Company, Lakeland Electric and Water, and Jackson Electric Authority. The FBC Program also interfaces with manufacturers, including Foster Wheeler, Stamet, Westinghouse, ABB, Babcock and Wilcox, 3M, Coors, and other system and component vendors. These vendors are working with FETC to attempt commercialization of advanced FBC power systems.

FETC and its industrial supporters have generally proven the basic FBC concepts and are now working on implementation and system design, scale-up, reliability, and control issues. Industrial stakeholders have additional issues that they want addressed in the advanced systems. These issues include reducing capital and operating costs with reliable equipment that can improve efficiency and environmental performance. These industrial stakeholders want improved efficiency, which means FETC must foster continued advances in components. They would like to see the adaptation of advanced turbine systems to PFBC. These stakeholders feel that there are improved system configurations that could be put into place, particularly production of a viable Vision 21 system that more closely couples efficiency with CO_2 reduction. They want improved environmental performance, improved sulfur capture with no increases in calcium-to-sulfur ratios, NO_X decreases with little or no cost impact, and reductions in calcium-to-sulfur ratios to reduce solid waste while maintaining sulfur capture. Furthermore, these industrial stakeholders stipulate that all of these wants are to be met at competitive capital costs, with a target value of $750/kilowatt (kW) for new FBC systems.

To date, there have been a number of successes in FBC technology fostered by FETC. There have been successful developments under the Department of Energy's CCT Program. Tidd was the only American-style, first-generation PFB bubbling unit. NUCLA continues as an atmospheric demonstration of early FBC designs. The FBC Program has had many pilot integration and testing successes. Under a FETC contract, Foster Wheeler integrated both a second-generation PFB carbonizer and combustor. A rich-quench lean topping combustor has been demonstrated for use with advanced PFBC. A filter that has a predictable life of 3 years at temperatures below 1,200 ` F is now available. We have worked on development of a coal sorbent-feed system for pressurized applications up to 225 psi that does not require lockhoppers. Finally, there has been consistent success in FBC ash utilization for acid mine remediation and in the field of soil improved as demonstrated by increased agricultural yields.

The PSDF completed a 1,000-hour combustion run with hot filters at temperatures above 1,300 ` F. Through 1997, the PSDF has operated hot gas filters for over 2,156 hours on coal with no ash bridging. The first integrated, advanced PFBC, which will include gas turbine components, has been constructed. The rich-quench-lean combustor (MASB) and gas turbine have been operated on propane, with the electricity generated being fed to the Grid.

To guide the FETC PFBC program, we have set some goals for the first and second decade of the 21st century. FETC would like to see the demonstration of a large atmospheric fluidized-bed unit at 300 megawatts (MW) and orders for larger units by the year 2002. The FBC Product Team would like to have hot gas filter systems available that are capable of 1,600 ` F operation and a predicted life of 3 years or more by the end of the first decade. The Lakeland CCT project will demonstrate the world's first advanced PFBC at 180 MW or larger with efficiencies over 40 percent by the middle of the first decade. Large-scale testing of municipal solid waste being cofired in an advanced PFBC system should also be accomplished in the first decade. By the end of the first decade, a PFBC design will be in place with at least 50-percent efficiency and emissions 10 percent lower than that required under current regulations.

Going into the second decade of the 21st century, we would like to see two old coal-fired plants repowered with PFB, which will reduce site CO_2 emissions by at least 20 percent. Again in the second decade, PFBC designs that utilize advanced turbine systems should be constructed. FETC would like to see the by-products from both atmospheric and pressurized fluidized beds being marketed as valued products for everyday use. Before the end of the second decade, critical components should be utilized with fluidized-bed combustors that yield 60 percent efficiency and low or near zero emissions. The Product Team would like to see the commercialization of a hybrid PFB system for pulp and paper recovery. Before the year 2020, we would like to see Vision 21 advanced ceramic membranes being used on PFBC systems.

The FETC PFBC program has a number of benefits that will be achieved if some of these goals are obtained in the 21st century. When a 200-MW 1959 vintage power plant is repowered with a PFBC system, the output can increase by 42 percent. CO_2 can be reduced by 17 percent. An SO_2 reduction of 90 percent over an unregulated plant is possible. NO_X can be reduced by 50 percent, and particulates by well over 95 percent. This particulate reduction means 227 tons of particulate matter that will not be put into the atmosphere. These repowering benefits are potentially available for 50 U.S. plants, or at least 10,000 MW could be upgraded using FBC technology.

If the United States moves to high-efficiency, domestic, greenfield applications after the year 2005, PFBC will yield efficiencies above 45 percent, or at least 10 percent higher than the current fleet average for conventional units and 5 percent more than a modern pulverized coal unit with flue gas scrubbing. Furthermore, the U.S. will still attain a 10 percent reduction in CO_2, a 50 percent reduction in NO_X, and a 20 percent reduction in particulate emissions. The potential market for these units is 319 gigawatts (GW). PFBC should create or capture 25 percent of that market or 78 GW by the year 2020.

In addition, there is at least a 1 GW potential for domestic and industrial cogeneration, although the market is soft. The environmental savings would be just as beneficial as those for the utility market: greenfield or repowered plants in the U.S. On an international basis for greenfield plants, there is a potential for 1,275 GW. We believe that the adaption of PFBC will be slow but the U.S. could still export on the order of 250 GW of power equipment during the first two decades of the 21st century. This could lead to the creation of 250 high-tech jobs in this country, would maintain at least another 250, and could probably save at least 2,000 high-paying manufacturing jobs or at least stabilize them for the workers in place.

Thank you.