

CLEAN COAL TODAY

A NEWSLETTER ABOUT INNOVATIVE TECHNOLOGIES FOR COAL UTILIZATION

PROJECT NEWS BYTES

Healy Clean Coal Project completed an important test in November 1999. The plant achieved a capacity factor of over 95 percent based on 50 megawatt power output over the period, while meeting environmental permit requirements. The test demonstrated that the facility has achieved operations and capacity factor objectives typical for a waste coal-fired power plant. In fact, the plant reached the milestone of 91,800 MWh of electricity generated 10 days ahead of schedule.

In September 1999, the 18-cylinder Coltec engine at the **Clean Coal Diesel Demonstration Project**, located at the University of Alaska, Fairbanks, successfully completed its initial checkout test on fuel oil in preparation for coal-fuel operation

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BETHLEHEM STEEL SUCCESSFULLY COMPLETES DEMONSTRATION



Burns Harbor blast furnaces at night

The Blast Furnace Granular Coal Injection (BFGCI) System Demonstration Plant, located at Bethlehem Steel Corporation's facilities in Burns Harbor, Indiana has completed test operations and has accomplished its demonstration objectives. The BFGCI technology involves injecting coal directly into an iron-making blast furnace, thereby reducing the need for coke on approximately a pound of coke for a pound of coal basis, and replacing natural gas used to maintain temperature of the iron-making operation.

The objectives of this project were to show the advantages of injecting granular rather than pulverized coal and to determine the effect of coal grind size and coal type on blast furnace performance. After three years of operation, the demonstration has shown that granular coal performs better than pulverized coal in large blast furnaces; the energy consumption to produce granular coal is 60 percent less than that required to pulverize coal; and blast furnace operation with low volatile coal is superior to operation with high volatile coal. In the Burns Harbor demonstration, the higher blast furnace sulfur load and slag volume resulting from coal injection also did not cause any operating problems. In fact, replacing 40 percent of the coke with coal has major environmental benefits.

This commercial-scale demonstration is managed by DOE's Office of Fossil Energy under a cooperative agreement with Bethlehem Steel Corporation. The DOE selected the BFGCI project in CCT Round III, and the Cooperative Agreement was awarded in November 1990. Construction began in September 1993 and was completed in January 1995. Test operations commenced in November 1995 and were completed this year.

The principal purpose of a blast furnace is to smelt iron ores to produce pig iron, the primary ingredient in the production of steel. Other raw materials consumed in the smelting process are coke, which is the primary fuel and reducing agent; limestone, which acts to flux the earthy constituents in the iron-bearing ore and coke ash to form a slag; and hot air and oxygen, which

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...Bethlehem continued

support combustion of the coke. The slag, containing most of the impurities from the raw materials, is skimmed from the molten pig iron and used as aggregate for roadfill or cement manufacture. Thus the sulfur introduced by the direct injection of coal in the BFGCI process becomes a constituent of a useful by-product.

Conventional ironmaking requires the use of coke, which is made from coal by a process that, if uncontrolled, can release significant emissions of airborne impurities. These emissions may occur from leaks in doors, lids, or offtake pipes, from feeding coke into the coke ovens, and from removing the coke end-product and quenching it with water.

In the demonstration project, two high-capacity blast furnaces, Units C and D at Bethlehem Steel's Burns Harbor Plant, were retrofitted with BFGCI technology. Each unit has a production capacity of 7,000 net tons of hot metal (NTHM) per day. The two units use about 2,800 tons of coal per day during full operation. Tests were successfully conducted on eastern bituminous coals with sulfur contents ranging from 0.8-2.8 percent and on a western subbituminous coal with a sulfur content of 0.4-0.9 percent. A wide range of abundant, relatively inexpensive coals can be used in the BFGCI process, whereas coke manufacture requires coals with specific physical and chemical properties.

As indicated by the flow diagram, in the BFGCI process the coal is subjected to grinding to produce a granular material (similar in particle size to granulated sugar) and injected into the blast furnace along with heated air. The mixture is blown into the lower part of the blast furnace through passages called tuyeres. The

process produces a cleaned, low-Btu gas for in-plant use.

The BFGCI technology also improves the economics of the ironmaking process. Replacing a portion of the coke with coal offers increased furnace throughput. Since coal is cheaper than coke, the raw material costs are lower. Coal injection is also significantly less expensive than injection with natural gas, as had been practiced at Burns Harbor prior to this demonstration project.

At current prices of natural gas, coke and coal, the savings are about \$6.50 per NTHM totalling \$34 million/year. Bethlehem Steel believes that coke and natural gas prices will increase over the years, thereby increasing the cost advantage of the BFGCI technology in the future.

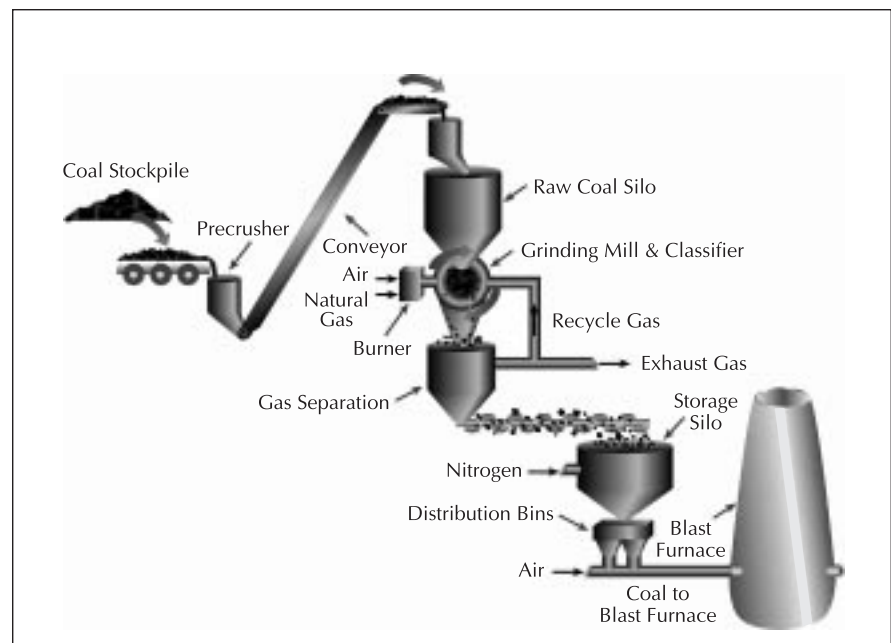
The coal injection facilities have been retained and continue to operate on a commercial scale at Burns Harbor. BFGCI technology should be applicable to essentially all U.S. blast furnaces

and can utilize a wide range of commercially available coals. The technology was developed jointly by British Steel and CPC-Macawber. British Steel has granted exclusive rights to market BFGCI technology worldwide to CPC-Macawber. CPC-Macawber also has the right to sublicense BFGCI rights to other organizations throughout the world. British Steel and CPC-Macawber have recently installed a similar facility at U.S. Steel's Fairfield, Alabama blast furnace.



Bethlehem Steel's granular-coal injection system

BLAST FURNACE GRANULAR-COAL INJECTION SYSTEM



...News Bytes continued

scheduled for next year. The check-out is critical for both the engine and the associated generator since any damages during the 4,000 mile trip from Beloit, Wisconsin to Fairbanks, Alaska would show up during the first 100-200 hours of testing. Once checkout is completed, Coltec engineers will install the hardened rings, liners, and fuel injection system components designed specifically for the abrasive coal-water slurry fuel.

Since the **Wabash River Coal Gasification Repowering Project** resumed operation in June 1999, after an outage due to a failure in the air compressor rotor and stator section gas turbine, the project has picked up the trend of breaking records, most recently breaking the highest quarterly syngas production record in the third quarter of 1999 with 2,712,107 MMBtu of gas produced. From August to October 1999, the facility completed the longest run to date of 1,305 hours. In September 1999, a three day petcoke test was completed with no interruption in syngas prior to or following the test. In the petcoke test, approximately 5,300 tons of petcoke were gasified to produce 107,100 MMBtu of synthetic gas.

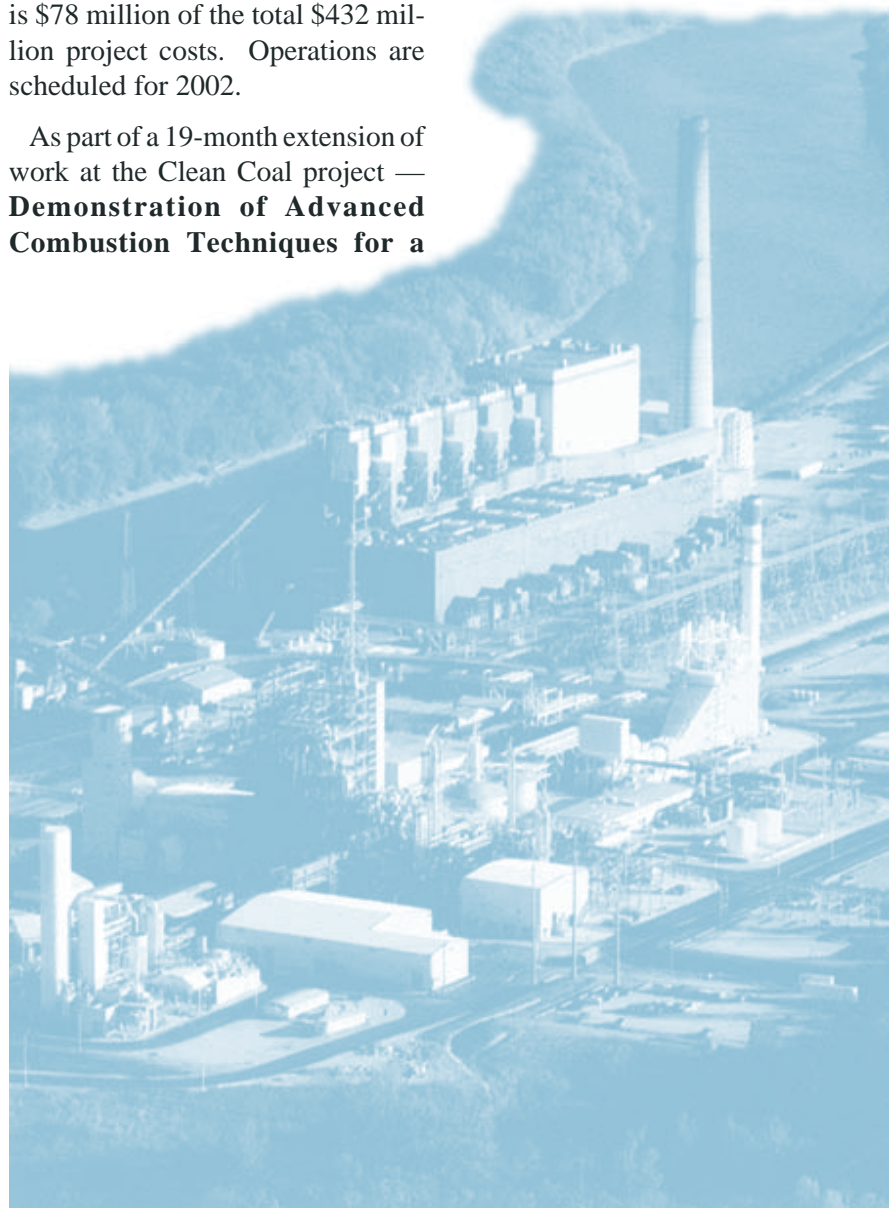
DOE has successfully completed design verification testing of Liquid Phase Dimethyl Ether (LPDME™) production at DOE's Alternative Fuels Development Unit at LaPorte, Texas. Results from the design verification testing will support decision making in the scaleup of the LPDME™ technology for a demonstration test under the **Commercial-Scale Demonstration of the Liquid Phase Methanol (LPMEOH™) Process** CCT project. LPDME™ was successfully tested at LaPorte at a 10 ton/day scale and showed good results for catalyst stability, pointing to the value of further development.

Economic studies are required to determine the impact of higher LPDME™ catalyst costs. Air Products and Chemicals, Inc. developed both processes.

In November, DOE agreed to a Clark County, Kentucky site for the **Kentucky Pioneer Energy Project**. Global Energy Inc., parent company of Kentucky Pioneer Energy, replaces Duke Energy Corp. as participant. The 400-MW IGCC project is one of the largest in the CCT program. The project would gasify briquettes made of coal and municipal solid waste, and will incorporate an advanced fuel cell. The DOE share is \$78 million of the total \$432 million project costs. Operations are scheduled for 2002.

As part of a 19-month extension of work at the Clean Coal project — **Demonstration of Advanced Combustion Techniques for a**

Wall-Fired Boiler, located at Georgia Power Company's Plant Hammond Unit 4C — work has begun on the design and installation of an overall unit optimization system using GNOCIS software. The major subtasks include unit optimization, boiler optimization, intelligent sootblowing, and precipitator modeling/optimization. In addition to DOE, other participants include EPRI (the original developer of the software), Southern Company Services, PowerGen, the U.K. Department of Trade and Industry, Tennessee Technological University, EnTEC, and Radian International.



BY-PRODUCTS CONSORTIUM FUNDS R&D PROPOSALS

Under a program supported by the DOE Office of Fossil Energy (FE), partnerships between government, industry, and academia are demonstrating the creative application of coal combustion by-products (CCBs). It is anticipated that these by-products can be used to address such disparate problems as groundwater pollution from animal waste, acid mine drainage from abandoned coal mines, potholes in asphalt roadways, as well as the high cost of synthetic countertops. Proposals to tackle these problems were among those recently funded by the Emissions Control By-Products Consortium, a cooperative research program sponsored by DOE's Federal Energy Technology Center (FETC) and managed by the National Mine Land Reclamation Center at West Virginia University. The Consortium is FE's most recent effort to marshal the forces of industry, academia, and government to develop new ways to solve real-world problems by recycling the high-volume solid waste materials currently being generated by the electric power industry. The cost sharing being realized suggests success thus far — for every FE dollar supplied through the Consortium more than two dollars are being applied to the research projects by the project performers and other non-Federal funding sources.

Recycling of waste materials for productive purposes is a popular concept, but finding economic new uses for CCBs — fly ash, bottom ash, boiler slag, and flue gas desulfurization (FGD) residues — has proven to be a challenging task. Although a variety of productive uses for CCBs have been developed over the years, most notably the use of fly ash as a cement replacement in concrete and FGD residues as a feedstock for wallboard, CCB materials historically have seen an overall re-use rate of less than 30 percent. The ever-increasing costs of landfill disposal, coupled with ever-tightening budgets in the power generation industry, have made it clear that cooperative efforts to develop new uses and new markets for CCBs can be key to keeping the cost of coal-fired power competitive in a deregulated environment.

Under the top rated Consortium project, Ohio State University will evaluate the long-term durability and effectiveness of an animal waste storage lagoon (Figure 1) that uses a compacted mixture of fly ash and FGD sludge as a low-permeability liner material to keep the leachate away from shallow groundwater sources. If successful, this project could allow the CCB material to enter a market that is now dominated by expensive clay and synthetic liner materials. FGD materials also are being investigated as a low-cost feedstock for the manufacture of synthetic countertop materials under another Consortium project, to be performed by Southern Illinois University. To improve road bed drainage and help prevent pot holes, the University of Wisconsin will try to create a strong but highly-permeable concrete road base material



Figure 1: Animal waste storage lagoon constructed with low-permeability FGD/fly ash liner (photo courtesy of Ohio State University)

using CCBs. A fourth Consortium project, to be performed by the Oklahoma Conservation Commission, involves the slurry injection of a highly alkaline ash from a fluidized-bed combustion (FBC) unit into an abandoned underground coal mine to achieve *in-situ* neutralization of acidic water that is being released from the mine. A total of 18 research projects, each with a performance period of 1-2 years and with a total value of over \$3.8 million (\$1.27 million from FE), have been funded by the Emissions Control By-Products Consortium.

Other projects in FE's broad CCB R&D program include a recently-completed effort with CONSOL

Energy, SynAggs, Inc., and Duquesne Light Company to build and operate a pilot plant that produces construction-quality aggregates from mixtures of fly ash and FGD sludge. CONSOL had previously developed a bench-scale process for manufacturing such aggregates (Figure 2), using private funding and financial support from the Ohio Coal Development Office and the Illinois Clean Coal Institute. However, the FE-sponsored pilot plant was needed to demonstrate that high-quality aggregates could be manufactured on a continuous, high volume (500 lb/hr) basis using feedstocks whose char-

acteristics reflected the normal variations inherent to the output of an operating power plant. In a recently-completed production run, over 200 tons of aggregates were produced to meet AASHTO (American Association of State Highway and Transportation Officials) Class A specifications. This material will be placed in an asphalt surface mix in a demonstration to be conducted in cooperation with the Pennsylvania Department of Transportation.

In another transportation related application of CCBs, FE has cooperated with Duquesne Light and GAI Consultants, Inc., to construct a 1,500-ft long walking trail surface made from a mixture of fly ash, scrubber sludge, and natural aggregates as part of a "rails-to-trails" project in Glassport, Pennsylvania. A mixture of fly ash and FGD sludge was also used as the trail base course (Figure 3). The CCB trail surface offers a harder, smoother alternative to the usual crushed limestone, at a cost that is less than half that of standard asphalt or concrete. Other ongoing and recently-completed cooperative projects include the underground injection of CCB grouts to prevent mine subsidence (Southern Illinois University), development of market-

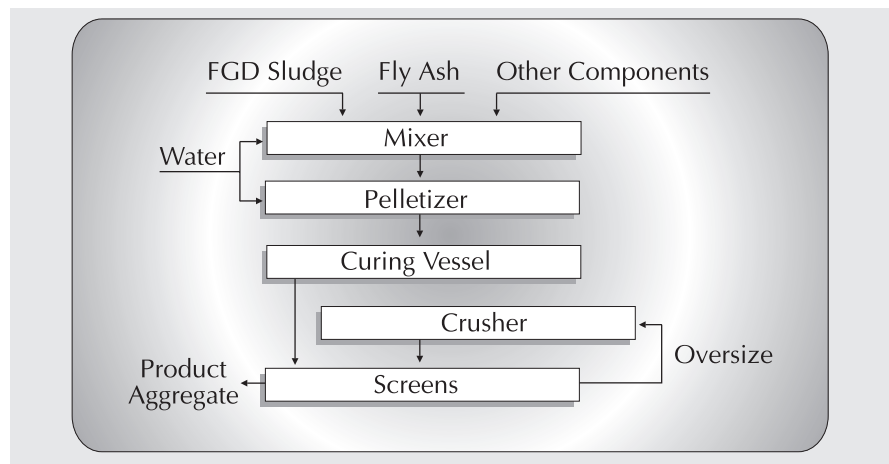


Figure 2: Simplified process schematic for CONSOL CCB manufactured aggregate

able products from coal gasification slags (Praxis Engineers), separation of carbon and creation of high-value products from high-carbon fly ashes (Michigan Tech University), the use of spray dryer and FBC by-products to stabilize hazardous wastes (University of Pittsburgh), and construction of cattle feed lots from FBC ashes (U.S. Department of Agriculture).

In-house research into CCBs is also being conducted by FETC. A patented process has been developed to use high-carbon fly ash in the manufacture of Portland cement. An oil agglomeration method for fly ash/carbon separation has been developed, and fundamental studies are

under way on the surface chemistry associated with the electrostatic separation of carbon from fly ash. One group at FETC has performed an extensive statistical analysis of water quality at 35 field sites in Pennsylvania where large volumes of CCBs were placed in the backfill of surface coal mines. This analysis showed that there was no significant degradation of water quality associated with CCB placement in the mines. Field demonstrations have also been conducted to determine the potential for injecting alkaline CCB grouts into surface mine spoils to abate acid mine drainage.



Figure 3: "Rails to trails" demonstration project using CCB materials

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FE CARRIES OUT MEMBRANE TECHNOLOGY R&D

The DOE Office of Fossil Energy (FE) is conducting R&D on a wide range of important membrane technologies. Membrane technologies offer the promise of significant increases in efficiency and environmental performance needed to meet the Vision 21 goals of 60 percent efficient coal-based power production and near-zero emissions. These enabling technologies rely on material characteristics rather than energy-intensive processes to separate selected gas stream constituents. Not only are the potential cost and performance gains significant, but membranes open the door to cost-effective production of high-value products, such as hydrogen, and capture of carbon dioxide, the primary greenhouse gas associated with power production.

HOT GAS PARTICULATE FILTRATION

FE's hot gas particulate filtration (HGPF) program is the most mature endeavor applying membrane barrier materials to remove gas stream constituents. This work is critical to downstream gas processing and use. The focus has been on the use of ceramic materials, primarily in a "candle" configuration, to separate particulate matter from the flue gas of pressurized fluidized-bed combustion and gasification technologies. Ceramic material is required because temperatures of up to 1,700 °F are experienced. Hollow filter elements are referred to as candles due to their nearly 5-foot length and outside diameter of just 2.36 inches. A first generation HGPF has been developed using clusters of clay-bonded silicon carbide candles. Alternative materials with potentially superior characteristics are being evaluated.

OXYGEN SEPARATION MEMBRANES

Most gasification technologies rely on oxygen to process a carbon-based feedstock. Advanced combustion systems also are being examined that would use oxygen in lieu of air. By using oxygen rather than air, the 78 percent nitrogen constituent is removed, which can otherwise cause unwanted nitrogen compound emissions. However, conventional air separation technologies use extremely energy intensive and expensive cryogenic and adsorption processes. For integrated gasification combined-cycle (IGCC) systems, air separation is an estimated 18 percent of the capital cost.

Currently, two of the largest gas producing companies in the United States, Air Products and Chemicals, Inc. and Praxair, are participating with FE in the development of air separation membrane technology. The oxygen ion transport membrane (OITM) is the concept being pursued.

The OITM employs a dense, mixed-metal-oxide ceramic material that possesses both electronic and oxygen ionic conductivity when operated at temperatures ranging from 500–1,000 °C. Ionic conductivity, transport of the oxygen ion, is facilitated by creating oxygen vacancies in the ceramic lattice structure.

In the process: (1) air under pressure enters the OITM; (2) oxygen clings to the membrane surface; (3) electrons ionize the oxygen molecule causing it to dissociate into the lattice structure; (4) the ionized oxygen diffuses across the membrane because of greater oxygen partial pressure in the air stream; and (5) the oxygen ions relinquish their electrons upon reaching the product

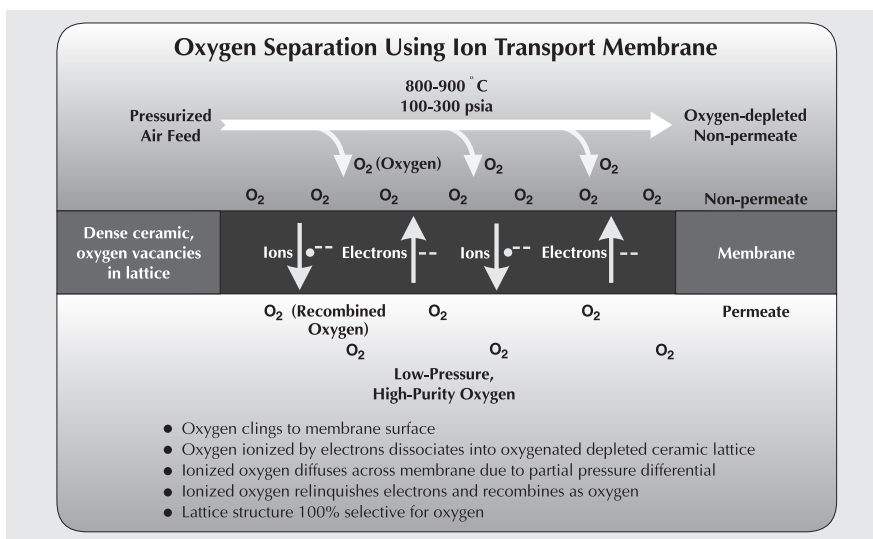
(permeate) side of the membrane surface and recombine as oxygen. The process induces electron flow, which complements the ionized oxygen transport. Since the lattice structure is designed specifically for ionized oxygen, the separation is 100 percent selective for oxygen, barring imperfections.

For IGCC systems, OITM technology can potentially reduce the total installed cost of the plant by 7 percent, improve its efficiency by 3 percent, and reduce the cost of electricity by 6 percent. The importance of the OITM extends to industries beyond power generation — oxygen is already the third largest bulk chemical produced in the United States.

HYDROGEN SEPARATION MEMBRANES

Hydrogen is an extremely valuable gas that can be used as a neat fuel for powering everything from cars to rockets. It is also the primary fuel for fuel cells and an important element in many products. The advantage in fuel applications is that, upon combustion, only heat and water are produced.

FE is sponsoring two membrane approaches to hydrogen separation. Both address separation from gas streams derived from coal gasification. Oak Ridge National Laboratory's (ORNL) Inorganic Membrane Technology Laboratory (IMTL) is exploring application of porous ceramic membranes, molecular sieves, to physically separate hydrogen by using Angstrom-sized passages engineered into the matrix. IMTL is updating classical equations for free molecular diffusion through capillaries in support of its membrane design. Success in achieving a 5 Angstrom pore diameter suggests that target flow rates of 30,000 lb/hr at 800 °C are possible.



Argonne National Laboratory (ANL) is implementing a second approach — a dense ceramic membrane dependent upon transport of hydrogen protons created by ionization of hydrogen molecules. The membrane is comprised of mixed oxides of barium and cerium, and doped with yttrium (BCY). BCY has proven to be an excellent proton conductor. Both the oxide ceramic phase and yttrium metallic phase contribute to high hydrogen permeability by providing high electronic conductivity and diffusion pathways. The approach has the potential to be 100 times more effective than molecular sieves.

CONTAMINANT CONTROLLING MEMBRANES

Researchers also are looking at potential separation of contaminants from the synthesis gas produced by gasifiers. This approach does not remove the hydrogen and carbon monoxide, the most sought after constituents in the pressurized stream, which saves energy by avoiding recompressing the product gases. The Research Triangle Institute in conjunction with the North Carolina State University is evaluating polymeric membranes for separation of hydrogen sulfide and carbon dioxide from synthesis gases. The concept

applies the principle of selectivity through solubility in removing these unwanted constituents. Up to 90 percent acid gas removal has been demonstrated at relatively low temperatures. Future work will address more realistic gasifier operating conditions.

ORNL along with the University of Kentucky, Center for Applied Energy Research have begun to delve into a novel adsorbent carbon fiber composite, molecular sieve gas separation media. Carbon fibers and powdered phenolic resin are molded and fired into a network of carbon fibers with microporous structure. This monolithic Carbon Fiber Composite Molecular Sieve (CFCMS) selectively adsorbs gases. Separation of hydrogen from hydrogen sulfide and carbon dioxide from methane have been demonstrated. Adsorbed gases are released by heating the CFCMS with a low voltage current, which allows for a low energy electric swing cycle.

In all, the collective membrane research being carried out by FE will support and enhance other work in developing Vision 21 technologies, which are geared toward significant efficiency enhancement and emission reductions relative to current fossil energy technologies.

UPCOMING EVENTS

February 8-10, 2000 —
International Conf. on Power Plant Operation, Efficiency, & Environmental Protection
Sponsors: National Thermal Corp., USAID, DOE/FETC, EPRI, TVA
Location: New Delhi, India
Contact: Sai Gollakota
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March 6-9, 2000 —
25th International Conference on Coal Utilization & Fuel Systems
Sponsors: ASME-FACT, CTA, DOE/FETC
Location: Clearwater, FL
Contact: Barbara Sakkestad
Phone: 301-294-6080
E-mail: barbarasak@aol.com

March 26, 2000 —
Particulate Matter & Stationary Fossil Fuel Combustion-Symposium at the 2000 American Chemical Society Meeting
Sponsors: American Chemical Society, DOE/FETC
Location: San Francisco, CA
Contact: Tom Feeley
Phone: (412) 386-6044
E-mail: feeley@fetc.doe.gov

April 11-13, 2000 —
The Use and Disposal of Coal Combustion By-Products: A Technical Interactive Forum
Sponsors: Office of Surface Mining, DOE/FETC
Location: Morgantown, WV
Contact: Kim Yavorsky
Phone: (412) 386-6044
E-mail: yavorsky@fetc.doe.gov

May 16, 2000 —
2000 Conference on Unburned Carbon in Utility Flyash
Sponsors: DOE/FETC
Location: Pittsburgh, PA
Contact: Kim Yavorsky
Phone: (412) 386-6044
E-mail: yavorsky@fetc.doe.gov

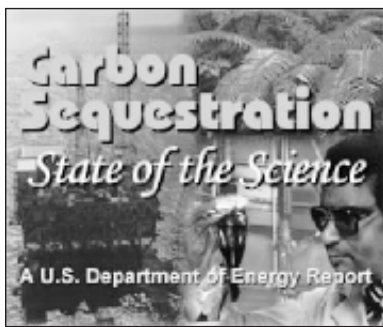
CARBON SEQUESTRATION WORKSHOP FOCUSES ON R&D

DOE's two-day Workshop on R&D Priorities for Carbon Sequestration, held in September in Gaithersburg, Maryland and sponsored by the Office of Fossil Energy and the Office of Science, was attended by 235 representatives from the government, industry, academia, and the research and environmental communities. The workshop generated constructive debate as to when carbon sequestration technologies might gain a foothold in the marketplace.

The objective of the workshop was to receive ideas from a broad community of DOE stakeholders concerning carbon sequestration research priorities, and to identify additional partnerships to address these needs. The Department had asked for feedback on the February 1999 report by the DOE's Office of Science and the Office of Fossil Energy entitled "Carbon Sequestration, State of the Science—A working paper for road mapping future carbon sequestration R&D."

In his keynote address, Principal Deputy Assistant Secretary for Fossil Energy Robert Kripowicz underscored the importance of sequestration as the third component in the Department's climate change strategy (following energy efficiency and use of lower-carbon fuels), and deemed it the option that can best take advantage of the current energy infrastructure. Martha Krebs, Director of the DOE Office of Science, traced the history of collaboration between her Office and FE, and indicated that a realistic strategy must include managing carbon emissions, rather than only avoiding them.

FE's carbon sequestration program, a \$9 million effort in fiscal year 2000, has enjoyed a substantial increase in funding since beginning in 1998, and has initiated specific projects in the areas of geological, ocean, and other sequestration methods. FE's overall greenhouse gas reduction program has been ongoing since 1993, identifying targets for R&D particularly through the International Energy Agency's Greenhouse Gas R&D Program. In September 1999, FE issued an up-to-\$18 million solicitation for research proposals in: modeling and assessments; separation and capture; geological, ocean, and terrestrial ecosystems sequestration; and advanced concepts. Earlier, in August 1999, DOE had agreed to fund from \$1-3 million in fiscal year 2000 for the first year of research on proposals received from the national laboratories.



The "State of the Science" report details progress to date and research needed to achieve the year 2025 "vision" of sufficient scientific and technical knowledge to make carbon sequestration a major carbon management option, sequestering a significant fraction of 1 gigaton of carbon/year by that date and sequestering four times that amount by 2050.

Workshop breakout sessions on specific technology areas generally reaffirmed the direction in which DOE is headed. Participants agreed with DOE on potential research categories outlined in the report, including sequestration in oceans, terrestrial ecosystems, geological formations, biological processes, and chemical approaches. Participants added a new

category, "singular events," which includes deep water seismic events. All these approaches must be verified by new or improved analytical instrumentation.

For R&D priority setting, participants emphasized the importance of total CO₂ that could be sequestered by a given technology as well as the length of time the technology would keep CO₂ from escaping. Commercialization could be more likely in the nearer term if spinoff benefits were possible from sequestration, such as CO₂ for enhanced oil recovery, enhanced coalbed methane recovery, or production of new carbon-based industrial materials. Sequestration, however, would be too costly if deregulation led to widespread use of distributed generation.

All groups agreed on the need to assuage potential public concerns about environmental impacts of sequestration technologies themselves, such as the potential of CO₂ escaping from improperly sealed or abandoned oil and gas wells. In addition, operational uncertainties must be reduced so industry can determine future cost and financial risk of technologies. Life cycle analysis must be conducted on all components of a particular process. In particular, certain enabling activities such as gas compression and transportation systems have not been evaluated in sufficient detail.

The magnitude of the problem requires a portfolio approach using a variety of sequestration technologies, according to workshop attendees. R&D efforts should continue to emphasize multiple pathways for CO₂ capture, reuse, and sequestration. The large scale breakthroughs needed will require considerable scientific and engineering innovation, with pilot and field experiments building on work already done in the laboratory.

KYOTO UPDATE: COP 5

The purpose of the most recent Conference of Parties negotiations, COP-5, which was held October 25 to November 5, 1999, in Bonn, Germany, was to promote progress on the Kyoto Protocol, particularly on procedures and measures to make the implementing arrangements work, and to attempt to get developing countries to accept carbon emission limits. DOE hopes that these provisions are determined before COP-6, which is scheduled for November 13-24, 2000. Interim negotiating sessions are scheduled for February and June 2000. To date, 18 of the 84 signators have ratified the Kyoto Protocol.

Progress at COP 5 included increased participation of developing countries, which is seen as key to U.S. Senate ratification of the Kyoto Protocol. On November 3, 1999, Argentina announced an emission target that would be a function of its Gross Domestic Product, reducing projected business-as-usual emissions levels for 2008-2012 by 2-10 percent, for a reduction in emissions growth. High-level discussions also were held with India, China, and other developing countries, although no specific commitments have yet been reached to reduce their emissions.

To help offset concerns that implementing the Kyoto Protocol will lead to less coal use, DOE Secretary Bill Richardson issued a challenge in June 1999 to expand options for coal by continuing to develop carbon sequestration and Vision 21 technologies. This could lead to availability of pollution free and near-zero carbon emission coal-fired technologies in the U.S. in the next 15 years, and would promote continued use of coal even as environmental regulations become more stringent.

UCIG MEETS TO EVALUATE COAL-DERIVED FUELS RESEARCH

The fall meeting of the Upgraded Coal Interest Group (UCIG) was held on September 16-17, 1999, at the FETC/Pittsburgh Conference Center with 27 participants from industry, academia and government attending. The UCIG was founded by the Electric Power Research Institute (EPRI) in 1994 to assist utilities in maximizing their fuel supply options in relation to new market conditions arising from the Clean Air Act Amendments and utility deregulation. UCIG consists of a number of utilities (currently including the Tennessee Valley Authority, Illinois Power, Allegheny Power, Detroit Edison, Southern Indiana Gas and Electric Company, and GPU Genco/Sithe Energy), technology developers (CQ Inc., Energy and Environmental Research, and Exportech), DOE, EPRI, and the Illinois Clean Coal Institute. UCIG seeks to promote the commercial availability of upgraded coal products and technologies by funding research activities, screening technologies, facilitating communication and technology transfer, and conducting market assessments.

Specific areas of current research interest supported by UCIG that were reviewed during the fall meeting included coal-water slurry (CWS) production; CWS co-firing and reburning for NO_x emissions reduction; upgrading and use of fines from waste coal impoundments; development of slurry fuels made from coal and wastes; production of solid composite fuels made from coal and biomass and/or wastes for co-firing in boilers; and an advanced technology for the pre-combustion removal from coal of sulfur, ash, and trace elements, especially mercury.

UCIG is considering supporting future large-scale testing of the DOE-developed GranuFlow® process. This low cost technology, patented in 1990 and licensed by CQ Inc. in 1997, involves the addition of a bitumen emulsion to a slurry of fine-sized coal before mechanical dewatering (filters or centrifuges), and enables production of a granular, free flowing product following dewatering. The process can reduce dusting and freezing problems associated with coal fines, improve the performance of mechanical dewatering devices, and may act as a binder/waterproofing agent and lubricant during pelletizing. DOE and CQ Inc., through a CRADA, currently are proceeding with a full-scale test of the GranuFlow® process at the Ginger Hill pond fines recovery and pelletization facility near Pittsburgh, Pennsylvania. The test will include an evaluation of the impact of the process on flotation treatment of coal fines, centrifuge performance, materials handling, and pelletization.

UCIG is currently seeking additional members from the power generation industry (utilities, IPPs, coal companies, engineering firms, universities, etc.). Power companies may join at \$30,000/year, with EPRI members usually using their "tailored collaboration" set-aside funds at EPRI to match a cash payment, thereby making the added cash cost to them \$15,000 instead of \$30,000. Research, development, engineering, and academic organizations can join as affiliate members by providing an in-kind service and/or equipment valued at \$15,000 per year.

PCAST SUPPORTS INTERNATIONAL ENERGY COOPERATION PROGRAMS



A Report from the President's Committee of Advisors on Science and Technology (PCAST) entitled *Powerful Partnerships: The Federal Role In International Cooperation on Energy Innovation* (June 1999), recommends doubling the present funding (less than \$250 million per year in FY1997) for federal programs in international energy cooperation to address the full spectrum of energy technology needs. PCAST recommends focusing on programs that build stronger foundations for energy technology innovation, promote innovation in energy end-use, and promote clean and efficient energy supply. The report suggests that increased effort is needed because the government has few programs to bridge the gap between R&D and commercial deployment, and this gap impedes the commercialization of innovative energy technologies. A recommendation is made to create a new Interagency Working Group on Strategic Energy Cooperation, under the auspices of the National Science and Technology Council. The government's contribution to this expansion of international energy cooperation activities would be provided by a new Strategic Energy Cooperation Fund, with funding allocations to relevant agencies in the President's budget request determined with the help of the Interagency Working Group.

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COAL'S CONTRIBUTION

The PCAST Report makes a number of important observations and recommendations concerning coal. It points out that more than 90 percent of the increase in global coal demand between 1996 and 2020 will be in developing countries, most of which will be in China. Meeting this demand without extremely high environmental and social costs will require improvements in and adoption of advanced coal technologies. PCAST recommends that U.S. coal R&D be oriented to serving the market needs of developing countries in ways that build on activities in Vision 21, DOE's new fossil energy initiative. Vision 21 aims to produce electricity from coal, with near-zero greenhouse gas and air pollutant emissions, at a cost that is less than that for today's state-of-the-art pulverized coal power plants. These plants might also co-produce electricity and hydrogen with near-zero emissions, and they might use a variety of carbonaceous feedstocks in addition to coal — e.g., natural gas, petroleum residuals, biomass, and/or municipal solid waste.

In the longer term, PCAST suggests that the use of gasification of coal and other carbonaceous feedstocks to produce syngas is a way to reduce CO₂ emissions to near-zero while also making hydrogen. For this approach to be successful, major markets for hydrogen would be needed, such as fuel cells developed for both transportation and stationary power markets. In the near-term, integrated gasification-combined cycle power generation (IGCC) is seen as a technology that can provide energy with very low levels of air pollutants. PCAST suggests that IGCC costs can be lowered through the

co-production of electricity and industrial process heat. Such energy co-production systems offer as benefits low levels of air pollution and significant cost reductions, energy savings, and reduced CO₂ emissions relative to systems that produce these products separately.

The PCAST Report also recommends that broad multinational collaborative efforts develop fossil-fuel decarbonization and carbon sequestration technologies. The United States should do the following:

- Cooperate to promote energy-sector and environmental reforms in developing and transition countries, making it more advantageous to produce multiple clean products from syngas derived from natural gas, coal, and other carbonaceous feedstocks;
- Collaborate in R&D and demonstrations of technologies designed to reduce the cost of making hydrogen from carbonaceous feedstocks while facilitating the recovery of by-product CO₂ for ultimate disposal; and identify, develop, and demonstrate, via multinational efforts, promising integrated systems for hydrogen production and use, with sequestration of the separated CO₂; and
- Through broad-based collaborative efforts on CO₂ sequestration, develop standards for security of CO₂ storage, conduct environmental impact studies, carry out both region-by-region assessments of sequestration potential *and* detailed reservoir-by-reservoir analyses of storage capacity and other characteristics, and carry out demonstrations with monitoring of storage security.

The PCAST report is available at: www.whitehouse.gov/WH/EDP/OSTP/html/P2E.pdf.

INTERNATIONAL INITIATIVES

FE REGULATES ELECTRICITY TRADE WITH MEXICO AND CANADA

Since 1939, the Federal government has regulated international electricity trade. Regulation of electricity exports and construction of transmission lines that cross our international borders has resided in the Department of Energy since 1977. Both Mexico and Canada have similar regulatory programs.

There are currently 28 transmission lines that cross the United States border with Mexico, and 84 lines that cross the Canadian border. Three-fourths of the trade with Mexico occurs using two San Diego Gas and Electric-owned lines between California and the Mexican State of Baja California. Only Baja California is synchronized with the U.S. electric system. Remaining interconnections are for short-term and emergency exchanges, and electricity trade is generally constrained by the non-synchronous nature of the U.S. and Mexican electric systems.

Secretary Richardson is working with his counterpart in Mexico to enhance the transmission systems between the two countries. By increasing the transmission capability, U.S. electricity producers can assist Mexico in responding to its border area load growth, which currently exceeds 6 percent per year.

In recent months, through the National Environmental Policy Act process, FE's Office of Electric Power Regulation has been reaching out to stakeholders on the Arizona-Mexico border as part of its review of a "Presidential" permit application submitted by the Public Service Company of New Mexico (PNM) to build a 216-mile long high-voltage transmission line from the switchyard of the Palo Verde Nuclear Generating Station, near Phoenix, Arizona, to the city of Santa Ana, in Sonora, Mexico.

The Environmental Impact Statement (EIS) process for the PMN project is scheduled to be completed by the end of 2000. Since the process began last February, 12 public meetings have been held, and 1,500 fact sheets in Spanish and English have been distributed to southern Arizona residents. Stakeholders have voiced such concerns as: impacts on the sensitive desert ecosystem, and particularly bird species; health and visual impacts of transmission lines; effects on property values; and possible impacts to historic sites and Native American lands. Mexico is commissioning a similar environmental study for the 70 miles of transmission to be constructed in the Mexican State of Sonora.

A final regulatory decision on the PNM project cannot occur before the EIS is completed and FE assesses the impact the project would have on the electric reliability of the U.S. system.

JOINT STATEMENT SIGNED FOR TECHNICAL COOPERATION TO STRENGTHEN RUSSIAN COAL SECTOR

On October 2, 1999, DOE Secretary Bill Richardson and the Russian Minister of Fuel and Energy, Viktor Kalyuzhny, signed a Joint Statement to help strengthen Russia's critical coal energy supply and delivery systems while sharing clean coal technologies. The joint statement expanded the mandate of the Coal Working Group under the Russia-U.S. Commission on Economic and Technological Cooperation. Russia has

See "International" on page 12...



In the Tubac, Arizona project, new transmission line would parallel existing lines



Fossil Energy reaches out to stakeholders during environmental scoping meeting

....*International continued*

identified coal as a primary component of its national energy strategy. "The Department of Energy will continue to play a central role in facilitating and coordinating U.S. efforts to assist in the restructuring of the Russian coal industry," said Secretary Richardson. He added, "In addition to helping find solutions to serious economic problems facing the Russian coal industry, we are focusing on improving the health, safety, and environmental operation of Russian mines." The Working Group now will be able to coordinate technical exchanges on clean coal and power systems technologies that can help protect the environment.

Earlier this year, Energy Department and Ministry staff met in Moscow and agreed to expand the scope of the Coal Working Group to permit the development of a concrete plan for obtaining international financial support. The financing would be used to purchase equipment that would improve the health, safety, and environmental operation of selected Russian coal mines. Other U.S. agencies involved with finding solutions to the serious economic problems confronting the Russian coal industry include the U.S. Export-Import Bank, the Environmental Protection Agency, the Agency for International Development (AID), the Trade Development Agency, the Overseas Private Investment Corporation, and the Mine Safety and Health Administration. The World Bank, the National Mining Association, and Partners in Economic Reform, an AID-funded non-governmental organization that specializes in mine safety and management-labor relations, are also members of the Coal Working Group.

COALTECH '99 CONFERENCE IN JAKARTA, INDONESIA SUPPORTS CCTs

The Federal Energy Technology Center, along with Indonesia's Energy Research Lab, co-sponsored the highly successful CoalTech '99 conference in Jakarta, Indonesia, November 1-2, 1999. The conference, designed to develop and foster knowledge of clean coal technologies (CCTs) in Indonesia's coal mining and power generation sectors, drew 175 attendees from a variety of countries. A highlight of the meeting was the formation of the Indonesian Coal Society to facilitate technical dialog and better understanding of Indonesian coal properties and CCT performance characteristics. Indonesia mines approximately 60 million tons of coal per year, of which 40 million tons are high quality and targeted for export. The remaining 20 million tons of lower quality coal are used in domestic power plants. These power plants are slated to reduce SO₂ emissions by up to 50 percent, and CCTs are seen as a way to achieve that end. During the opening ceremonies for the conference, FETC and LSDE (Laboratorium Sumderdaya Energi) signed a Joint Statement to discuss potential cooperation on clean coal and other advanced power technologies. As a first sign of future cooperation, LSDE has requested that FETC co-sponsor the second CoalTech Conference during October 23-24, 2000 in Jakarta.



Scott Smouse of FETC witnesses signing of a Joint Statement on potential cooperation between FETC and LSDE with Dr. Rachmat Mulyadi, head of LSDE

TRIBOELECTROSTATIC SEPARATION APPLIED TO SLOVAKIAN BROWN COAL

Under a cooperative research agreement between FETC and the Slovak Academy of Sciences, FETC researchers have recently completed a study of the application of triboelectrostatic separation to Slovakian brown coal. The brown coal, a significant resource for power production in Slovakia, contains elevated levels of ash, sulphur, and arsenic. The study concluded that using triboelectrostatic separation reduced ash levels in the coal significantly. The results were presented at the 10th International Conference on Coal Science on September 13, 1999, in Taiyuan, China, as well as at the 16th Pittsburgh Coal Conference on October 14, 1999, in Pittsburgh, Pennsylvania.



R&D MILESTONES



DOE Small Business Innovative Research (SBIR) research on economical sorbents for mercury control complements EPA research efforts. TDA Research, Inc. (TDA) of Wheat Ridge, Colorado, performed the mercury control research under Phases I and II of DOE's SBIR program. In Phase I, TDA tested their improved carbon-based, sulfur-containing sorbent, by measuring breakthrough curves for mercury vapor in air. TDA's process, which is a significant departure from previous methods, has the potential to greatly lower

the costs compared to competitive sorbents. Under Phase II, TDA prepared and characterized bulk quantities of the best performing sorbents and tested their capabilities to remove mercury from coal-fired power plant flue gas. The sorbent, produced from a low-cost feedstock contains small particles and has high uptake in the injection mode. Field tests were conducted at Comanche Power Station, Pueblo, Colorado. Results indicate TDA's sorbent has capacities equal to previously tested materials and appears to be economically competitive. Most recently, TDA was awarded an EPA Phase I SBIR grant to develop clay-based sorbents for mercury removal in coal-fired electric utilities. TDA will focus on modifying properties of clays to increase their capacity for mercury uptake and retention. This will complement TDA's ongoing work with DOE and may enhance TDA's prospects for commercializing the sorbents.

FETC researchers develop sorbent capable of removing sulfur to the parts per billion range. To reach Vision 21 goals, contaminants such as hydrogen sulfide from coal-derived synthesis gas must be removed to parts per billion (ppb) range for fuel cell and chemical co-production applications. In-house research has led to development of the first regenerable desulfurization sorbent capable of removing hydrogen sulfide to ppb range from fuel gas streams. The sorbent was prepared at United Catalysts, a Louisville, Kentucky firm, under the direction of FETC researchers. Sorbent performance has been demonstrated in a high-pressure, bench-scale test facility at Research Triangle Institute using synthesis gas that was to simulate coal gas from Tampa Electric Company's Polk Power Station. Initial tests indicated that the sorbent is regenerable, has a stable sulfur capacity, and maintains its sulfur removal efficiency in the ppm range during multi-cycle tests. In addition, the mechanical strength of the sorbent improved during the multi-cycle tests.

Interagency Agreement with the United States Department of Agriculture investigates use of various waste materials for terrestrial carbon sequestration. Researchers believe that deep-tilling of forest litter, other related biomass, and coal combustion by-products could enhance poor soil's short- and long-term productivity and sustainability, as well as offering the potential for carbon sequestration. Field research will take place in Upper Coastal Plain at the Savannah River Site, Aiken, South Carolina, focusing on soil restoration by deep tilling to a depth of 18 inches prior to replanting with loblolly pine trees. Researchers will then measure the above- and below-ground carbon pools, carbon fluxes (CO₂ and dissolved organic carbon), organic matter turnover, soil chemical properties, soil physical properties, and water chemistry. These measurements will result in a carbon mass balance assessment, a productivity study, and an examination of incorporating coal ash into forest soils. The operational system and the economics of the treatments also will be evaluated.

In October 1999, DOE opened its first major Vision 21 competition, asking industry for proposals for a new class of non-polluting fossil fuel plants that could co-produce electricity, chemicals and carbon-based products. DOE is providing a total of \$30 million for the winning projects, to be awarded in stages over the next year, with each of the initial projects expected to receive from \$1.5-2.5 million. Industry is required to pay at least 20 percent of project costs. Proposals are requested in the areas of "module" development, i.e., advanced gas separation, fuel flexible gasifiers, fuel cells, and other technologies; system integration of two or more modules; advanced plant design; and virtual plant simulation software.

STATUS OF ACTIVE CCT DEMONSTRATION PROJECTS

ENVIRONMENTAL CONTROL DEVICES

Southern Company Services, Inc. – *Demonstration of Advanced Combustion Techniques for a Wall-Fired Boiler.* Long-term testing of the advanced overfire air (AOFA), low-NO_x burners (LNB), and combined LNB+AOFA systems are complete. Final testing of GNOCIS is complete. Phase 4 has been extended 19 months to evaluate additional equipment for NO_x control and to demonstrate on-line optimization techniques. (Coosa, GA)

New York State Electric & Gas – *Milliken Clean Coal Technology Demonstration Project.* The Final Report was reviewed and was published. (Lansing, NY)

New York State Electric & Gas – *Micronized Coal Reburning Demonstration for NO_x Control.* All testing has been completed at the Kodak site in Rochester, New York. The goals and objectives for the site have been met or exceeded. The system will remain in operation, allowing Kodak to effectively reduce NO_x in accordance with its agreement with the State of New York. The final report has been reviewed and is presently being published. (Ithaca, NY) (Lansing, NY and Rochester, NY)

NOXSO Corporation – *Commercial Demonstration of the NOXSO SO₂/NO_x Removal Flue Gas Cleanup System.* Project is on hold pending results of bankruptcy proceedings.

ADVANCED ELECTRIC POWER GENERATION

City of Lakeland, Department of Water & Electric Utilities – *McIntosh Unit 4A PCFB Demonstration Project, and McIntosh Unit 4B Topped PCFB Demonstration Project.* Lakeland Electric is re-evaluating its options to meet future power demand. (Lakeland, FL)

JEA – *ACFB Demonstration Project.* In September 1997, DOE signed an agreement with JEA to cost-share refurbishment of the first (Unit 2) of two units at the Northside Generating Station. Preconstruction activities began in August of 1999. A public hearing was held on September 30, 1999 for the draft Environmental Impact Statement.

Necessary changes are being made and the final EIS is scheduled for early 2000. (Jacksonville, FL)

Kentucky Pioneer Energy, LLC (formerly Clean Energy Partners, LLC) – *Kentucky Pioneer Energy Project.* Kentucky Pioneer Energy, LLC has replaced the Clean Energy Partners, LP as the project participant and has moved the site to a new location in Clark County, Kentucky. NEPA activities are in progress. (Clark Co., KY)

Sierra Pacific Power Co. – *Piñon Pine IGCC Power Project.* Sierra continues to make progress toward achieving integrated operation of all systems. During a planned plant-wide outage in the fall, Sierra installed a second set of filters in the line which regulates pressure of the Filter Fines Depressurization Hopper. Operations earlier in the year indicated that one set of filters was not sufficient to handle the fines loading. DOE and Sierra agreed to extend the cooperative agreement (on a no-cost basis) until January 1, 2001, or until divestiture of the Piñon Pine facility, whichever comes first. Divestiture of all generating facilities is a condition of Sierra's July merger with Nevada Power. Sierra continues to operate the plant normally in the gas combined cycle mode. (Reno, NV)

Tampa Electric Co. – *Tampa Electric Integrated Gasification Combined-Cycle Project.* Tampa's Polk Power Station has completed three years of successful commercial operation. The gasifier has operated 15,500 hours, and the combustion turbine has operated 16,500 hours producing over 5,500 MWh. The gasifier set a new record non-interrupted run of 36.9 days in early fall of 1999. (Mulberry, FL)

Wabash River Joint Venture – *Wabash River Coal Gasification Repowering Project.* The facility is in full operation under a no-cost time extension, which currently is scheduled to terminate on January 1, 2000. (West Terre Haute, IN)

Alaska Industrial Development and Export Authority – *Healy Clean Coal Project.* A 90-day commercial operation test at the Healy Clean Coal Project began on August 17, 1999. Under the terms of the power sales agreement between the Alaska Industrial Development & Export Authority and Golden Valley Electric Association, Inc., the host

utility, the plant must operate at not less than 50 MW, net of station service, at a capacity factor of not less than 85 percent, for a period of 90 consecutive days. Test operations and equipment inspections were conducted to assess whether the plant is performing within design specifications and tolerances, and to establish that the unit will perform on a sustained operating basis. On November 6, 1999, the plant exceeded the 90-day electricity production requirement of 91,800 MW-hr at a capacity factor of over 95 percent. Of particular significance is that the requirements of 90-day commercial operation test were achieved despite a coal duct explosion and inconsistent coal quality that hampered operations. The test was completed in November 1999, and following equipment inspections, the demonstration operations will resume to complete sustained operations testing and turbine testing. (Healy, AK)

Arthur D. Little, Inc. – *Coal-Fueled Diesel Engine Demonstration Project.* Preparatory work is under way prior to preliminary performance checkout of the diesel engine. Fuel oil, the more conventional fuel, will be used instead of coal slurry to ensure that the diesel engine is in running condition and support systems are operating properly. Preliminary performance checkout will begin in the first quarter of 2000. Upon completion, work will begin to modify the engine so it can operate on coal slurry. (Fairbanks, AK)

COAL PROCESSING FOR CLEAN FUELS

Custom Coals International – *Self Scrubbing Coal™: An Integrated Approach to Clean Air.* Following bankruptcy proceedings, C.J. Betters Enterprises of Monaca, Pennsylvania purchased the facility in December 1998 for \$3 million, and was to reach an agreement with DOE to supply a detailed proposal for continuation of the project. In September 1999, C.J. Betters indicated to DOE that they are no longer interested in the continuation of the project. (Central City, PA; Martin Creek, PA; Richmond, IN; Ashtabula, OH)

Rosebud SynCoal® Partnership – *Advanced Coal Conversion Process (ACCP) Demonstration.* The Project has processed over 2.2 million tons of raw subbituminous coal. Over 1.5 million tons of SynCoal® has been sup-

plied to customers, including industries (primarily cement and lime plants) and utilities. Rosebud SynCoal® Partnership has completed construction of a Pneumatic SynCoal® Supplemental Fuel Project at Montana Power's Colstrip Unit 2. The system has been performing well. Colstrip Unit 2 has experienced significant benefits in improved heat rate, reduced auxiliary load and reduced slag related limitations. (Colstrip, MT)

Air Products Liquid Phase Conversion Company, L.P. – *Liquid Phase Methanol Process Demonstration Project.* The Liquid Phase Methanol (LPMEOH™) Process Demonstration Facility continues to experience stable operation on coal-derived synthesis gas. On-line withdrawals of spent catalyst and additions of fresh catalyst slurry have remained successful in maintaining methanol production rates. Since being restarted with fresh catalyst in December 1997, the demonstration facility has operated at greater than 99 percent availability, and since April 1999, has produced over 45 million gallons of methanol, all of which was accepted by Eastman Chemical Company for use in downstream chemical processes. The monitoring of all potential catalyst poisons and methods for their removal and control continue to be an important part of the on-going plant operation. (Kingsport, TN)

INDUSTRIAL APPLICATIONS

Bethlehem Steel Corporation – *Blast Furnace Granulated Coal Injection System Project.* All testing has been completed and the final report has been submitted, accepted by DOE personnel and is available to the public. Tests have clearly demonstrated that granular coal injection can be used on a large blast furnace with good results. In addition, the furnace operation shows that low volatile coal replaces more coke than does lower-carbon-content, high volatile coal. The high volatile coal required 31.4KWH/ton to pulverize and only 19.6KWH/ton to granulate. Providing granulated coal instead of pulverized coal reduces the cost of power for size reduction. A Topical Report entitled "Blast Furnace Granular Coal Injection System Demonstration Project" has been prepared by DOE and will be available soon. (Burns Harbor, IN)

CPICOR Management Company, L.L.C. – *Clean Power From Integrated Coal/Ore Reduction.* DOE has continued its environmental analysis for preparing an Environmental Impact Statement for this project. The CPICOR Management Company (CMC) continues to perform baseline environmental monitoring and preliminary engineering and design in support of the NEPA process. CMC also continues to work closely with the Australian developers of the HISMelt® Process to establish a process and mechanical design database for this project. This project will be designed to produce 3,300 tons per day of liquid iron and approximately 160 MWe from the by-product gases. (Vineyard, UT)

ThermoChem, Inc. – *Pulsed Combustor Design Qualification Test.* The steam reformer test unit that will house the existing 253-tube pulsed combustor for testing is complete, except for final assembly and setting on its new foundation. The five major sections have been mated and will be erected and set on the new foundation. Erection and instrumentation wiring/checkout is scheduled to be completed by March 2000. Shutdown testing is scheduled to start in April 2000, with CCT project testing still anticipated to be complete at the end of June 2000. Testing in the Process Data Unit (PDU) that was scheduled for September 1999 did not occur because of significant other testing requirements at the MTCI Test Facility. The PDU testing using Black Thunder subbituminous coal was rescheduled for January 2000. (Baltimore, MD)



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