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CLEAN COAL TODAY

A NEWSLETTER ABOUT INNOVATIVE TECHNOLOGIES FOR COAL UTILIZATION

PROJECT NEWS BYTES

SGI International, owner of the Liquids-From-Coal® technology used in the **ENCOAL Mild Coal Gasification Project**, has announced a sales agreement with Dussek Campbell to market all of the wax produced at ENCOAL. At full production, the ENCOAL facility, located in Gillette, Wyoming, should be capable of producing about 18 million pounds of wax annually. This wax has potential for use in a broad range of industrial applications, including fiber board, fertilizer de-dusting agents, anti-corrosive coatings, and fire logs. Dussek Campbell, a subsidiary of Burmah Castrol, markets waxes from the petroleum industry, the long-term supply of which is expected to decline. Marketing this wax and other by-products is

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IN THIS ISSUE

POWER SYSTEMS DEVELOPMENT FACILITY

ENSURING CLEAN AFFORDABLE POWER FOR THE 21ST CENTURY

A cost-shared industry/U.S. Department of Energy (DOE) partnership at the Power Systems Development Facility (PSDF) continues to make advancements toward ensuring availability of clean, affordable fossil fuel-based power for the 21st century. Recent successes and continued development are providing the foundation for fossil fuel technologies capable of meeting future energy and environmental demands.

Candle filter arrays for the Siemens Westinghouse hot gas filter system at the PSDF in Wilsonville, Alabama.

The PSDF, overseen by DOE's National Energy Technology Laboratory (NETL), is the nation's test facility for 21st century power generation technologies. This large-scale pilot facility is designed to evaluate advanced gasification technology and combustion systems and components at a scale sufficient to predict commercial potential. The $275-million PSDF cost-shared effort focuses on coal-based systems, recognizing that coal is the nation's most abundant resource and the fuel of necessity in most developing countries. Southern Company Services, Inc., operates the facility in Wilsonville, Alabama. Industry participants fund 20 percent of the project and the DOE Office of Fossil Energy (FE) funds the balance. Industry participants include Southern Company, the Electric Power Research Institute, Foster Wheeler Corporation, Kellogg Brown & Root, Peabody Group, Combustion Power Corporation, and Siemens Westinghouse Power Corporation.

Research at Wilsonville aims to make coal both cost-competitive and environmentally comparable to natural gas. Recent work has involved testing of hot-gas particulate filtration systems because of their critical importance to both advanced combustion and gasification technologies. To support the work, an innovative reactor has been designed and built — the "transport reactor."

From its beginnings as a test bed, the transport reactor has emerged as a promising new gasifier, offering the potential for high efficiency, fuel flexibility, and low capital cost. Although the transport reactor can be operated as both

See "PSDF" on page 2...

...PSDF continued

a combustor or gasifier, the commercial interest is primarily in gasifier applications. Gasification offers the advantage of converting the coal into basic constituents, enabling separation of pollutants and greenhouse gases to produce clean gas for power generation, chemicals, and clean liquid fuels. Emissions of sulfur, nitrogen oxides (NO_x), and fine particulates are reduced. When pure oxygen is fed to the reactor, it also allows a concentrated stream of carbon dioxide (CO_2) to be produced and more easily sequestered. Efficiencies are expected to surpass the 40–45 percent achieved by today's IGCCs.

Progress is also being made in hot-gas particulate filtration and development of an advanced pressurized fluidized-bed combustion system (APFBC). Advanced particulate control devices (PCDs) are showing promise as highly effective particulate removal at APFBC and gasifier operating temperatures, which enables exit gases to retain sufficient energy to drive gas turbines. The PCDs are also essential in meeting rigid gas quality standards for system components of FE's Vision 21 program of high-efficiency, near-zero polluting technologies, such as fuel cells, gas separation membranes, CO_2 capture processes, and advanced gas turbines. The APFBC work is taking place in a separate unit that integrates a circulating pressurized fluidized-bed combustor, a special low-NO_x combustor and gas turbine arrangement, and a hot gas PCD. The APFBC has been commissioned and is operating.

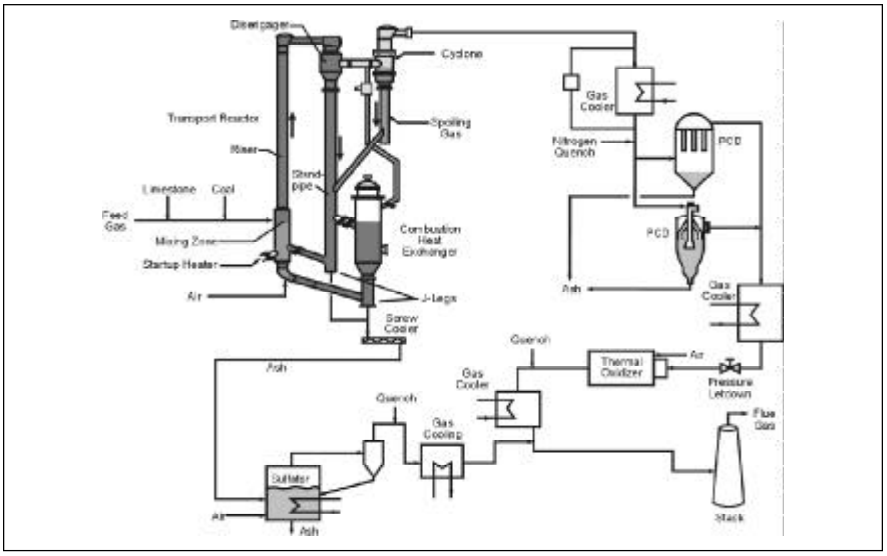
Future work will entail evaluation of hybrid systems such as integration of fuel cells with gas turbines and gasifiers, and testing of other key Vision 21 components such as fuel flexible gas turbines, acid gas removal processes, CO_2 capture processes, and gas separation membranes for hydrogen, oxygen, and CO_2. Moreover, as new off-the-shelf components emerge with the potential for enhancing power system performance, the PSDF may be used to assess performance under commercial conditions and reduce the risk and associated costs for commercial applications.

The Transport Reactor

The transport reactor employs a simple compact design that offers highly efficient and fuel flexible combustion and gasification, which translates into lower costs. The transport reactor is configured in a loop. Coal and limestone enter at the top of a mixing zone where they contact hot char and react to produce a fuel gas, sulfur compounds, and a char containing carbon. These constituents are circulated around the reactor by the gas flow (see schematic below). The coal feed rate is 1 ton/hour in the combustion mode and 2 tons/hour in the gasification mode.

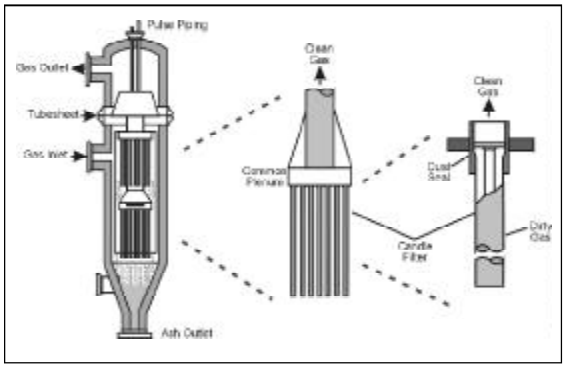
Sulfur compounds are collected by limestone, and the limestone and char are separated from the product gas in a disengager. The char is partially burned by oxygen or air introduced at the bottom of the mixing zone, to provide the heat that allows new coal to react. A slipstream of char and sulfur compounds is removed from the system and sent to a sulfator to recover additional heat and produce inert sulfur compounds. The reactor was reconfigured for gasification operations and ran as a gasifier in September 1999. During the initial commissioning test runs, over 450 hours of coal-based operation were achieved with three coals and three sorbents. Gasification conditions varied depending on the fuel tested, with temperatures ranging from 1,450–1,800 °F and pressures up to 240 psig. The goal is to produce 110 Btu/scf gas and 90 percent carbon conversion in the transport reactor under gasification conditions. Gasification commissioning tests are expected to resume in mid-October; studies on how to increase the syngas heating value will continue. A subsequent performance evaluation test of the gasifier is expected later this year.

In the first test of a candidate sulfur removal technology, a slipstream of transport reactor syngas will be supplied to the Direct Sulfur Recovery Process (DSRP). Research Triangle Institute is supplying the DSRP as a trailer-mounted mobile test unit.



Transport Reactor system schematic

Future plans also call for evaluating fuel cell performance using syngas derived from the transport reactor. The hydrogen-rich syngas eliminates the need for energy intensive reforming required to convert natural gas to usable fuel cell fuel.



Siemens Westinghouse candle filter system

Particulate Control Devices

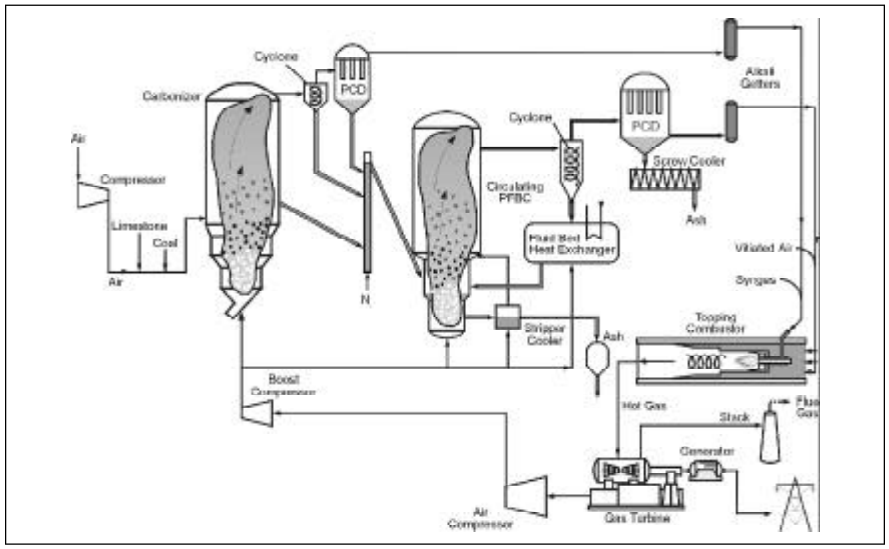
A PCD that shows significant promise is the hot-gas candle filter system. Candle filter systems typically consist of arrays of cylindrical ceramic or metal filters supported by a metal structure within a pressure vessel. (A schematic of the Siemens Westinghouse design is shown above.) Filter element arrays are formed by attaching individual candle elements to a common plenum section. All gas filtered through the candles in a single array is transferred through a pipe to the clean side outlet of the filter. In the Siemens Westinghouse design, arrays are stacked vertically to form clusters, which are suspended from a tube sheet. Ash is collected on the outer surface of the filter elements during filtration and is removed by a reverse direction pulse of high-pressure gas. Filter elements can be made of porous ceramics or metals.

While filter system operation at process design conditions has been successful, operation at off-normal conditions continues to pose problems. The objective of the DOE Advanced Hot Gas Filter Program is to develop more durable hot-gas filter elements that can withstand process upset conditions. The approach being used is to develop filter elements from materials including ceramic composites, novel ceramics, and metals that do not exhibit brittle failure and are tolerant of thermal stresses. PCD testing is continuing under gasification conditions on the transport reactor and will begin again under combustion conditions on the circulating PFBC. New filter element materials will be studied and work will continue to develop reliable failsafe devices (which close off gas flow if a filter fails), nondestructive filter element evaluation methods, alkali concentration measurements, vibration measurements, and on-line particle detectors.

A second PCD in the transport reactor structure features the Combustion Power Company granular bed filter system, a different particle separation method. It has not yet been operated.

Advanced Pressurized Fluidized-Bed Combustion

The APFBC technology at the PSDF is being developed by Foster Wheeler Corporation (see schematic below). The test system is still in the shakedown mode and has not operated on coal. Through 1998 and much of 1999, shakedown of the APFBC system could not be completed. This was due to the inability to operate the Siemens Westinghouse Multianular Swirl Burner (MASB) — as needed to provide hot gas to the combustion turbine/compressor. The MASB is intended to be a rich-quench-lean low-NO_x combustor. Initial operation in this design mode with propane resulted in large amounts of soot formation and damage to the burner liner in two runs. The MASB was reconfigured as a lean propane burner in 1999 and ran successfully, providing hot gas to the combustion turbine for approximately 400 hours. This modification allowed commissioning of the APFBC system to proceed. This system consisted of the MASB/turbine, the circulating PFBC, and a Siemens Westinghouse PCD. The next APFBC commissioning run is now expected to take place shortly.



The APFBC system schematic

BARGE-MOUNTED PFBC

As an offshoot of technology being developed under the U.S. Department of Energy (DOE) Clean Coal Technology Demonstration Program, the DOE Office of Fossil Energy is exploring conceptual designs for barge-mounted power systems that have significant commercialization potential in developing countries. Work is under way by DOE and a Cooperative Research and Development Agreement (CRADA) partner, RimStar America, of California.

As designed, units would have a range of outputs from 40–300 MWe and fit on a marine barge that is transportable by a heavy lift ship. The power barges use coal-fired pressurized fluidized-bed combustion (PFBC) technology, which has been under joint development by DOE and Foster Wheeler. To enhance overall economics, the barges would use an arrangement of industrial turbomachinery specially configured for use with coal-fired PFBC systems, instead of attempting to adapt gas turbines that originally were designed to burn either gas or oil.

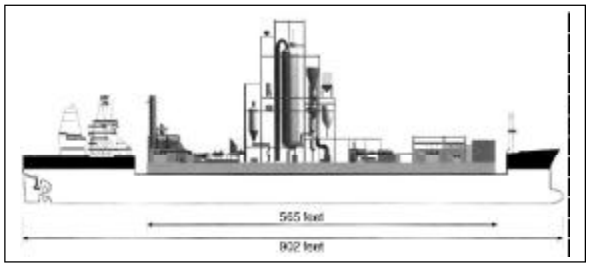
Barge-mounted power plants using gas turbines and diesel engines have already been built, and many such units are in operation today. Coal-fired PFBC power units would be a new breed, but would fit into a relatively small footprint, making barge mounting feasible for this clean, coal-fired technology.

The developing world has a growing need for sources of environmentally clean, economical power generation. At the present time, oil and gas prices have risen to the point where coal-fired generation provides strong operating cost savings. Movable systems would allow developing countries to test PFBC for a short period of time on local coals, and would give investors the flexibility to move the barge as required to protect their asset. The compact size of the PFBC unit allows its placement on a barge that is transportable to any coastal site in the world. Finally, barge mounting enables the units to be manufactured in a U.S. naval shipyard. Financial incentives are available in the form of U.S. Maritime Administration loan guarantees for a major portion of the debt incurred in financing of the units.

BARGE-MOUNTED CONFIGURATIONS

The barge-mounted designs are based on the use of Dresser-Rand Corporation (D-R) industrial turbomachine components. These units, presented in the table below, have been designed to fire Philippine Liguan bituminous coal. The two large units are mounted on a barge with dimensions of 108 feet across the beam by 570 feet from stem to stern; two smaller units fit on barges that are 108 feet by 370 feet.

The 140-MWe PFBC power barge, shown below, is mounted on a heavy lift semi-submersible transport ship, in position to move to virtually any coastal location in the world.



Conceptual drawing of a 140-MWe barge-mounted PFBC power plant

ECONOMIC VIABILITY

The PFBC industrial component barge-mounted designs show significant potential for competitive deployment in the evolving deregulated market for electric power. The current high costs of oil and gas ($5.67 and $4.56 per 10^6 Btu, respectively, as of July 2000) result in total cost of electricity (COE) values ranging from 45–60 mills per kWh by gas turbine combined cycle generating plants. This figure is based on an estimate

Barge-Mounted PFBC Configuration

MWe	Net Efficiency % (HHV)	Steam Cycle psig/°F/°F	Barge Displacement tons	Capital Cost[1] $/kWe	COE[2] cents/kWh
300	39.9	2,400/1,000/1,000	20,880	860	3.5
140	37.8	1,800/1,000/1,000	16,720	1,200	4.6
92	35.8	1,500/1,000/900	12,780	1,380	5.0
43	34.8	1,500/1,000/900	10,760	1,890	6.6

Notes: 1. Capital cost is bare erected basis, including barge, plus engineering and construction management. Does not include certain land-based facilities. 2. COE based on 15-year book life, 80 percent capacity factor.

Coal-Fired PFBC vs. Gas/Oil-Fired Combined-Cycle

System	MWe	Efficiency	Fuel	Fuel $/10^6 Btu	Fuel Cost mills/kWh	Capital Cost[1] $/kWe	COE mills/kWh
GE 7FA262 combined-cycle	262	56.0 LHV	Natural gas	4.50	27.4	475	46
GE 7FA262 combined-cycle	262	55.0 LHV	No. 2 oil	5.50	34.1	550	57
PFBC, steam @ 2,400 psig 1,050 ºF/1,050 ºF	303	40.0 HHV	Bituminous coal	1.30	11.1	1,100	40

Note: 1. Total plant cost (TPC) basis

for an F-class machine, operating as a combined cycle with 54 percent LHV efficiency, at previously noted oil and gas prices.

Total COE values for the largest PFBC unit (300 MWe) is on the order of 40 mills per kWh, based on coal delivered to the site at $1.30 per 10^6 Btu. If the comparison is based on variable costs (fuel plus variable operation and maintenance costs), the advantage for the coal-fired plants is greater. The coal-fired PFBC units will thus be dispatched ahead of the oil- or gas-fired units, and will operate at higher capacity factors.

The table above compares data for the various generation alternatives at a capacity factor of 80 percent. An efficient and reliable coal-fired unit can reasonably be expected to operate at this capacity factor. Unless special circumstances exist, operation of a gas- or oil-fueled combined-cycle unit at 80 percent capacity factor is less likely at the fuel price levels noted in the table.

If current oil and gas price levels are sustained or increase further, serious consideration must be given to new coal-fired generation. The PFBC concept becomes more attractive if it is fired with opportunity fuels such as petroleum coke.

PFBC Boiler and Related Components

The PFBC power barge units use a combined cycle for conversion of thermal energy from the fluid bed to electric power. A Brayton cycle using air and combustion products as working fluid is used with a conventional sub-critical steam Rankine cycle. The cycles are coupled by generation, superheat, and reheat of steam within the PFBC vessel, and feedwater heating in the gas turbine heat recovery unit (HRU).

Inlet air passes through an inlet filter, and then into an axial-flow low-pressure compressor. The air exiting the compressor flows through an intercooler and then into a centrifugal high-pressure compressor. The air then is sent to the PFBC vessel to provide O_2 for combustion and fluid momentum for material transport.

Ceramic filters remove the dust from the PFBC hot gas discharge. The 1,560 ºF gas is returned to the expander inlet section of the turbomachine, where it expands to drive the compressor and an electric generator. The expander exhaust gases are conveyed through an HRU to recover the thermal energy that remains, and then to the plant stack.

Industrial Turbomachines

Gas power trains for the large size PFBC power units (140 MWe and 300 MWe) are driven by one or two compressed air energy storage (CAES) hot gas expanders, manufactured by D-R. This expander is currently operating in daily service at the Alabama Energy Cooperative CAES plant in McIntosh, Alabama. The PFBC combustor furnishes the process gas to the expander for power generation.

The smaller PFBC plants (43 MWe and 92 MWe) use a second D-R product, a hot gas expander originally designed for power recovery from hot gas streams in nitric acid production. The expander is available in four frame sizes, based on the disc diameter of the rotating stages. For the 43-MWe and 92-MWe units, the largest expander (the Model 526) is used singly or in a set of two arranged in series on the shaft (gas flows through them in parallel).

The turbomachinery train is completed by selection of axial-flow LP compressors and centrifugal-flow HP compressors from the D-R line of equipment, and the integration of these machine elements onto a common shaft, along with an electric generator and necessary auxiliaries such as controls, lube oil skid, etc. This and other configurations under study could advance global commercial potential of the coal-fired barge concept.

$PM_{2.5}$ MONITORING EFFORT ADVANCES

In response to growing concerns over health and visibility effects of $PM_{2.5}$ (particulate matter with aerodynamic mean diameter at or below 2.5 µm) emitted into the atmosphere from manmade sources, the U.S. Department of Energy, Office of Fossil Energy (FE) was directed by Congress in 1998 to begin a research program to ensure that the best science and technology are available to aid in regulatory decision making affecting ambient $PM_{2.5}$. In 1997, National Ambient Air Quality Standards were established for $PM_{2.5}$ calling for a 24-hour average concentration limit of 65 µg/m^3 and an annual mean concentration limit of 15 µg/m^3. This standard is to be reviewed in 2002, lending great importance to the data that FE is generating through its monitoring program. Coal combustion produces primary $PM_{2.5}$ (fly ash, carbon soot, associated trace metals), gaseous precursors (SO_2 and NO_x), and secondary fine particulates (ammonium sulfates and nitrates).

The FE monitoring effort is a supplement to the nationwide $PM_{2.5}$ monitoring effort led by the U.S. Environmental Protection Agency (EPA). FE is currently focusing on the mid-Atlantic and Appalachian regions where there is a major concentration of coal-fired power plants, generally upwind of the largest regional complex of urban areas in the United States. Later, FE will expand its $PM_{2.5}$ program to include characterization of emissions and plumes, source-receptor modeling, and evaluation of the impacts of coal plant emissions on ambient $PM_{2.5}$. In a parallel effort, FE will tailor its ongoing work in emissions control technology R&D to respond to the specific control needs identified by the $PM_{2.5}$ monitoring and evaluation program.

FE's monitoring effort is being performed at four sites (two major, two supplemental) under the Upper Ohio River Valley Project (UORVP), and at five sites (one major and four supplemental) under the Steubenville Comprehensive Air Monitoring Project (SCAMP). The ambient air monitoring facility at DOE's National Energy Technology Laboratory (NETL) in South Park, Pennsylvania, forms the third key component of FE's regional monitoring network (see page 8). A fourth project, the Carnegie-Mellon University (CMU)/EPA Pittsburgh supersite, was selected by FE under an FY 2000 solicitation, and will be funded at a yet-to-be-determined level. An interagency agreement between NETL and the Tennessee Valley Authority also provides a key link to ambient monitoring programs, investigations of power plant plume chemistry, and visibility impairment issues in the southeastern Appalachian mountain environment.

Central SCAMP monitoring site, Steubenville, Ohio

UPPER OHIO RIVER VALLEY PROJECT: LAWRENCEVILLE AND HOLBROOK, PENNSYLVANIA

The primary pair of sites in the UORVP are the Lawrenceville (Pittsburgh) urban site operated by the Allegheny County Health Department, and the Holbrook, Pennsylvania, rural monitoring facility located at a site operated by the Pennsylvania Department of Environmental Protection. Lawrenceville and Holbrook contain several types of filter-based PM ambient monitoring equipment ($PM_{2.5}$ and PM_{10}), continuous samplers for co-polluting gases (CO, SO_2, NO_x, NH_3, etc.), and surface meteorological stations.

Lawrenceville (Pittsburgh) monitoring site on roof of Allegheny County Health Department

$PM_{2.5}$ and sequential filter samplers at Holbrook monitoring site, UORVP

Preliminary analysis of the first year of monitoring data shows similar trends at Lawrenceville and Holbrook, with identical absolute median levels of $PM_{2.5}$. Sulfate is the dominant chemical species at both sites during winter months. $PM_{2.5}$ and PM_{10} mass concentrations are higher in summer than in winter, with fall measurements at an intermediate level. Levels appear to be more affected by regional than by local effects. Continuous monitoring equipment (Tapered Element Oscillating Microbalance) and filter-based samplers performed well. The UORVP is scheduled to complete sampling in the summer of 2001, and will enter its principal analysis and interpretation phase later that year.

STEUBENVILLE MONITORING PROJECT

Steubenville, Ohio, was featured in the 1993 Harvard University School of Public Health "Six Cities" study as a location where correlations between ambient $PM_{2.5}$ mass and adverse health effects had been noted. These correlations had been cited by EPA as one of the primary justifications for its 1997 ambient $PM_{2.5}$ standards. The SCAMP project, which includes both outdoor and indoor monitoring,will offer complete characterization of the relationships between ambient $PM_{2.5}$ and human exposure, including the chemical components of $PM_{2.5}$ at various locations, and will provide a comprehensive data base for use in subsequent epidemiological studies, long-range transport studies, and State Implementation Plan development. CONSOL Energy is the primary performer of SCAMP, and will provide the necessary coordination and data integration between the various components of the study.

FE is supporting the outdoor study, which includes daily, and in some cases continuous, measurements of $PM_{2.5}$ mass and composition. Measurements were taken outside the homes of older adult and child study participants (who also will wear personal samplers as part of the indoor study). For the outdoor study, which began measurements in the summer of 2000, CONSOL formed a team with the Harvard University School of Public Health, Ohio University, Franciscan University of Steubenville, Wheeling Jesuit University, and Saint Vincent College. The indoor component of SCAMP is being performed by the Harvard University School of Public Health under subcontract to CONSOL, and is supported by a consortium of non-DOE sources.

CMU/EPA/DOE SUPERSITE

The central Pittsburgh supersite, located on the CMU campus, will expand on the UORVP by adding a wide range of state-of-the-art measurements and increasing monitoring frequency. An ultimate goal is development and evaluation of current and next-generation aerosol monitoring techniques. DOE and EPA will collaborate in the effort with a team from academia, private industry, and local and state air pollution agencies.

Baseline monitoring is planned for an 18-month period that will include detailed characterization of PM size, surface, and volume distribution, and PM chemical composition as a function of size and on a single particle basis. Three 14-day intensive sampling periods are planned to examine temporal variations and to collect data for model testing and validation.

The project will also create a database of ambient PM measurements for source-receptor and deterministic modeling in the Pittsburgh region. Estimates will be made of the impact of the various sources (transportation, power plants, natural, etc.) to the PM concentrations in the area.

In a separate effort not co-funded by FE, EPA will conduct comprehensive modeling, and epidemiology and indoor exposure studies to test critical hypotheses relating to health effects, exposure, and control strategies.

..."News Bytes" continued

expected to help the overall economics for restarting the ENCOAL facility or building a commercial size plant.

Under a competitive solicitation to improve production from low volume stripper gas wells, DOE is funding an important potential spinoff application for SynCoal®, developed by the **Advanced Coal Conversion Process (ACCP) Demonstration**, a DOE Clean Coal Technology project in Colstrip, Montana. SynCoal would filter contaminated wastewater from stripper wells at a cost lower than can be achieved by filtering with activated carbon. This could reduce water disposal costs by as much as 70 percent and prolong the lifetime of thousands of wells. The filtered water is also clean enough for agricultural use, an important factor in the West. The novel filtering system will be tested at a gas production facility owned and operated by NARCo of Denver.

In a separate development, **ACCP** participant Western SynCoal LLC is testing a new reactor design with no moving parts for use in its patented stabilization process. This reactor may also have application as a replacement for the company's vibratory fluid bed reactors. If successful, this reactor technology could radically improve the commercial economics of the SynCoal process and simplify modular commercial-scale designs.

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Comments are welcome and may be submitted to the Editor.

NETL FINE PARTICULATE RESEARCH

The National Energy Technology Laboratory (NETL) state-of-the-art, ambient air, fine-particulate monitoring facility, located at its site in South Park Township, Pennsylvania, is part of the Upper Ohio River Valley network of air sampling stations. The NETL facility started collecting samples of ambient air particles and assessing air quality in June 1999. The sampling station was located to take advantage of an existing meteorological tower that supplies necessary weather data.

NETL team by the 14-bay rack

The air monitoring station consists of a new 715-ft^2 indoor facility housing equipment to continuously monitor gaseous pollutants O_3, SO_2, CO, NO_x, NH_3, H_2S, and peroxide, in addition to $PM_{2.5}$ particles containing carbon and polycyclic aromatic hydrocarbons. A fully instrumented, 14-bay rack was constructed to support a variety of $PM_{2.5}$ monitoring equipment.

Monitoring equipment provides data for several activities. CONSOL Research and the Allegheny County Health Department have co-located U.S. Environmental Protection Agency (EPA)-certified Federal Reference Method (FRM) $PM_{2.5}$ samplers into two of the bay racks to complement the NETL FRM sampler. Other testing is being done under EPA's Environmental Technology Verification Program, which is designed to enable users to make informed equipment purchases. As part of a project funded under the University Coal Research Program, the site is also host to a system developed at Brigham Young University that samples particulate matter and semi-volatile organic compounds in the vapor state. In addition, the Mine Safety and Health Administration's world class balance room is located adjacent to the monitoring station and is used to determine filter sample particle mass.

NETL scientists standing at the Andersen speciation sampler used to collect fine particulate matter

Preliminary results of back trajectory analysis programs provided by the National Oceanic and Atmospheric Administration indicate that most of the $PM_{2.5}$ organic particles collected at NETL are transported from sites located west of Pittsburgh.

UPCOMING EVENTS

–October 17–19, 2000–
Industry Partnerships for Environmental Science and Technology Conference
Location: Morgantown, West Virginia
Sponsor: DOE/NETL
Contact: Event Management
Phone: (304) 285-4750 or (800) 553-7681

–October 4–5, 2000–
High-Temperature Fuel Cell Power Plant Systems Training Workshop
Location: Denver, Colorado
Sponsor: DOE
Phone: (304) 598-8300

–October 30–November 2, 2000–
Fuel Cell Seminar and Exhibition
Location: Portland, Oregon
Sponsored in cooperation with: DOE, EPRI, GRI, Netherlands Energy Research Foundation, and others
Phone: (202) 973-8671
Fax: (202) 331-0111

–November 13–14, 2000–
Coal-Tech 2000 International Conference and Exhibition on Low-Rank Coal Utilization
Location: Jakarta, Indonesia
Sponsors: Indonesian Coal Society, in cooperation with LSDE, NETL, NEDO, and Indonesian Coal Mining Association
Contact: Scott Smouse
Phone: (412) 386-5725
Fax: (412) 386-4561
E-mail: scott.smouse@netl.doe.gov

–December 4–6, 2000–
Advanced Turbine Systems Conference
Location: Alexandria, Virginia
Sponsor: DOE
Contact: Kim Yavorsky
Phone: (412) 386-6044
Fax: (412) 386-6486

ATS PROGRAM — A DOE SUCCESS STORY

The U.S. DOE Advanced Turbine Systems (ATS) Program partnerships have produced the most advanced combustion turbines in the world, incorporating breakthroughs that were barely imagined a decade ago. The program has combined resources of government, major turbine manufacturers and suppliers, and universities. Projects have been leveraged by DOE funds, and cost-sharing by industry participants has increased as technology risks decreased.

Two sizes of turbines emerged commercially through the ATS Program, industrial-scale products less than 20 megawatts (MW), and large, combined-cycle utility-scale products greater than 400 MW. Developers have surpassed the original aggressive goals of the program. These achievements include increased fuel-to-electricity efficiency from about 50 percent to 60 percent for utility-scale gas turbines, and a reduction in nitrogen oxides (NO_x) emissions to single digits (9 ppm or less). ATS participants have developed new heat transfer and aerodynamic codes to enhance turbine designs. Advances include improvements in combustor and compressor efficiencies, cooling of hot-gas-path components, application techniques for thermal barrier coatings, brush seal lead-resistance, alloys and casting techniques to sustain increased turbine temperatures, hot-gas-path component refurbishment, and techniques to monitor temperature. These improvements are reducing manufacturing costs, increasing the life of critical components, and reducing maintenance costs associated with ATS products and existing turbines.

General Electric (GE) unveiled the commercially ready 400-ton advanced, locomotive-size *H System* gas turbine in February 2000, representing a major achievement of the ATS Program. Such ATS products have immediate application in meeting existing and projected electricity generation capacity addition requirements. Over the next two decades, an estimated 300 gigawatts of new capacity will be needed to meet new demand and to replace retired capacity. Natural gas-fired turbine systems are expected to provide more than 80 percent of this new capacity. ATS products will also help bring advanced coal-based power generation technologies into widespread commercial deployment sooner. Both integrated gasification combined-cycle (IGCC) and pressurized fluidized-bed combustion (PFBC) costs and performance are enhanced by increased gas turbine efficiency and reduced capital and operating costs.

NEXT GENERATION TURBINE SYSTEMS

Driving the new Next Generation Turbine (NGT) Program are climate change concerns, deregulation and restructuring of the utility sector, and continuing regulatory pressure to reduce pollutant emissions. Climate change concerns provide incentives for increased efficiency, use of renewable fuels, and development of systems conducive to carbon capture and sequestration. Utility deregulation and restructuring drive power generators and users toward smaller, more flexible, less capital-intensive systems than exist today. These systems are being used in increasing numbers in distributed generation applications. Regulatory pressures demand near-zero emissions.

The NGT Program responds to these drivers by pursuing three basic technology thrusts: (1) Systems Development and Integration; (2) Reliability, Availability, and Maintainability (RAM) Improvement; and (3) Crosscutting R&D. Equipment manufacturers, suppliers, and small businesses will be the primary performers in the systems development and RAM elements. Universities, research institutes, and DOE national laboratories will be the primary participants in the crosscutting R&D element.

- **Systems Development and Integration:** Intermediate size turbine systems (30 MWe to 200 MWe), flexible in operation and fuel use, will be developed that meet the needs of new, emerging, and deregulated power generation markets in the United States. Some systems being studied include gas turbine/fuel cell hybrids and flexible turbine systems. The overall goal of this technology area is to develop and test ultra-clean, high-performance, high-efficiency turbine power systems for near-term power markets and integration into Vision 21 power plants in the longer term.

- **Reliability, Availability, and Maintainability (RAM) Improvement:** As more gas turbines enter the marketplace, the focus will be on maintenance, repair, and power plant operation. The increased complexity of gas turbine plants, the economic imperative of high reliability, and the need to reduce life-cycle costs are the key drivers for improving RAM technology.

- **Crosscutting R&D:** Government and national laboratories, industry, and universities will comprise the work teams to conduct crosscutting research in combustion modeling, materials science, computer simulations, and instrumentation needed to support Systems Development and Integration.

DOE envisions that NGT systems will be used as power modules in its Vision 21 energy plants — non-polluting advanced energy plants that will run on multiple fuels and produce a slate of clean liquids, chemicals, and feedstocks as well as electricity.

INTERNATIONAL INITIATIVES

FE HOSTS FOREIGN SERVICE OFFICER TRAINING COURSE

In cooperation with the U.S. Department of State's Foreign Service Institute and Bureau of Economic and Business Affairs, the Department of Energy hosted the first week-long Coal and Power Sector Training Course in the Pittsburgh, Pennsylvania, area during July 24-28, 2000. The 22 participants were hosted at several extensive site tours to learn about various technologies. They also attended lectures and discussions on timely issues in the international energy arena, such as electricity deregulation, climate change, and emergence of new technologies for clean coal, distributed generation, greenhouse gas reduction and other pollution control, and ultra-clean fuels.

Participants in the inaugural FSO Coal & Power training course, in Pittsburgh, Pennsylvania.

The Foreign Service Institute was established in 1947 to furnish Foreign Service Officers (FSOs) with training throughout their careers. The FSOs explain U.S. policies and interests to foreign nationals and their governments, and also have a function in promoting exports and negotiating international agreements. Increasingly, FSOs are involved in energy matters. The Foreign Service promotes free market economies and works with international institutions to seek progress in meeting global concerns regarding the environment and other international interests. The Foreign Service also acts as an advocate for U.S. business interests and to protect intellectual property rights. According to the State Department, efforts by FSOs resulted in U.S. exports totaling $934 billion in 1998, or 12 percent of the U.S. gross domestic product.

The training course provided participants an overview of the fundamentals of the coal and power sectors worldwide, and provided a forum for discussion among energy specialists from the U.S. government and private industry. Emphasis was placed on technological changes in the coal and power industry specifically related to developing countries. During the week of training, participants made a number of field trips including Ebensburg Power Company's 50-MWe waste coal-fired cogeneration plant; Edison Mission Energy's 2,012-MWe pulverized coal-fired Homer City Plant and on-site coal preparation plant; First Energy/Penn Power's 2,742-MWe Bruce Mansfield Power Plant with its large wet SO_2 scrubber, and National Gypsum Company's adjacent wallboard manufacturing plant; Allegheny Energy's 88-MWe gas turbine Springdale plant; and the Siemens Westinghouse Solid Oxide Fuel Cell pilot manufacturing facility.

Implementation of the FSO training between FE and numerous private companies is a prime example of successful government-industry collaboration. The Coal and Power Sector training preceded an FE-supported Oil and Gas Industry course, held in Houston, Texas, the following week. The Foreign Service Institute intends to offer both training courses annually in the future.

INDIA GREENHOUSE GAS PROJECT TO INCLUDE REGIONAL CENTRES

With support of the DOE Office of Fossil Energy (FE) and U.S. Agency for International Development (USAID), a regional Center for Power Efficiency and Environmental Protection (CenPEEP) was inaugurated in June 2000 in Lucknow in the state of Uttar Pradesh, India. FE's technical advisory role is the result of a Participating Agency Service Agreement with USAID-India, under the Greenhouse Gas Pollution Prevention project, which has just been extended for five years.

India's National Thermal Power Corporation (NTPC) and its largest and most efficient power generation entity established the first (national) CenPEEP in 1994 at its Research and Development Centre in Noida, near New Delhi. CenPEEP is an independent, power industry-funded group of coal/power plant experts who manage various activities for the Indian power industry, including plant design and improvement, R&D, and training. CenPEEP has been serving as a resource for technical knowledge and demonstration in support of improved

power sector management, increasing operating efficiencies, and strengthening environmental protection. The Centre in Uttar Pradesh, and another planned for Patna, Bihar, will act to expedite training throughout India.

DOE team members have been instrumental in demonstrating the value of efficiency and environmental improvements at selected NTPC and State Electricity Board plants, and in developing "Heat Rate Improvement Guidelines for Indian Power Plants." During 2001, FE and USAID will provide training in power plant efficiency such as improved operating and maintenance practices, as well as environmental monitoring. Efficiency improvements in Indian plants will help meet the 15 percent improvement goal established in March by the U.S. and Indian governments (see Summer 2000 issue of *Clean Coal Today*).

APEC COAL FLOW SEMINAR: A TOOL FOR REGIONAL STABILITY

Proceedings are being published for the Asia Pacific Economic Cooperation's (APEC) Sixth Coal Flow Seminar, held this Spring in Kyongju, Korea. APEC was formed in 1989 to address issues of regional interdependence, and its members include 18 countries bordering the Pacific Ocean. The seminar, where policymakers discuss the flow of coal imports and exports among APEC nations, is funded by the U.S. Department of Energy (DOE), along with Japan's Ministry of International Trade and Industry, and Korea's Ministry of Commerce, Industry, and Energy. The DOE Office of Fossil Energy (FE) is the main U.S. government presence at the seminar and every year has provided technical speakers.

There were 120 participants from nine APEC economies at this year's conference, the theme of which was "Coal in the New Millennium." With economies rebounding from the Asian economic crisis, APEC is looking for new coal demand projections. Seminar participants believe that a shared view of future coal supply and demand, as well as pricing and environmental concerns, can contribute to greater market stability in the region.

Speakers addressed broad challenges affecting coal in APEC nations, such as excess capacity as a result of lower growth rates during the recent economic crisis, environmental concerns, and insufficient infrastructure. However, on the positive side, the economic crisis resulted in liberalization/privatization reforms so that the energy sector is expected to become more competitive.

FE's Dr. Sun W. Chun, Chairman of APEC Experts Group on Clean Fossil Energy, gave one of the opening addresses and noted that APEC is the fastest growing region in the world in energy terms. Clean coal technologies can help achieve sustainable development in the region, and support the strategic importance of the region's indigenous coal in the context of a vulnerable oil market.

Another keynote address by Dr. Charles Johnson of Honolulu's East-West Center (EGCFE), one of the conference organizers, focused on the overriding issue of greenhouse gas constraints and the competitive position of coal in Asia. Johnson noted that local and regional environmental restrictions for SO_2 and particulates, as well as increased competitiveness of natural gas, pose a greater threat to coal expansion than does the Kyoto Protocol. According to Johnson, most economies are following a gradual approach to carbon emission reductions, which should allow time for introduction of clean coal technologies. Under likely scenarios, Johnson expects coal consumption to double within the next 25 years.

A number of seminar speakers provided the individual country perspective. Among them were FE's Dr. C. Lowell Miller, who noted that the U.S. coal industry has successfully responded to major challenges since the 1960s. He explained that the new slate of near zero-polluting clean coal technologies to be developed under FE's Vision 21 program can provide new markets for coal in the 21st century. Korea noted its desire to diversify import sources and develop overseas coal mines; but government assistance may be required for overseas investment. China spoke of a rise in exports, with government infrastructure investments. A representative from the Russian research community addressed problems of industry restructuring, while Australia discussed productivity improvements. Japan expects to continue importing coal but at lower rates.

Proceedings are available from the APEC homepage (www.apecsec.org.sg) or the EGCFE homepage (www/2.ewc.hawaii.edu/apec); limited number of hard copies available by faxing EGCFE at (808) 944-7380.

R&D MILESTONES

R&D 100 Award granted to NETL Researchers. *R&D Magazine* recently recognized a regenerable desulfurization sorbent, developed and patented by the U.S. DOE Office of Fossil Energy, as one of the 100 most technologically significant products and processes of the year. Awardees will be acknowledged and processes described in the September issue of *R&D Magazine*. The process removes hydrogen sulfide from coal gasification gas streams. In addition to the excellent performance of the sorbent, commercially prepared by United Catalysts Inc., the costs are expected to be considerably lower than that achievable for conventional sorbents. The R&D 100 Awards were established in 1963. Over the years, the R&D 100 Awards have recognized winning products such as Polacolor film (1963), the flashcube (1965), the automated teller machine (1973), the halogen lamp (1974), the fax machine (1975), the liquid crystal display (1980), the full-color graphics printer (1986), the Kodak Photo CD (1991), the Nicoderm antismoking patch (1992), Taxol anticancer drug (1993), lab on a chip (1996), and HDTV (1998).

The High Performance Power Systems (HIPPS) project has exceeded performance goals, making this indirectly fired cycle system a viable stepping stone to Vision 21. Working under DOE sponsorship, system developers, UTRC (a Division of United Technologies Corporation) and their subcontractor UNDEERC, have announced that HIPPS can achieve an overall efficiency in excess of 45 percent when burning coal. Central to a HIPPS plant is a High-Temperature Advanced Furnace (HITAF) that heats the compressed working fluid (air) to the turbine inlet tempterature. The radiant heater panel of the HITAF has been successfully operated to heat the working fluid to 2,000 °F, surpassing design expectations. The HIPPS system design would potentially improve efficiency, reduce carbon dioxide and other air pollutant emissions, and reduce the cost of electricity. Technical work on HIPPS concludes at the close of this year, and a final report on the project should be issued next spring.

In August 2000, seven new projects were chosen for negotiation under the second of three rounds of Vision 21 proposals. These projects will develop technologies needed for Vision 21ultra-clean energy plants of the future. The first group of six projects were selected last March, and a third group should be selected by next spring. Under the current round, four projects will focus on technology components — alloys for heat exchangers, gasification modules, ceramic membranes, and advanced gasification-combustion concepts. The other three projects will address advanced plant design and visualization software — a "virtual workbench" to simulate performance of various components, a computational tool to design low-emission-combustion systems for gas turbines, and tools for modeling flows in gas particle systems such as gasifiers and fluidized-bed combustors. The 13 projects selected thus far have a total value of $32 million — $24 million from DOE and $8 million cost-shared.

FE-sponsored research contributes to construction by Reema International of a 10,000 barrel/day gas-to-liquids plant in Trinidad. The proposed plant will use Fischer-Tropsch (F-T) technology to convert 100 million cubic feet/day of natural gas into 10,000 barrels/day of sulfur-free and aromatic-free diesel, jet fuels, naphtha, and other high-quality specialty products. Additionally, the plant will produce 420,000 gallons/day of clean, industrial-quality water. The F-T technology produces a clean diesel fuel that can be blended with crude oil-based diesel, thereby upgrading it to meet environmental and health standards. Reema acknowledged that FE-supported R&D at the University of Kentucky Center for Applied Research and at the DOE-owned facility in LaPorte, Texas, operated by Air Products & Chemicals, contributed to the realization of this plant.

In July 2000, DOE's Office of Fossil Energy selected for funding 13 new carbon sequestration research projects. Research to date has consisted of early exploratory ventures funded mostly by federal funds. The new projects, to be funded for up to $15 million over the next three years, are larger scale partnerships with private research institutions, industries, and universities sharing a major portion of the research costs. The awards are the first phase of a competition begun last December. Projects include high-temperature membranes, as well as low-cost, reusable chemicals for CO_2 separation; storage of CO_2 in coal seams and in saline reservoirs; magnetic resonance techniques to identify suitable geologic storage locations; analytical techniques to determine long-term fate of CO_2 injected in the ocean; analysis of frozen CO_2 hydrates on the ocean floor; a reforestation program in abandoned mine lands; use of a "bioreactor" to enhance CO_2 conversion; photosynthesis of CO_2 from power plant exhaust; and modeling and sequestration database development.

FE HOSTS ANNUAL NO_x SPECIALTY CONFERENCES

On May 16-18, 2000, the DOE Office of Fossil Energy's National Energy Technology Laboratory (NETL) sponsored its annual pair of conferences on reducing air pollution caused by nitrogen oxides (NO_x). The conferences, held in Pittsburgh, Pennsylvania, devoted the first day to Unburned Carbon (UBC) on Utility Fly Ash, and the following two days addressed Selective Catalytic and Selective Non-Catalytic Reduction (SCR/SNCR) for NO_x control. A record 183 representatives from industry, the research community, and government attended the UBC Conference, 341 attended the SCR/SNCR Conference, and 116 individuals attended both conferences.

The NO_x limits under Title IV of the Clean Air Act Amendments, which address acid rain, are being met generally by low-NO_x burners instead of the more expensive post-combustion NO_x controls such as SCR and SNCR. Low-NO_x burners, however, often lead to excessive quantities of unburned carbon on fly ash. Unburned carbon, also referred to as loss-on-ignition (LOI), has been receiving increased attention because it reduces the efficiency of boilers and can render fly ash unsalable. In any event, compliance with Title I of the CAAA, which addresses ozone/smog, will require use of the more expensive post-combustion techniques.

In a keynote speech at the first (UBC) conference, Llewelyn King, Publisher of *Energy Daily*, cited the importance of electric power and the role of clean coal in meeting power needs. Technical sessions addressed topics including control measures, new uses for high-carbon fly ash, and post-combustion treatment. On the technical panels, one speaker noted that the U.S. Environmental Protection Agency (EPA) estimates $1 billion/year in disposal costs if coal combustion by-products become classified as hazardous wastes. A university researcher described a correlation procedure to predict carbon burnout characteristics based on the amount of light reflected from a coal sample. Several speakers spoke on beneficial uses of high-carbon fly ash in cement manufacture. Another presenter described an approach for identifying promising alternative beneficiation processes according to carbon content, particle size distribution, and other fly ash characteristics.

UBC conference keynote speaker, Llewelyn King, publisher of "Energy Daily"

At the second conference on SCR/SNCR, keynote speaker Peter Tsirigotis, Chief of the Program Development Branch in EPA's Clean Air Markets Division, emphasized that EPA is firm on the feasibility of meeting the May 1, 2003, target date for the NO_x SIP call. He said that new bills in Congress aim for more stringent limits on SO_2, NO_x, and mercury. The second keynote speaker, Jerry Golden, Manager, Production Technology at the Tennessee Valley Authority, noted that SCR, although costly, still offers the least-cost solution on a system-wide basis. Technical speakers covered issues such as commercial applications of the two technologies, ammonia generation systems, new catalyst developments, and innovative technologies for NO_x control. One company pinpointed the maximum tolerable level for ammonia slip as 2 ppm. Ammonia slip is detrimental to coal-based SCR operations because the resulting ammonium bisulfate, formed by reaction with SO_3 in the flue gas, is a sticky solid that plugs the air heater and is difficult to remove. That company recommended operating at no more than 80 percent NO_x conversion, to minimize the ammonia slip problem. Another speaker discussed the SNCR demonstration at AEP's Cardinal Plant (see Summer 2000 *Clean Coal Today*) where operation has been successful. Capital costs at Cardinal were $11/kW, of which $1/kW was attributed to pressurized boiler operations.

SCR/SNCR conference keynote speaker, EPA's Peter Tsirigotis

SCR/SNCR keynote speaker, Jerry Golden, of Tennessee Valley Authority

Conference proceedings are available on NETL's website (http://www.netl.doe.gov) under Publications. Plans are under way for next year's conferences, scheduled for May 15-18, 2001, in Pittsburgh.

STATUS OF ACTIVE CCT DEMONSTRATION PROJECTS

ENVIRONMENTAL CONTROL DEVICES

Southern Company Services, Inc. – *Demonstration of Advanced Combustion Techniques for a Wall-Fired Boiler.* All testing on the original project has been completed and reported. Phase 4 has been extended 19 months to evaluate use of GNOCIS and other computer programs to decrease NO_x and LOI and increase efficiency by optimizing the use of additional plant equipment, including ESPs and sootblowers. (Coosa, GA)

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 continues to evaluate its options to meet future power demand. During this internal review, Lakeland, Foster Wheeler, DOE, and others have been reviewing the system concept, siting, and financial issues in order to improve the project. (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. Unit 2 is scheduled for operation in early 2002, to be followed by two years of demonstration. (Jacksonville, FL)

Kentucky Pioneer Energy, L.L.C. – *Kentucky Pioneer Energy Projec*t. Kentucky Pioneer Energy, L.L.C., has replaced the Clean Energy Partners, LP, as the project participant and has moved the site to a new location in Trapp, Kentucky. A Draft EIS will be issued in late 2000. (Trapp, KY)

Sierra Pacific Power Co. – *Piñon Pine IGCC Power Project.* Sierra continues to implement the repairs needed for sustained operation of the gsaifier. Earlier this year, Sierra replaced 18 feet of refractory in the gasifier. The plant restarted in August, but had to be shut down due to over-temperature damage to the clean gas plenum in the hot gas filter vessel. Several filters were broken. Sierra hopes to re-start the plant again in November. The project will end January 1, 2001. The plant continues to operate normally in the gas-fired combined-cycle mode. (Reno, NV)

Tampa Electric Co. – *Tampa Electric Integrated Gasification Combined-Cycle Project.* Tampa's Polk Power Station has completed over three and one-half years of successful commercial operation. The gasifier has provided syngas to the combustion turbine to produce electricity for over 21,000 hours. (Mulberry, FL)

Wabash River Joint Venture – *Wabash River Coal Gasification Repowering Project.* The Wabash River Cooperative Agreement expired on January 1, 2000. The participant has submitted a draft copy of the final report, which has been reviewed by DOE and returned to the participant for final revision. (West Terre Haute, IN)

Alaska Industrial Development and Export Authority (AIDEA) – *Healy Clean Coal Project.* Demonstration operation under the Cooperative Agreement was completed in December 1999, and final reporting is under way. Copies of topical reports describing the key technical activities carried out during the project's two years of demonstration operations are available on the Clean Coal Technology Compendium at http://www.lanl.gov/projects/cctc/. As the result of a settlement reached in March 2000, AIDEA turned the plant over to Golden Valley Electric Association, Inc. for custodial care in April 2000. Golden Valley has engaged a consultant to determine the technical, regulatory, and economic feasibility of a "full retrofit" to a conventional low-NO_x burner and lime spray dryer emission control system, and of a "limited retrofit" that retains the TRW entrained (slagging) combustors, but re-designs the coal handling system. The plant will not operate until this determination is complete and the appropriate modifications are made. (Healy, AK)

Arthur D. Little, Inc. – *Clean Coal Diesel Project.* Performance checkout of the diesel engine began in June 2000 and will continue through September 2000. Fuel oil is being used to ensure that the diesel engine is in running condition. Work is continuing on designing the hardened parts for diesel operation on coal slurry fuel. Upon completion,

work will begin to modify the engine so it can operate on coal slurry. Pilot testing of the coal slurry fuel on a small diesel engine is scheduled to take place this fall. (Fairbanks, AK)

COAL PROCESSING FOR CLEAN FUELS

Western SynCoal LLC (formerly Rosebud SynCoal® Partnership) – *Advanced Coal Conversion Process (ACCP) Demonstration.* The ACCP Demonstration Project in Colstrip, Montana, has processed nearly 2.6 million tons of raw subbituminous coal. Over 1.7 million tons has been supplied to customers, including industries (primarily cement and lime plants) and utilities. A new customer is now using SynCoal as a fuel supplement in its gold ore roaster process. The supplemental fuel system at Colstrip Unit 2 has been in operation for over a year and has been performing well. Unit 2 has consistently 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. Two recent planned outages were undertaken to perform tests to support the upcoming *in situ* catalyst activation and evaluate the ramping capabilities of the demonstration unit, as well as to change out adsorbent materials in the catalyst guard bed. A catalyst withdrawal/addition campaign was also completed in July 2000 to maintain catalyst activity in the reactor. Since being restarted with fresh catalyst in December 1997, the demonstration facility has operated at greater than 99 percent availability, and since April 1997, the facility has produced over 62 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 ongoing plant operation. (Kingsport, TN)

INDUSTRIAL APPLICATIONS

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. CMC is discussing teaming arrangements with several engineering and IPP firms. (Vineyard, UT)

ThermoChem, Inc. – *Pulse Combustor Design Qualification Test.* Installation of the steam reformer, 253-tube pulse combustor test vessel, and structure is in progress. Installation is scheduled for completion in October 2000. Testing of the 253-tube pulse combustor will begin in late October 2000. Shakedown tests of the Process Data Unit using Black Thunder, Wyoming subbituminous coal were completed in April 2000. The Process Data Unit is being modified to improve operability. The test plan is being revisited and testing is expected to resume in October 2000. (Baltimore, MD)