Office of Fossil Energy, U.S. Department of Energy • DOE/FE-0491 • Issue No. 64, Fall 2005

CLEAN COAL TODAY

A Newsletter About Innovative Technologies for Coal Utilization

News Bytes

On August 8, 2005, President George W. Bush signed the Energy Policy Act of 2005. The new law contains a number of provisions encouraging the use of coal. For details see article on page 8.

The Electrochemical Society, the intellectual home for fuel cell technology, has elected NETL's Dr. Mark Williams as a Fellow, citing him for "sustained internationally recognized contributions to and promotion of electrochemical energy conversion technologies, especially fuel cells." Williams, director of the NETL Fuel Cell Program, has been promoting fuel cell technologies for nearly 20 years at NETL. His recognition further highlights the strides made in fuel cell technology development through NETL's support of SECA and stationary fuel cell powered systems.

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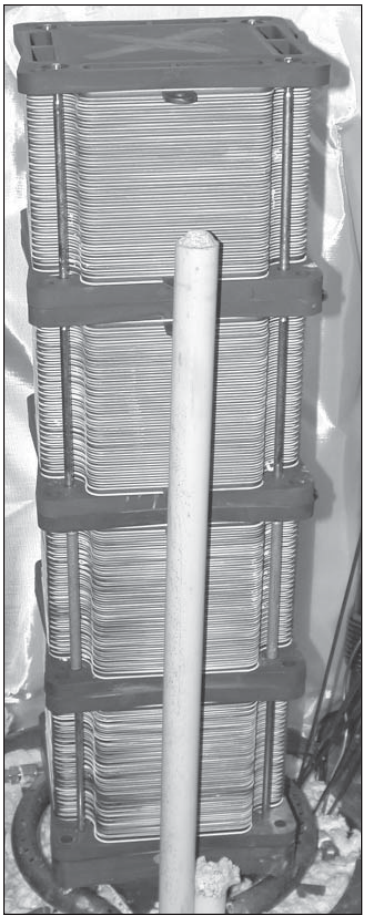
New DOE Program to Advance Fuel Cell Central Power Stations

Recent advances in technology have precipitated movement of fuel cells into the central power arena in support of FutureGen — coal-based central power plants capable of co-producing electricity and clean fuels (including hydrogen), enabling carbon sequestration, and producing near-zero emissions. While the initial focus of the Office of Fossil Energy (FE) stationary fuel cell research and development program has been on distributed generation applications, the strategy has always included eventual integration with central power plants. The central power element of the strategy is now being implemented under the Fuel Cell Coal-Based Systems program.

The recent focus of the FE fuel cells program has been on solid oxide fuel cells (SOFC) because of their potential for mass production and high power density, which reduce cost, and ensure compatibility with reformed or gasified fossil fuels including coal. Progress in SOFC development under FE's Solid State Energy Conversion Alliance (SECA) program reached the point of identifying SECA SOFC designs with the most promise for scale-up to central power applications. A recent Fuel Cell Coal-Based Systems (FCCBS) solicitation sought SECA SOFC candidates that could be scaled up, aggregated into modules, and serve as building blocks for greater than 100-MW FutureGen-type plants. FutureGen plants use gasification to convert coal to a synthesis gas, primarily carbon monoxide and hydrogen; SECA SOFCs use both of these synthesis gas constituents as fuel. The FCCBS objective is to have a SECA SOFC-based power island that costs $400/kW and can enable 50 percent efficiency (HHV) and 90 percent CO_2 capture (90 percent of the carbon in the syngas) in a FutureGen plant by 2015.



SECA fuel cell stack

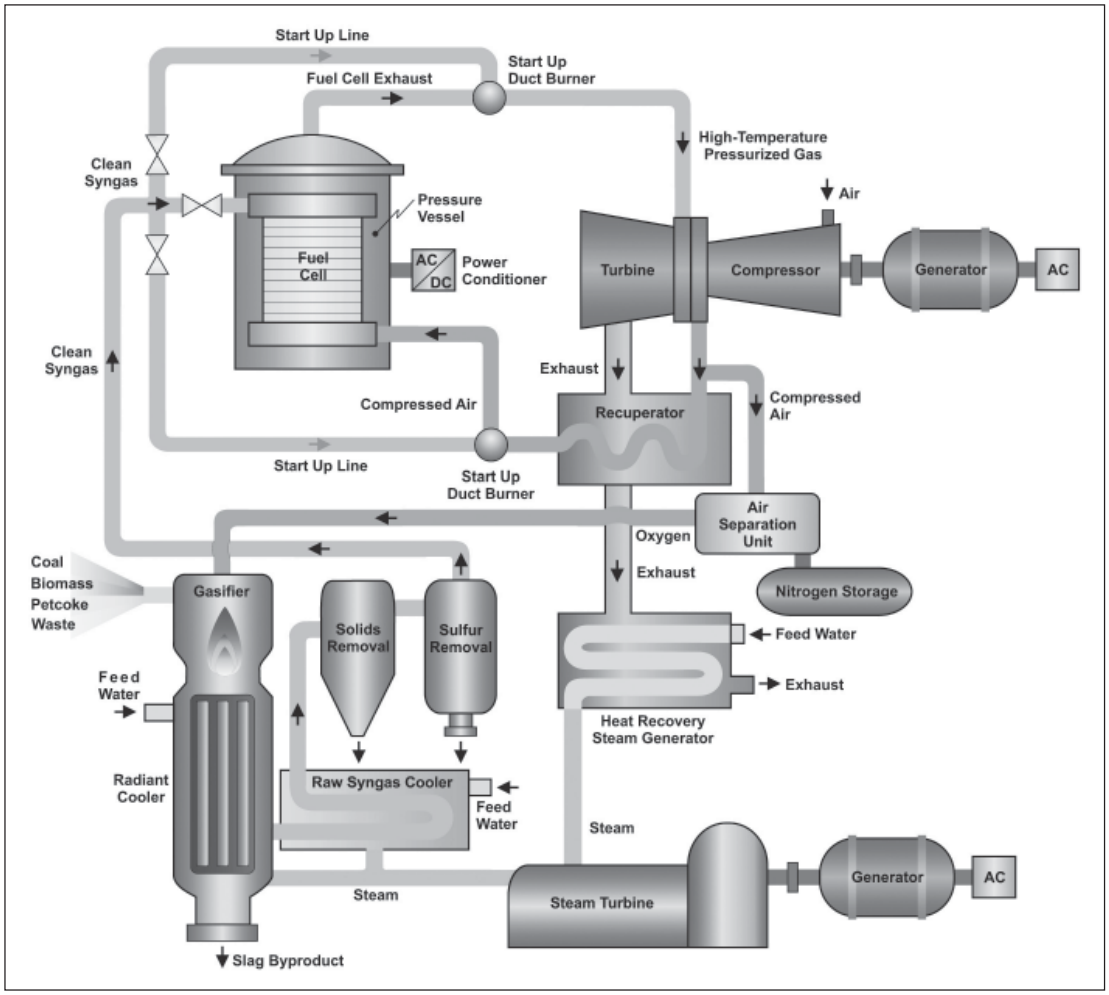
See "Fuel Cells" on page 2...

"Fuel Cells" continued...

In August 2005, DOE selected the first two projects to be awarded under the FCCBS. Research teams led by General Electric Hybrid Power Generation Systems (GE HPGS) and by Siemens Westinghouse Power Corporation (SWPS) will participate in a three-phase effort culminating in proof-of-concept testing of multi-megawatt units scalable to greater than 100-MW central power plants. Both teams chose to integrate SECA SOFCs with gas turbines in fuel cell/turbine (FC/T) hybrids to meet performance targets. The high-temperature, high-efficiency SECA SOFCs are ideal to affect a synergistic FC/T hybrid configuration. The SOFC would serve in place of a combustor for the gas turbine, and the gas turbine provides the balance-of-plant function of pressurized air delivery to the fuel cell. FC/T hybrids can boost fuel-to-electricity efficiencies by several percentage points over stand-alone fuel cells while preserving SECA cost goals. For FCCBS applications, the fuel cell must provide the majority of the power.

Project Teams

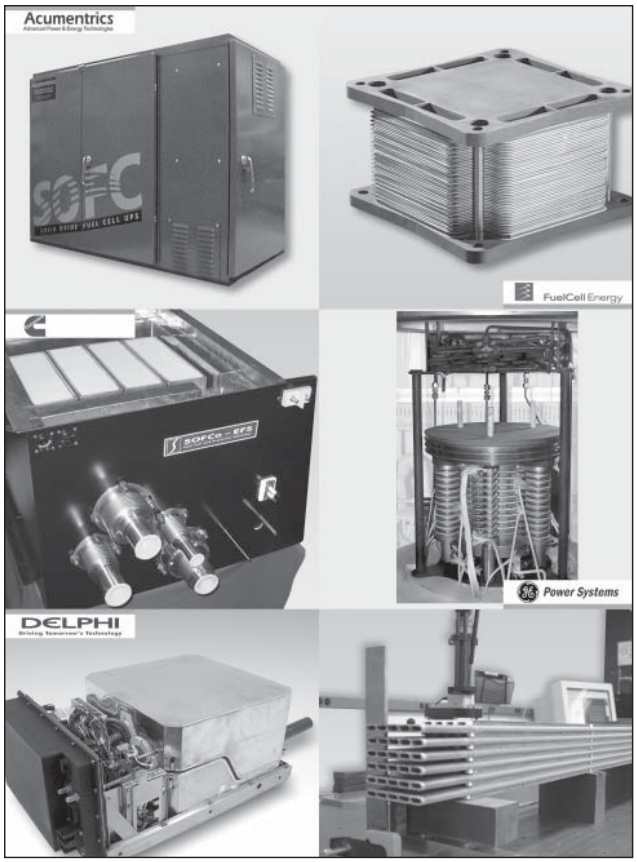
GE HPGS is partnering with GE Energy, GE Global Research, the Pacific Northwest National Laboratory, and the University of South Carolina to develop integrated gasification fuel cell (IGFC) systems integrating GE's high-performance anode-supported planar SOFC technology with their gas turbine and recently acquired (ChevronTexaco) coal gasification technology. SWPC is partnering with ConocoPhillips, Air Products and Chemicals, Inc., and Fluor Enterprises. The advanced modified tubular SOFC design from the SWPC SECA program will be optimized for operation at elevated pressure, and its dimensions scaled up to the largest practical values to achieve an active anode area greater than 1,500 cm^2 per cell. The Conoco Phillips E-Gas™ entrained staging transport reactor (ESTR) gasifier will serve as the baseline in plant performance evaluations. In addition, the baseline design incorporates an ion transport membrane (ITM) air separation unit to provide oxygen.



Schematic of a fuel cell coal-based central power system.

Coal-Based Program

The FCCBS effort is to be carried out in three phases. All require independently verified system analyses proving that SOFCs and associated systems have the potential to meet cost and performance targets. During the test program, researchers must deal with the challenges of scaling up individual fuel cells and fuel cell stacks, and tailoring designs to enable mass production. They must aggregate stacks and modules with-



SECA Core Technology Program partner fuel cells; Top L-R: Acumentrics, FuelCell Energy; Middle L-R: Cummins, GE Power Systems; Bottom L-R: Delphi, Siemens Westinghouse

out compromising efficiency, and integrate fuel cells and turbines to optimize synergy. Protection against fuel cell contamination by coal synthesis gas is very important.

Phase I of the FCCBS entails design, resolution of issues relative to performance, and manufacturability, and culminates in operation of a thermally self-sustaining fuel cell stack on coal syngas proposed for proof-of-concept (POC) or POC-simulation. The fuel cell stack, deemed easy to aggregate into a module (the building block for multi-megawatt systems), must show potential for a power island system cost of $600/kW or less.

Phase II consists of further development of the SOFC and system designs based on results of Phase I testing, and culminates in fabrication and test of the fuel cell module on POC or equivalent syngas. Power island system cost potential with the module must be $400/kW or less.

FCCBS Phase III includes fabrication of a fuel cell or FC/T hybrid POC system, a multi-megawatt system consisting of multiple fuel cell modules, and integration of the system with a coal gasifier. The integrated system must operate for a least 25,000 hours of testing, including interfaces with the gasifier.

Results of the FCCBS will be coordinated with ongoing R&D in integrated gasification combined-cycle (IGCC) activity being performed under the DOE Advanced Power Systems program. The strategy is to enhance integration of FCCBS and IGCC systems after 2015 and to demonstrate a 60 percent efficient FutureGen-type plant with a commercial cost of $1000/kWw or less through the Clean Coal Power Initiative.

SECA: Genesis and Support for FCCBS

The SECA Program began in June 2000, and mobilizes both industry and the research community through a unique alliance. Under SECA, Industry Teams develop fuel cell systems and the research community supports the industry teams through a Core Technology program that addresses key issues. A major SECA goal is to develop fuel cells that cost $400/kW versus the $4,000/kW figure for current state-of-the-art fuel cells. The approach is to leverage inherent compositional and performance characteristics of SOFCs, and mass produce 3- to 10-kW modules that can be combined like batteries to meet a range of market requirements. This "mass customization" reduces market entry costs by enabling high volume production up front rather than customizing fabrication for each application.

The SECA program has made impressive progress in overcoming performance degradation, and in reducing costs. Cell composition and microstructure improvements have resulted in record-breaking power densities of over 400 mW/cm^2 at high fuel utilizations. Researchers have identified the most promising systems for scale-up to central power, IGFC mode. The FCCBS solicitation was the natural next step.

SECA currently has six Industry Teams (Acumentrics, Cummins/SOFCo, Delphi/Battelle, FuelCell Energy, General Electric, and Siemens Westinghouse) using varied approaches to design SOFC systems, consistent with DOE's goals and the individual company business plans. Leading researchers in industry, academia, and National Laboratories are supporting the Industry Teams with cutting-edge research and development.

JEA SUCCESSFULLY COMPLETES WORLD'S LARGEST CFB DEMONSTRATION

JEA, formerly the Jacksonville Electric Authority, submitted its final report to the U.S. Department of Energy (DOE) in June 2005, marking successful completion of an eight-year landmark demonstration project funded under the Clean Coal Technology Demonstration Program, that continues in baseload commercial operation. The project — located at JEA's Northside Generation Station Unit 2 in Tampa, Florida — won Power magazine's prestigious "Power Plant of the Year" award in 2002, while the JEA Project Manager was named "Engineer of the Year" by the Florida Engineers Society. The demonstration effort scales up atmospheric fluidized-bed technology demonstration to the near-300-MW size, providing important data on a technology that can accomplish greater than 90 percent SO_2 removal and 60 percent NO_X reduction, at relatively high efficiencies, all at capital costs comparable to those of conventional pulverized coal plants. The technology is also fuel-flexible, allowing the use of low-grade and opportunity fuels, and produces a dry, granular solid by-product material that is easily disposed and potentially saleable. Features at JEA include the CFB combustor designed by Foster Wheeler, an INTREX™ integrated recycle heat exchanger in the furnace, steam-cooled cyclones, a parallel pass reheat control, an SO_2 polishing scrubber, and a fabric filter for particulate control. At the time the JEA Clean Coal project began operating in 2002, it was the largest of its type in operation. DOE provided $74.7 million of the $321.4 million total project costs.

Aerial view of the JEA Northside Plant

In the CFB process, combustion takes place in a bed of coal and limestone sorbent that is fluidized by air flowing upwards from nozzles at the bottom of the combustor. As the coal particles decrease in size due to combustion, they are carried higher in the combustor. Secondary air is introduced, and coal and sorbent particles are carried out of the combustor to the cyclone separator and recycled to the lower portion of the combustor. The bulk of the SO_2 is absorbed by limestone in the bed, with excess removed by a spray dryer absorber. In the system at JEA, the solids from the cyclone pass through INTREX™ integrated recycle heat exchangers, where they are cooled while providing final superheat to the steam generated in the CFB. The solids level in the INTREX™ heaters is controlled to provide a gas seal between the cyclones and the CFB. Ash is removed from the boiler through stripper coolers that remove unburned carbon and cool the ash. NO_x is minimized by low combustion temperatures of 1,500–1,700 °F, and ammonia is injected in a selective non-catalytic reduction system to reduce NO_X even further.

In planning the project, JEA consulted with community and environmental groups, and agreed to meet emission limits well below EPA requirements. Performance tests with various fuels and fuels blends achieved reductions greater than the promised levels of < 0.15 lbs of SO_2 per MMBtu, < 0.09 lbs of NO_X per MMBtu, and < 0.011 lbs of particulates per MMBtu. SO_2 test results ranged from 0.058–0.110 lbs per MMBtu, and the spray dryer also removed 95–98 percent of incoming mercury. NO_X emissions ranged from 0.0081–0.084 lbs per MMBtu, and particulate emissions ranged from 0.0024–0.0041 lbs per MMBtu. The project fulfilled its commitment to the community to achieve emission reductions of at least 10 percent.

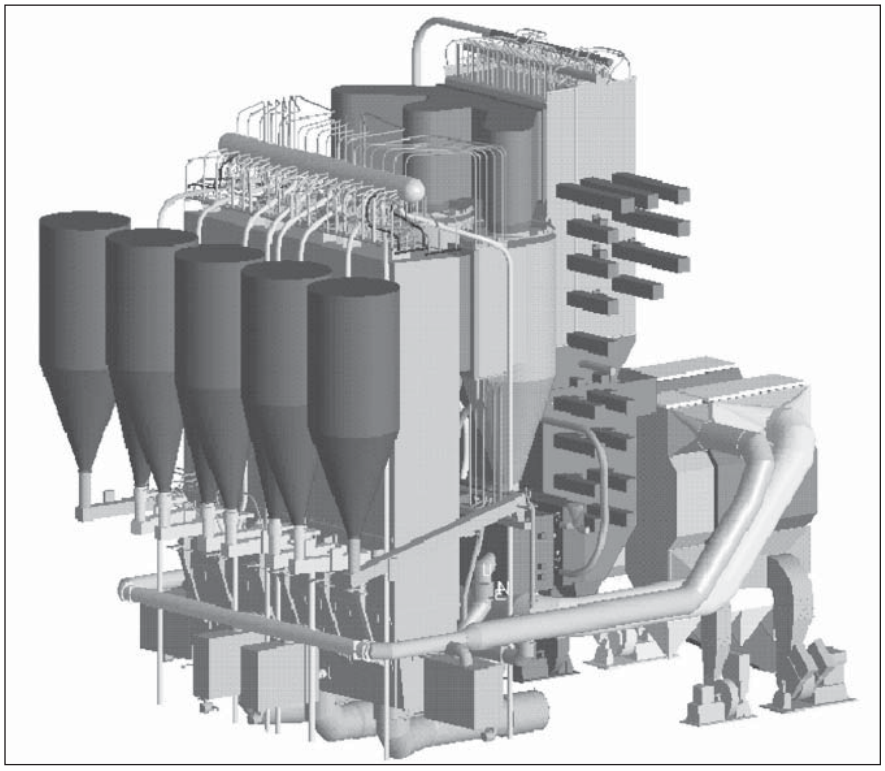
The CFB was first fired in December 2001, initial synchronization occurred in February 2002, and full load operation took place in May 2002. Unit 2 was in a combination of start-up, testing, and operation throughout the summer of 2002. It was JEA's intention to test the unit on coal, petroleum coke (petcoke), and coal/petcoke blends, and then operate normally on 100 percent petcoke for the present due to its low cost. A blend of coal and petcoke, however, has proved most efficient as a feedstock.

JEA conducted four performance tests on different fuels — 100 percent Pittsburgh No. 8 coal, Illinois No. 6 coal, an 80 percent petcoke/20 percent Pittsburgh 8 blend, and a 50-50 petcoke/Pittsburgh No. 8 blend. Each fuel was tested at 100, 80, 60, and 40 percent loads. Boiler efficiency data were collected for the 100 percent load tests and ranged from 88.2–91.65 percent, exceeding the design guarantees. The unit was able to effectively maintain the desired load during all tests. Over the longer term, overall plant efficiency averaged 35.9 percent (net).

As detailed in the Final Report, the test program was able to identify some outstanding technical issues the sponsor is continuing to address. While the CFB operated satisfactorily on coal, it could not be operated on 100 percent petcoke feed due to ash agglomeration in the INTREX™ heaters and stripper coolers. These problems also occur when burning high petcoke blends and have resulted in some outages. Another issue has involved backsifted bed material into the fluidizing air plenum of the combustor. JEA is addressing this problem by removing material from the plenum before it plugs, and will be replacing the fluidizing nozzles during a future planned outage. Thus, a variety of changes to the INTREX™ heaters and the stripper coolers are being evaluated to ensure reliable operation. JEA anticipates that resulting improvements will increase plant availability to above the industry standard for baseload operation.

Aerial view of JEA highlights the coal storage domes

The limestone feed system was another area needing adjustment during the test program. The original system was prone to "rat-holing" and bridging, interrupting the flow of limestone to the boilers. To eliminate limestone feed interruptions, the lower portion of the limestone silo was replaced along with the mechanical feed equipment. This modification greatly improved operations. The limestone preparation system, however, was not able to meet the design drying capacity or the design sizing curve. Changes have been made to the system to improve drying capacity and reduce fines production. The combination of problems with the limestone system has resulted in the need to remove most of the SO_2 in the CFB by injecting additional limestone. Nevertheless, SO_2 reduction goals were maintained — further evidence of the innate superiority of CFB technology in removing pollutants.



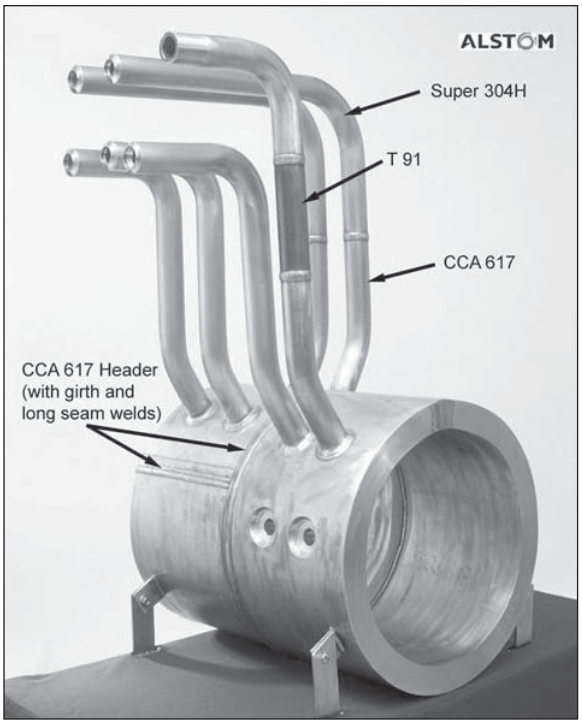
CFB boiler schematic, with cyclones (left foreground) that separate the entrained particles from the flue gas and return them to the boiler

The JEA project has done much to prove CFBs as a viable option for power generation, and the technology is spreading. Foster Wheeler is currently working on a 460-MWe unit in Poland and two lignite-fired units in the 250- to 275-MWe range came on-line in 2002 in Mississippi. Two similar units, using waste coal, were installed at the Seward Station in Pennsylvania. In total, reports indicate eight CFB projects in development in the United States.

Materials Development for Ultra-Supercritical Boilers

As part of its effort to develop cleaner, more efficient power generating systems to meet future energy needs, the U.S. Department of Energy (DOE), Office of Fossil Energy is collaborating on important work to develop high-temperature, corrosion-resistant alloys for use in ultra-supercritical steam cycles. Steam cycles with operating pressures exceeding 3,600 pounds per square inch (psi) and main superheat steam temperatures approaching 1,100 °F are considered "ultra-supercritical" (USC). DOE and its project partners are working to achieve boiler operation at 1,400 °F/5,000 psi steam conditions, with net cycle efficiency of 47 percent, higher heating value basis (HHV), surpassing European USC technology. This offers a marked improvement over supercritical technology already in wide use, which has net thermal cycle efficiencies ranging from 37–40 percent (HHV) and offers the additional benefit of reducing emissions by some 25 percent.

The Ohio Coal Development Office supports a consortium partnering with DOE in a five-year materials development effort. The consortium includes Energy Industries of Ohio; the Electric Power Research Institute, Inc.; Babcock & Wilcox Company; Riley Power; Foster Wheeler; and Alstom Power, with assistance from the Oak Ridge National Laboratory. Research is focusing on the mechanical properties of advanced alloys, as well as the durability of various coatings and applicability of various welding techniques and materials. Steamside oxidation testing has been completed in the laboratory and in-plant fireside corrosion resistance testing has begun. Substantial progress has been made during the last three years of the project (and since the research effort was last reported in Clean Coal Today, Summer 2004).



The demo header is made from an advanced nickel alloy, Inco 617, by bending plate, girth welds, longitudinal welds, socket welds, dissimilar welds between Inco 617 and super 310 stainless steel, and between super 310 stainless steel and T91 steel. Successful manufacture of the demo is evidence of the ability to swage, bend, and machine the various materials

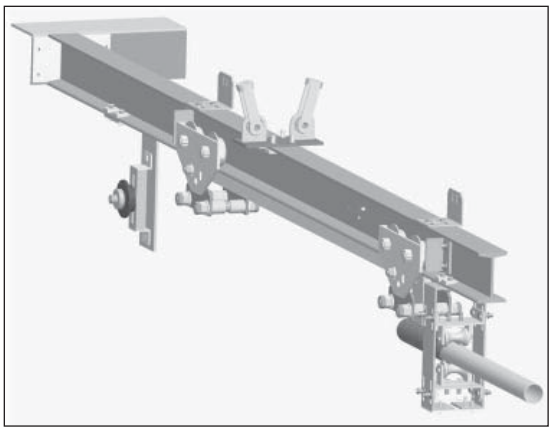
Project Goals

Preliminary analysis had suggested that utilization of nickel-based alloys at 1,400 °F would be impractical due to requirements for very thick walls to withstand high temperatures. For that reason, the initial goal of 1,400 °F/5,000 psi was adjusted slightly downward. However, in short-term tests recently completed, several nickel-based alloys (IN 740 and CCA 617) appear to show better than expected creep strength (ability to resist strain under constant load over time), making the 1,400 °F temperature goal more achievable. In addition, lowering the steam pressure to 4,000 psi may allow for use of lower strength materials at the 1,400 °F goal without compromising safety. This could reduce plant costs with only a minor reduction in plant efficiency.

The Test Program

Conceptual design has been completed, including alloy selection, component sizing, and delineation of temperature/stress profiles. Economic viability has been demonstrated and materials have been procured. Based on creep strength and allowable stress considerations, six alloys (IN 740, Haynes 230, CCA 617, HR 6W, Super 304H, and Save 12) were selected for superheater/reheater tubing, with the first four also being candidates for heavy section applications. Two alloys (T 92 and T 23) were selected for application in waterwall tubing.

Long-term creep rupture tests completed to date have identified the applicable temperature limits of various alloys. Two of the nickel-based alloys (IN 740 and CCA 617) exceeded expectations and show much promise for use at the highest temperatures. Initial creep-fatigue tests have helped estimate the life reduction due to cycling, which will need to be incorporated into plant design. Additional tests are in progress, including the testing of dissimilar metal welds.



Shown is the air-cooled retraction device that removes the probe, which then is subjected to fireside corrosion testing on the different alloys that have been exposed in the boiler

Steamside oxidation (corrosion) tests have been completed up to 4,000 hours at 1,200 °F, and up to 2,000 hours at 1,470 °F. Most of the ferritic steels, such as T 92 and Save 12, showed severe corrosion. The nickel-based alloys, especially IN 740 and CCA 617, exhibited the greatest resistance to oxidation with no evidence of exfoliation. These two groups were among the alloy specimens subjected to steamside oxidation laboratory tests designed to evaluate claddings, spray coatings, and diffusion coatings. Results show that ferritic steels benefit the most from coating, while nickel-based alloys are not likely to need coatings. Process scale-up activities are being pursued.

To evaluate the high-temperature fireside corrosion resistance of candidate materials, laboratory tests as well as in-plant tests have begun. Two superheater test loops composed of advanced alloys have been designed and installed at the Niles Power Station of Reliant Energy. Additional in-plant testing, using corrosion probes composed of various alloys, coatings, and weld overlays, will be conducted at power plants while firing several different coals. Laboratory testing has been completed under two temperature ranges — 850 °F to 1,100 °F, and 1,200 °F to 1,600 °F. Under both sets of conditions, corrosion decreased rapidly with chromium content up to about 27 percent and then leveled off.

Experience in welding, machining, cutting, boring and grinding USC alloys has been gained in the course of fabrication of the two USC test loops. Preliminary results indicate that submerged arc welding, a high-deposition rate process generally favored for thick sections of material, including piping, might not be feasible for nickel-based materials.

In all, tests by DOE and its consortium partners are making progress in identifying key materials meeting the demands of ultra-supercritical steam cycles. These materials are expected to become commercially available once their long-term performance is verified.

"News Bytes" continued...

More than 100 people attended a public scoping meeting sponsored by DOE in connection with the Environmental Impact Statement for the Orlando Gasification Project. The meeting was held in Orlando, Florida, on August 30, 2005. The project was selected — and is being negotiated — under Round 2 of the Clean Coal Power Initiative, and would demonstrate air blown IGCC at the Orlando Utilities Commission Stanton Energy Center. Participants include Southern Company Services, Southern Power Company, Orlando Utilities Commission, and Kellogg Brown and Root.

UPCOMING EVENTS

November 14–18, 2005

2005 Fuel Cell Seminar

Organizer: DOE

Location: Palm Springs, CA

Contact for Seminar Headquarteras: 202-973-8671

E-mail: fuelcell@courtesyassoc.com

FE Contact: Mark Williams at: 304-285-4747

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November 21–22, 2005

Clean Coal and Power Conference Hall

Organizers: U.S. Energy Association with the U.S. DOE and National Mining Association

Location: Renaissance Mayflower Hotel, Washington, DC

Will rapidly advancing technologies for clean coal and advanced power systems live up to their promise? The Clean Coal and Power Conference will focus on political, environmental, economic, and social issues related to growth in global energy demand, and will explore the role of coal as a viable fuel to meet that demand. Competition in electricity and fuel markets, utility restructuring, environmental regulations, and global climate change initiatives will be among the topics addressed.

For exhibiting Conference information, contact Rob Donovan at 202-312-1238, or rdonovan@usea.org

For registration and other conference information, contact Faith Cline at 202-586-7920, or faith.cline@hq.doe.gov

Energy Bill Supports Coal

On August 8, 2005, President George W. Bush signed the far reaching Energy Policy Act of 2005. This represents the first major energy law in 13 years, and contains many provisions promoting clean coal use. The law contains 18 titles, with provisions across the spectrum of fuels and renewable energy sources. It also deals with such areas as hydrogen R&D, electricity grid reliability, and energy sources in Indian country. In some cases, the law creates authority for new programs, and also it reauthorizes existing programs. Tax credit incentives are another important feature.

Below are some of the coal highlights of the new law. Other summary information as well as actual text of the legislation can be found at www.energy.senate.gov, then "Energy Policy Act 2005."

Clean Coal Power Initiative (Title IV, Subtitle A): Authorizes $200 million each year from 2006–2014. This is an existing DOE program that has five projects under contract and a number in negotiation following two rounds of competition. The new law requires that 70 percent of the funds must go to a variety of gasification projects. Emissions targets for the projects will become increasingly restrictive.

Clean Coal Centers for Excellence (Title IV, Subtitle A): Grants to institutes of higher education to develop advanced technology.

Clean Power Projects (Title IV, Subtitle B): Grants, loans, loan guarantees, and cost sharing to deploy clean coal generating equipment with improved energy efficiency and environmental performance. It also provides a loan to place the Healy, Alaska, clean coal project back in service, and it authorizes the Western Integrated Gasification Demonstration Project. In addition, it provides loan guarantees for petroleum coke projects, a $5 million authorization for Electron Scrubbing Demonstration, and $85 million yearly from 2006–2010 to evaluate Fischer-Tropsch transportation fuels derived from Illinois Basin coal.

Clean Air Coal Program (Title IV, Subtitle C): Cost-shares repowering and retrofitting of existing coal-fired plants with both more efficient clean coal electric generation equipment, and processes for improved environmental performance in nonattainment areas. Up to $2.8 billion has been authorized between 2007 and 2013.

Fossil Energy R&D (Title IX, Subtitle F): Authorizes $1.137 billion for 2007–2009, for a range of FE programs (in addition to authorizations under Title IV). The Energy Secretary is to identify cost and performance goals for programs. An additional program is created for Powder River Basin and Fort Union lignite coal mercury removal.

Tax Credit for Investment in Clean Coal Facilities (Title XIII, Subtitle A): Institutes credits to IGCC (20%), industrial gasification (20%), and other advanced coal projects (15%). Energy Secretary can allocate $800 million for IGCC, $350 million for other coal gasification, and $500 million for other advanced coal-based technology. Accelerated depreciation for new air pollution control equipment is established.

Tax Credit for Business Installation of Qualified Fuel Cells and Stationary Microturbine Power Plants (Title XIII, Subtitle C): Offers a $500 tax credit to business for every 0.5 kW of capacity. The fuel cells must be at least 30 percent efficient and generate electricity using an "electrochemical process."

Production Tax Credits (Title XIII, Subtitle B): Provides for modification of existing credit for unconventional fuels, including coal-to-liquids.

Incentives for Innovative Technologies (Title XVII): Establishes loan guarantees to encourage broad spectrum of technologies for clean or renewable energy, including coal gasification. Technologies must reduce or sequester man-made greenhouse gases.

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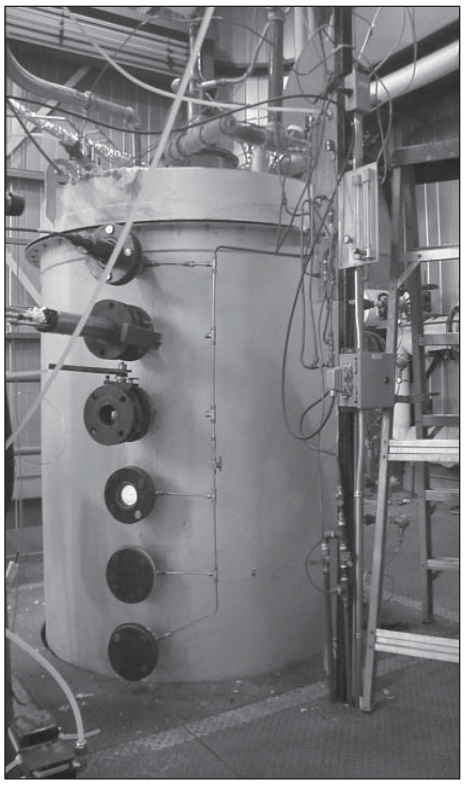
Comments are welcome and may be submitted to the Editor.

INTERNATIONAL INITIATIVES

U.S. AND CANADA COOPERATE ON OXY-COMBUSTION

The U.S. Department of Energy, Office of Fossil Energy (FE), through the International Energy Agency's Greenhouse Gas Programme, is providing funding for the investigation of oxy-fuel combustion by the CANMET Energy Technology Centre in Ottawa, Ontario, Canada. The ultimate goal is to devise an oxy-combustion system that, together with CO_2 capture capability, can be retrofitted to an existing fossil fuel power plant while occupying little added space. The current test program, scheduled to end in March 2006, is taking place at a specially built oxy-combustion pilot plant. Researchers are focusing on integrating oxy-combustion with low-NO_X burners and multi-pollutant capture. Work at CANMET supports the Administration's Global Climate Change Initiative to reduce greenhouse gases, and complements other oxy-fuel combustion work sponsored by FE's National Energy Technology Laboratory (NETL) (see Clean Coal Today, Winter 2004).



CANMET's pilot-scale vertical combustor

Oxy-fuel combustion involves the combustion of coal or another fossil fuel with a mixture of pure oxygen and recycled flue gas. Using oxygen instead of air eliminates the presence of N_2 in the flue gas, and results in a concentrated, sequestration-ready stream of CO_2 that would otherwise have to be derived through costly CO_2 separation processes. The CO_2 can be easily cleaned, compressed, and used for enhanced oil recovery, enhanced coalbed methane production, or stored in geological formations. Oxy-fuel combustion also results in efficiency advances of high flame temperatures, and reduced equipment sizes due to lower gas volume.

The CANMET oxy-fuel burner has been tested successfully with both bituminous coal and lignite, showing that the burner can operate with a variety of feedstocks. Using low-NO_X burners, NO_X emissions have been reduced by as much as 80 percent compared to traditional combustion. By adjusting process parameters and using a variety of solvents, the proprietary two-stage condensing heat exchanger has been able to remove mercury from lignite coals, as well as SO_X and other flue gas contaminants. The heat exchanger uses refrigerated water and can handle a wide range of flue gas compositions.

Researchers also have been experimenting with compression and purification of the CO_2-rich flue gas in order to facilitate CO_2 capture and sequestration. Following preliminary system design and analysis, researchers will construct a CO_2 recovery and compression train. The system will be optimized to reduce the cost of compression while purifying and polishing the CO_2 product.

Future work at CANMET involves construction of a test rig for the compression and purification system, and the design of a capture-ready plant. The oxy-combustion plant will be designed so that a CO_2 compression train can be installed at a later date in the event economics become favorable, as could happen if CO_2 emissions come to be capped and traded. Otherwise, oxy-combustion plants would focus only on removal of NO_X, SO_X, particulates, and mercury.

INTERNATIONAL INITIATIVES

NEW ENERGY DIALOGUE STRENGTHENS INDO-U.S. TIES

U.S. Department of Energy (DOE) Secretary Samuel Bodman, and Dr. Montek Singh Ahluwalia, Deputy Planning Commissioner of India, have launched a new Energy Dialogue between the United States and India to promote increased trade and investment. Under terms of the Dialog, public and private entities would work together to identify areas for collaborative work involving a variety of energy sources.

The Dialogue will build on the history of cooperation between the two countries while providing a new focus on technology moving forward. India is concerned about energy security — the availability of clean, reliable, and affordable energy supplies for its growing economy. Both countries will benefit from increased stability in global energy markets.

While India has an abundant coal supply, existing power plant technologies are inefficient, with more than half the plants operating at 30 percent or less efficiency levels. The coal is high in ash content, thereby inflating transportation costs per Btu. In addition, coal mining and processing technologies need modernization. Still, coal provides more than 50 percent of the country's commercial energy and will continue to be its major energy source for the foreseeable future. Coal consumption is expected to grow at about 5 percent per year, driven primarily by strong growth in the electric power sector. The country plans to add 150,000 MW of new capacity by 2015 to meet its surging demand for electricity. Generating electricity using efficient clean coal technologies would significantly improve the economics of coal production and use, while at the same time reduce associated environmental impacts.

A joint Steering Committee is chaired by DOE Under Secretary David Garman, and India's Secretary of External Affairs, Shyan Saran. The Committee will provide oversight, set goals, and manage the overall direction of the Dialogue. Five Working Groups have been established to coordinate activities in specific areas: Coal, Power and Energy Efficiency, Oil and Gas, New Technology and Renewable Energy, and the Civil Nuclear Energy.

DOE Office of Fossil Energy (FE) Principal Deputy Assistant Secretary, Mark Maddox, is the U.S. chair of the Coal Working Group. The coal group is discussing cooperation with the Ministry of Coal and Coal India in such areas as mine safety, closure of old mines, coal mine fires, coal cleaning and gasification, and coal bed methane. FE also participates in the other working groups, with particular interest in the Power and Energy Efficiency Working Group, chaired by the U.S. Agency for International Development. DOE's National Energy Technology Laboratory has been working with U.S. AID for the last 25 years in efforts to help India improve its electric power generation capabilities and infrastructure. The power/energy efficiency group aims to advance understanding of efficient generation and end-use efficiency, transmission, and distribution of electricity. The group also will promote exchange of information on regulatory policies, with special emphasis on the "last-mile" distribution and utilization of electricity in urban and rural networks.

U.S. companies interested in FE's activities under the Dialogue, can contact Raj Luhar at raj.luhar@hq.doe.gov or Scott Smouse at scott.smouse@netl.doe.gov.

Clean Coal Today Survey

The Clean Coal Today newsletter has been published quarterly since 1990, providing a variety of articles to inform readers about the Office of Clean Coal (OCC) R&D programs. Generally, the information contained in the newsletter relates to activities of DOE Office of Fossil Energy and its stakeholders that pertain to coal. Please help us to be responsive to your needs and interests by filling out this questionnaire and returning it to the address provided. We recommend that you respond on-line at: www.netl.doe.gov/cctc/newsletter/ccttodaysurvey.asp, where you also can find all past newsletter issues for easy reference.

Questions on Clean Coal Today

Advances in communications permit us to consider several options by which we can distribute the newsletter.

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Short newsbytes [ ]

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Guest articles [ ]

Industrial applications [ ]

Other – list _____

_____

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Specific technologies

Advanced electric power generation: FBC, IGCC, turbines, fuel cells, hybrids [ ]

Other gasification [ ]

Gas cleanup [ ]

Carbon sequestration [ ]

Coal to clean liquid fuels [ ]

Co-production [ ]

Hydrogen from coal [ ]

Materials research [ ]

Distributed Generation [ ]

Environmental control technologies – SO_2, NO_X, Hg, greenhouse gas, combinations thereof [ ]

Membranes [ ]

Coal demo programs (e.g., CCT, PPII CCPI) [ ]

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_____

What new features, sections, or topics would you like to see in Clean Coal Today?

(insert response here) _____

Other Program Materials The OCC mailing list is used to distribute other materials and announcements including Topical Reports, Project Performance Summaries, Annual Clean Coal Program Updates, Program Plans, major conference announcements, etc.). To review these documents, browse through the Clean Coal Technology Compendium at www.netl.doe.gov/cctc.

How useful do you find Topical Reports? [ ] 1 (Not At All Useful) [ ] 2 [ ] 3 [ ] 4 [ ] 5 (Extremely Useful)

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Ms. Phoebe Hamill, FE-24
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RIBBON CUTTING MILESTONE FOR THE CCPI LIGNITE FUEL ENHANCEMENT PROJECT

North Dakota Governor John Hoeven and U.S. Senator Kent Conrad were among honored guests at the Great River Energy (GRE) Coal Creek Station in Underwood, North Dakota, for an August 9, 2005, ceremony marking completion of the design and construction of a prototype lignite coal drying module. The 75- to 110-ton/hour module uses low-temperature waste heat to reduce the moisture in lignite before the fuel is fed into the power plant boiler, allowing more power to be produced from a smaller quantity of fuel. Design characteristics suggest that lignite moisture at GRE can be reduced from 38.5 percent to 29.5 percent.

The dryer is a two-stage fluidized-bed design with heating coils submerged in the bed. The overall prototype dryer system includes raw as well as dry coal conveyors, crushing and feeding equipment, and a baghouse.

Later in the Fall of 2005, following testing of individual equipment and the integrated system, GRE plans a test run. Successful operation of the prototype dryer would facilitate GRE proceeding to commercial demonstration — designing and constructing a full set of dryers for the complete 546-MW coal-fired unit.

The technology is potentially applicable to the more than 100 GW of installed U.S. capacity burning high-moisture coals, and offers significant efficiency and emissions reduction benefits to the U.S. power industry. For more details of this project, see http://www.netl.doe.gov/publications/factsheets/project/Proj219.pdf

Ribbon Cutting of Prototype Dryer (L to R): Kirk Benson, CEO, Headwaters Inc.; Charlie Bullinger, Leader, Engineering Services, GRE's Coal Creek Station; Joseph Strakey, Director, Office of Coal and Power R&D, NETL; Rick Lancaster, Vice President of Generation, GRE; North Dakota Governor John Hoeven; North Dakota Senator Kent Conrad; Henry Hanson, Chairman, Board of Directors, GRE; John Weeda, Manager, GRE's Coal Creek Station; David Saggau, President & CEO, GRE

Active CCT Demonstration, PPII, and CCPI Project Status

CCT Demonstration Status

JEA – *ACFB Demonstration Project*. The four planned demonstration phase test burns, which began January 13, 2004, were completed on August 12, 2004. Fuels and fuel blends tested during the period included 100% Pittsburgh #8, a 50/50 blend of Pittsburgh #8 and petcoke, 100% Illinois #6, and a 80/20 blend of petcoke and Pittsburgh #8. The tests were conducted at 100, 80, 60, and 40 percent of full load. The four test report emissions were monitored at each load level and were well below permitted values, final report is posted on Clean Coal Technology Compendium, and project is in closeout. (Jacksonville, FL)

Kentucky Pioneer Energy (KPE), L.L.C. – *Kentucky Pioneer Energy Project*. KPE submitted a Continuation Application (CA) in May 2005 to proceed to the next phase. The CA is currently being reviewed. (Trapp, KY and West Terre Haute, IN)

TIAX (formerly Arthur D. Little, Inc.) – Clean Coal Diesel Project. The project remains in a holding pattern until the University of Alaska Fairbanks (UAF) preferential payment claims lawsuit is settled. (Fairbanks, AK and Beloit, WI)

PPII Status

Otter Tail Power Company – *Demonstration of a Full-Scale Retrofit of the Advanced Hybrid Particulate Collector (AHPC) Technology*. After completing more than 2 years of commercial demonstration, Otter Tail Power Company has made modifications to the unit to provide more ESP and fabric filter surface for particulate removal. To date, the AHPC has demonstrated superior particulate removal when the integrity of filter bags remains intact. However, superior particulate removal has been accompanied by greater operating costs due to increasing overall pressure drop or premature bag failure. DOE has issued a no-cost extension until January 31, 2006, to Otter Tail for the AHPC project while the system modifications are being monitored for improved overall performance. If the system modifications show promise for technology commercialization and terms and conditions are favorable for DOE and Otter Tail, continued demonstration and performance testing will be sought. (Big Stone City, SD)

Sunflower Electric Power Corp. – *Demonstration of a 360-MWe Integrated Combustion Optimization System.* The combustion optimization sensors package is operational. Data are being archived on the MKE computer and by EtaPRO. The low-NO_X burner modifications and coal-balancing dampers have been installed and are operating successfully. All five pulverizers are equipped with an automated coal-flow balancing system, and are successfully operating. Due to larger than anticipated costs for installation of new low-NO_X burners and overfire air systems, Sunflower has withdrawn the continuation application to DOE for proceeding to Phase III Budget Period 2 of the project, and DOE has accepted Sunflower's withdrawal position. The project is now in closeout. (Garden City, KS)

Tampa Electric Company, Big Bend Power Station Tampa – *Neural Network Sootblower Optimization Projec*t. The neural network was successfully implemented to optimize sootblowing on Unit 2, a 455-MWe boiler, at Tampa Electric Companies Big Bend Station. The project applied a neural network intelligent sootblowing (NN-ISB) system in conjunction with state-of-the-art controls and instruments to optimize the operation of a utility boiler and systematically control boiler slagging/fouling. The NN-ISB simultaneously achieves multiple process improvement objectives. The main quantifiable objectives of the intelligent sootblowing system were to reduce NO_X and particulate matter emissions, and to improve unit efficiency. After implementation of the NN-ISB, NO_X reductions up to 8.5%, opacity improvements during sootblowing activities up to 1.5%, and unit efficiency improvement up to 1.3% were reported. Some other benefits include: reduction in total sootblower usage; full integration of sensors technology and optimization; improvement in boiler steam and drum pressure operation; less deviation in steam tube temperatures during high load conditions; and improvement in human-machine interface. This project has concluded and the final project report has been completed. (Apollo Beach, FL)

Universal Aggregates, LLC – *Commercial Demonstration of the Manufactured Aggregate Processing Technology Utilizing Spray Dryer Ash.* The project is in the operations phase. Universal Aggregates has successfully run the entire plant process including mixing, extrusion, curing, crushing, screening, and recycling screened fines. The plant has shipped finished product to its distributor on a limited basis. The facility now is staffed 24/7 as efforts are made to adjust material additives and equipment configurations to produce a consistent product from the spray dryer ash removed from the Birchwood Power Generation Facility. Universal Aggregates has requested and been granted a no-cost extension until December 31, 2005, to allow modifications and improvements to increase throughput capacity and to extend the plant continuous run time. (King George, VA)

CCPI Status

NeuCo, Inc. – *Integrated Optimization Software*. The goal for Budget Period 1 was to install each of the five modules on at least one unit and demonstrate their integration. The modules are integrated and early results indicate that the overall NO_X levels have decreased, the heat rate has improved, the NH3 flow consumption has been reduced, and the units have been running smoothly. NeuCo submitted a Continuation Application (CA) to proceed to the next budget period. The CA is currently being reviewed. (Baldwin, IL)

University of Kentucky Research Foundation – *Advanced Multi-Product Coal Utilization By-Product Processing Plant.* The first budget period (Project Definition) of the project is well under way. The Center for Applied Energy Research has completed characterizing and quantifying the volume of materials in the lower ash pond, located at the 2,200-MWe Ghent Power Generating Station. The assessment shows that the 200-million cubic foot pond is an excellent source of feedstock for the ash beneficiation project plant. A mobile field system, representative of all project plant systems and processes, is now in operation at the project site and is being used to evaluate unit processing of fly ash, bottom ash, and ultra-fine fly ash for scale-up to the commercial-scale project plant. A total of 150 tons of materials has been extracted from the ash pond and processed into sample product (pozzolan). CEMEX, the commercialization partner, is testing samples of this material for cementious characteristics and performance. Initiated in November 2004, the Project Definition Phase goes through May 2006. (Ghent, Carroll County, KY)

We Energies – *TOXECON™ Retrofit for Mercury and Multi-Pollutant Control*. This project is currently in the construction phase. Work constructing the baghouse, ductwork, and balance of plant is ongoing. Construction of the wall panels for the 10 baghouse compartments is complete, and baghouse hopper installation as is. The three induced draft fans have been installed and work has been initiated to install the fan inlet ductwork. Work to install ductwork from the existing electrostatic precipitator outlet to the baghouse inlet and from the baghouse outlet to the stack continues. The project is within budget and on schedule, with system operation projected to begin in January 2006. The ThermoElectron mercury continuous emission monitor (CEM) has been installed and operating since July 2005. Data obtained from the ThermoElectron CEM has been shown to be consistent with that obtained by a sorbent trap method. (Marquette, MI)

Western Greenbrier Co-Generation, LLC – *Western Greenbrier Co-Production (WGC) Demonstration Project.* WGC continues to work to develop key project areas including arrangements for sale of power to support a public tax-exempt bond sale to fund the project. In addition, work continues on developing the preliminary process design, EPC bids, and a satisfactory credit/completion assurances package. Environmental information related to water/fuel availability, treatment, reclamation, and processing is being developed, and selection of O&M contractor and negotiation of O&M agreement, transmission and interconnection agreements, update of the commercialization plans, and other supporting project areas continues. WGC stated that their intent is to request a no-cost extension of the cooperative agreement until the end of April 2006. (Rainelle, WV)

Great River Energy (GRE) – *Lignite Fuel Enhancement.* GRE has completed the prototype dryer fabrication and installation at the Coal Creek Station. In September 2005, GRE began the integration of the prototype dryer with the other dryer system components, i.e., inlet and outlet coal conveyors, inlet/outlet hot air ducts and hot water piping, bag house, explosion suppression system, and instrument control system. The electrical cable tray has been installed. The dryer system components are also being integrated with the plant equipment, i.e., raw coal silo to crusher, bucket elevator to dry coal silo, hot air supply line, hot water supply line, and plant drains. The silo, crusher, screen, and bucket elevator section integration, and hot air ductwork from the air heater to mixing box have been completed. The air distribution plate was installed as was the inlet hot air ductwork under the dryer. Installation of other vessel internals, such as heater tube bundles has been initiated. (Underwood, ND)

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