



CLEAN COAL TODAY

A NEWSLETTER ABOUT INNOVATIVE TECHNOLOGIES FOR COAL UTILIZATION

PROJECT NEWS BYTES

On April 27, 1998, the **Piñon Pine Integrated Gasification Combined Cycle** power plant was officially dedicated in a ceremony attended by 250 local, state, federal, and international visitors. Dedication remarks were offered by senior level officials from the Sierra Pacific Power Company, U.S. Department of Energy, M.W. Kellogg, and Foster Wheeler USA. Since this event immediately preceded the Sixth Clean Coal Technology Conference, a significant number of foreign visitors attended. They showed interest in the air-blown, fluidized-bed gasification technology, which can be used with high ash, lower grade coals common abroad.

Since startup of the entrained slagging combustion system began in January 1998 at the **Alaska Industrial Development and Export**

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CHALLENGES AND OPPORTUNITIES FOR CLEAN COAL TECHNOLOGY

Some 340 attendees from 22 countries participated in the Sixth Clean Coal Technology Conference held in Reno, Nevada, April 28–May 1, 1998. Co-sponsors included the Center for Energy & Economic Development, the National Mining Association, the Electric Power Research Institute, the Council of Industrial Boiler Owners, and the U.S. Department of Energy (DOE). Sierra Pacific Power Company hosted the conference and a site visit to its Tracy Station, Piñon Pine Integrated Gasification Combined-Cycle (IGCC) Project.

DOE Assistant Secretary for Fossil Energy, Patricia Fry Godley, set the stage for the conference by recognizing Clean Coal Technology (CCT) Program accomplishments, and challenging participants to define what it will take to finish the job — deploy commercial CCTs on a large scale into U.S. and global markets. Participants were encouraged to find ways: (1) to leverage the investment in CCTs and the attendant databases; (2) to work with international organizations toward increased use of CCTs in near-term overseas markets; and (3) to develop innovative incentives and financial mechanisms for CCTs, aside from subsidies.



DOE Assistant Secretary for Fossil Energy, Patricia Fry Godley

Godley also outlined DOE's efforts to build on the CCT experience toward achieving "Vision 21," where energy-plexes would squeeze every available Btu out of coal, and produce multiple products in lieu of emissions and waste. But it was recognized that Vision 21 efficiency improvements alone may not be enough, which has prompted exploration of CO₂ sequestration options.

DOMESTIC MARKET

Panel discussions identified two basic issues that currently drive technology decisions in the domestic utility market — environmental concerns and utility restructuring. Deliberation of environmental concerns focused on the most significant challenges. Utility restructuring discussions addressed potential implications for power generators. The following highlights some of the findings.

See "Conference" on page 2...

...Conference continued

Environmental Concerns. The CCT Program has provided a portfolio of technologies to effectively deal with acid rain concerns. Challenges remain, however, in achieving ozone standards (a NO_x control issue), fine particulate control (PM_{2.5}), and CO₂ emission reduction.



Ozone nonattainment prompted the U.S. Environmental Protection Agency (EPA) to issue a NO_x transport State Implementation Plan (SIP) call for 22 states to meet the following standards:

Date	NO _x Emissions
May 1999	0.2 lb/10 ⁶ Btu
2003	0.15 lb/10 ⁶ Btu
2007	Cap emissions

Utilities expressed concern that the proposed compliance schedule does not allow sufficient time to develop a cost-effective response. Selective Catalytic Reduction (SCR) represents the only option currently available, and little experience exists with U.S. high-sulfur coals. Capping NO_x emissions in 2007 may push technology beyond the capability of SCR.

Evaluation of PM_{2.5} fine particulate emissions may lead to a requirement for additional SO₂ reductions associated with sulfate formation from stack gases. Even complete particulate emission control cannot prevent compounds precipitated from post-stack chemical reactions.

CO₂ reduction per the Kyoto Protocol may spell disaster for coal-based power generation in the absence of trading between developed and developing countries under a proposed Clean Development

Mechanism (CDM) and/or sequestration. (See the article on CO₂ trading on page 10.)

Utility Restructuring. Utility restructuring is moving rapidly forward with some 40 percent of the states sponsoring conceptually and functionally different legislation. Some argue that federal legislation is needed to provide some consistency in what they consider will be a “crazy quilt” of implementing mechanisms. State legislation is driven by different rate structures, fuel mixes, stranded cost implications, and environmental policies. Federal legislation is being deliberated.

The electric power industry embraces the concept of open competition, but some speakers expressed concern that legislation is skewing the market away from market-based outcomes by establishing “Renewable Portfolio Standards,” which would require sellers to include an increasing proportion of above-market cost renewable generation in their annual sales over time.

Competition will spur generators to increase capacity factors on existing plants to meet increased demand and also upgrade existing plants where there is significant potential to increase both efficiency and capacity. Existing coal-fired plant upgrades might lead to efficiency improvements of 2-4% and capacity increases of 10-13%.

Restructuring has the potential to remove barriers to distributed power systems. Distributed power can produce significant efficiency improvements relative to central power generation because there are no line losses and heat, steam, and other by-products can be readily used.

Competition will drive a paradigm shift for power generators to a commodity viewpoint with commodities being electricity, heat, steam, and



chemical by-products. A market-based utility will deal with electricity as a commodity as well as the by-products that have been considered commodities in the past. Providing a multiplicity of commodities enhances market potential.

In a market-based utility industry, coal-based technologies must meet the challenge of \$800/kW capital cost (at acceptable risk) while complying with all environmental standards and without guarantee of cost recovery. The Coal Utilization Research Council shows 30-year levelized cost of electricity for advanced coal-based systems (7,000 Btu/kWh heat rate) to be competitive with natural gas-fired systems by 2020 at \$800/kW, and year 2000 coal and gas prices of \$1.30/10⁶ Btu and \$2.25/10⁶ Btu respectively. To achieve \$800/kW, more CCTs must be installed and designs refined to mitigate risk and cost. The importance is underscored by the fact that financing will be more difficult in a deregulated environment, where customers are no longer required to cover capital investments in the rate base.

Employing integrated gasification combined-cycle to co-produce power and syngas-derived products may provide an avenue for this technology to enter the marketplace. The key initially is to find low-cost disadvantaged fuels such as heavy petroleum liquids or petroleum coke. For some applications, syngas conversion alone may be the best option. These applications will serve to reduce the risk and cost of IGCC technology. There is some movement domestically toward installing gasification-based systems for co-production at refineries and paper mills.

INTERNATIONAL MARKET

An International Business Forum was held to identify emerging opportunities for CCTs worldwide. The following presents some of the key points made during the Forum.

Market Definition. While the domestic market for CCTs is not promising, the international market for CCTs has tremendous near-term potential. Basic elements exist in many developing countries for CCTs to play a major role in meeting energy

demands. For many, coal is the primary indigenous fuel, and the need for jobs and mitigation of poverty may reduce the stigma global climate change associates with coal.

The total world power market between now and 2010 is estimated to be 950 GW. Of that total, 50 percent resides in Asia, 30 percent in Europe, and 20 percent in the Americas. Within Asia, China alone has 16 percent of the total world market, Japan, Indonesia, and Korea have 17 percent, and India alone has 6 percent. These numbers, plus reliance on coal in the Asian market, make Asia the primary target for CCTs.

Realizing Market Potential. Realizing market potential for CCTs requires action to mitigate the higher risk and cost of CCTs. Environmentally superior performance of CCTs serves as an incentive, but costs must be competitive with other options. Cost saving measures can be taken, such as using disadvantaged fuels, producing multiple commodities, and firmly defining projects to reduce contingencies. Trading mechanisms for CO₂, such as the 161-nation "Global Environmental Facility" and others proposed under the Kyoto Protocol, hold promise for obtaining incremental cost decreases for CCTs, assuming CO₂ reduction requirements or incentives are formalized.

Fluidized-bed combustion technology, the most mature CCT power system technology, has made inroads into foreign markets because of its tremendous fuel flexibility and proven track record. This demonstrates the possibilities for the more advanced systems. IGCC is already making progress through use of disadvantaged fuels and production of multiple commodities. There are some 20 known IGCC projects, 10 already in place, and 10 more in the planning stage.

CCTs TECHNICAL PROGRESS UPDATE

Presentations at the Sixth Clean Coal Technology (CCT) Conference updated progress on the 18 active CCT projects. The balance of the 39 total projects under the CCT Program have completed operation and have either issued final reports or are in the process of report preparation. The following writeup highlights the technical advances realized by the CCT Program.

To date, 15 of 19 *Environmental Control Device* demonstrations have completed operation. These projects, as well as ongoing efforts, have made significant contributions toward cost-effective SO₂ and NO_x control, which was the initial thrust of the CCT Program. A portfolio of proven control options has resulted that are responsive to the full range of boiler types, and a database has been established to address future challenges. The projects served to provide input to establishing emissions standards under the Clean Air Act Amendments of 1990 in the areas of NO_x and air toxics emission control. The remaining active projects in this area will provide additional information that will significantly enhance the knowledge base in critical areas such as the effectiveness of digital control systems, multiple control system integration, micronized coal reburning, and regenerable flue gas cleanup.

In the area of *Advanced Electric Power Generation*, encompassing 11 projects, 2 pioneering projects are completed, 4 projects are operational, and 5 are in design. One of the two completed pioneering projects, the *Nucla CFB Demonstration Project*, provided the database and operating experience to make atmospheric fluidized-bed technology a commercial option at small utility scale. The other completed project, the *Tidd PFBC Demonstration Project*, established the potential of pressurized fluidized-bed combustion (PFBC) as a highly efficient, very low polluting combustion technology, and laid the foundation for commercialization.

The *Jacksonville Electric Authority Large-Scale CFB Combustion Demonstration Project*, currently in design, moves atmospheric fluidized-bed combustion technology to the larger sizes of utility boilers being considered in capacity additions and replacements. The 300-MWe demonstration unit in the Jacksonville project will be more than double the size of the Nucla unit (110 MWe). Features include an integrated recycle heat exchanger (INTREX™) in the furnace, steam-cooled cyclones, a parallel-pass reheat control, an SO₂ polishing scrubber, and a fabric filter for particulate control. Expected environmental performance is 0.17 lb/10⁶ Btu SO₂ (98% reduction), 0.11 lb/10⁶ Btu NO_x, and 0.017 lb/10⁶ Btu particulates (0.013 lb/10⁶ Btu PM₁₀).



The Ohio Power Company's Tidd PFBC Demonstration Project

The city of Lakeland's *McIntosh Unit 4 Demonstration Project*, currently in design, takes PFBC to a larger scale than the *Tidd* project and introduces second-generation PFBC technology. Current plans call for a 169-MWe net generating capacity for the pressurized circulating fluidized-bed unit at the McIntosh plant, which is more than double the scale of the *Tidd* PFBC (70 MWe). A second project will include the addition of a topping cycle that incorporates a carbonizer and topping combustor. Recent efforts focused on testing of the hot gas particulate filtration unit, which is critical to system performance. Silicon carbide and alumina/mullite candle filters proved effective under conditions simulating those of the demonstration unit. At both 1,550 °F and 1,400 °F, the candle filters performed for over 1,000 hours at design levels without evidence of ash bridging. Four new oxide-based candle filters showed promise. These will undergo further testing because of the potential for reduced cost and operation at higher temperatures.

Three of four IGCC projects are in various stages of operation under the CCT Program. They represent a diversity of gasifier types, cleanup systems, and applications. PSI Energy's 262-MWe *Wabash River Coal Gasification Repowering Project* began operation in November 1995 and continues in its third year of commercial service. The utility preferentially dispatches the unit over other coal-fired units because of high efficiency. The unit, which is the world's largest single train IGCC, has produced approximately 1.6 million megawatt hours of electricity through early 1998, and in March 1998 alone generated a record one trillion Btus of syngas

fuel. Refinements to the design are continuing, to include replacement of ceramic candle particulate filters with a metallic filter (operating temperature 800 °F) and installation of a chloride scrubber and new COS hydrolysis catalyst for SO₂ control.

The 250-MWe *Tampa Electric Integrated Gasification Combined-Cycle Project* began commercial operation in September 1996 and continues to successfully accumulate run time. System availability steadily increases over time, reaching 75 percent for the past 6 months. This was largely due to removal of the raw gas/clean gas heat exchanger and installation of a larger filter to prevent particulate leakage to the turbine. Recent tests included evaluation of various coal types on system performance.

After experiencing start-up problems, the Sierra Pacific Power Company (SPPC) readies for sustained operation of its IGCC system on syngas. The 99-MWe *Piñon Pine IGCC Project* at SPPC's Tracy Station began operation on natural gas in November 1996. The GE Frame 6FA, the first of its kind in the world, performed well. The plant has undergone shakedown, design modifications have been made, and start-up logic for the KRW air-blown pressurized fluidized-bed gasifier has been revised. The system will be operated on syngas as much as possible through September 1998 when it will be inspected.

The *Healy Clean Coal Project* also entered the ranks of the operational power generation systems. The entrained slagging combustor system began operation in January 1998



Wabash River Coal Gasification Repowering Project Joint Venture IGCC plant



Tampa Electric Company's Integrated Gasification Combined-Cycle Plant

in the demonstration testing phase and has met or exceeded performance specifications.

In the **Clean Fuels** area, two of five projects in the CCT Program completed operation and the others have entered the operations phase. Completion of *Development of the Coal Quality Expert™* has provided a valuable tool for selecting coals for site-specific performance needs. The successfully concluded *ENCOAL® Mild Coal Gasification Project* offers a means for co-producing clean, coal-derived solid and liquid fuels. *Custom Coals International's Self-Scrubbing Coal™ Project*, which successfully produced and sold a nearly ash-free product, was recently restructured. The *Advanced Coal Conversion Process Demonstra-*



Sierra Pacific Power Company's Piñon Pine IGCC Plant

tion nears completion with an impressive record of production and sales for its upgraded, clean Syncoal® product. Finally, the *Liquid Phase Methanol Process Demonstration Project* has completed a record-setting first year of operation producing high quality methanol and offering co-production options for IGCC (see page 6).

Of the four **Industrial Applications** projects, two are complete, one is in design, and one is in operation. Completion of the *Cement Kiln Flue Gas Recovery Scrubber* project provided a cost-effective means to control SO₂ emissions from coal-fired cement plants. The *Advanced Cyclone Combustor* emerged with the potential to replace oil and gas-fired units in industrial boilers. An alternative iron-making process is being pursued through the *Clean Power From Integrated Coal/Ore Reduction* project, currently in design. Bethlehem Steel Corporation's *Blast Furnace Granulated Coal Injection System Project*, designed to substitute coal for coke, continues to perform successfully.

LPMEOH™ DEMONSTRATION PROJECT COMPLETES FIRST YEAR OF OPERATION

April 2, 1998, marked the first anniversary of operations at the Liquid Phase Methanol (LPMEOH™) Process Demonstration Plant at Eastman Chemical Company's chemicals-from-coal complex located in Kingsport, Tennessee. From its rapid initial start-up in which the design methanol production rate of 80,000 gallons-per-day was achieved within four days of the introduction of coal-derived synthesis gas, to a record-setting period of continuous operation, the LPMEOH™ Process Demonstration Plant is opening new windows of opportunity for the production of fuels, chemicals, and electric power.

This commercial-scale demonstration of the LPMEOH™ process is managed under a cooperative agreement with the Air Products Liquid Phase Conversion Company, L.P., a partnership between Air Products and Eastman. The project was selected in Round III of the Clean Coal Technology Program. This scale-up of the LPMEOH™ process is based on over 7,000 hours of operation by Air Products of the Department of Energy's 3,200 gallon-per-day facility in LaPorte, Texas.

The demonstration's novel reactor combines the reaction and heat-removal systems, distinguishing LPMEOH™ from other commercial methanol-production processes that send synthesis gas through a fixed bed of dry catalyst particles. The excellent heat management capability of the liquid phase reactor provides a significant improvement, particularly for methanol catalysts where strict temperature control is needed. In contrast to fixed beds, the liquid phase is comprised of a micron-size, temperature-sensitive methanol catalyst suspended in an inert mineral oil. Because of its superior heat management capability, the LPMEOH™ reactor can directly process carbon monoxide-rich synthesis gas typically produced in modern gasifiers.

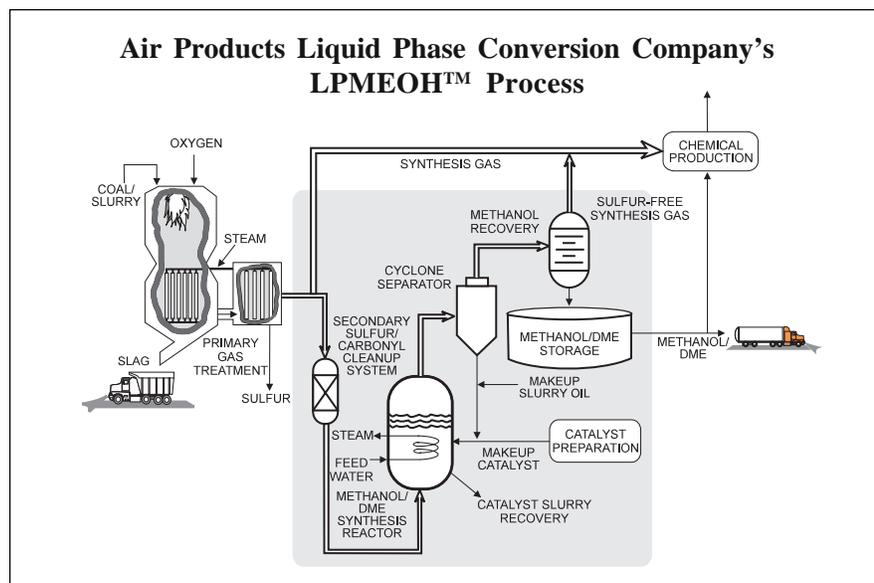
Since initial operations began in April 1997, the LPMEOH™ Process Demonstration Plant has produced over 15 million gallons of methanol, nearly all of which has been accepted by Eastman for use in its commercial chemical synthesis of acetic anhydride. The demonstration plant also has achieved an



The LPMEOH™ demonstration plant at Eastman's vast chemicals-from-coal complex in Kingsport, Tennessee

availability in excess of 93 percent. The hydrogen to carbon monoxide ratio in the reactor feed stream has varied from 0.4 to 5.6 with no negative effects on performance. Important parameters such as high inlet superficial velocity of reactor feed gas, maximum expanded slurry level, and the overall heat transfer coefficient of the internal heat exchanger have been demonstrated at 115-120 percent of design levels. Also during the first year, operational issues related to slurry flows and solids accumulation within the demonstration plant were resolved. The solutions implemented are expected to result in significant benefits for future designs, including significant capital cost savings, increased operating flexibility, and lower maintenance costs.

The potential for catalyst contamination from trace poisons present in coal-derived synthesis gas continues to be a major long-term performance issue for the project. Results from the initial startup were good, verifying the activation procedure for the catalyst. During the first months of operation, however, the catalyst



showed a higher deactivation rate than was expected. For the next six months, improvement was shown, but deactivation still remained greater than the target rate determined from pilot-plant testing on clean synthesis gas derived from natural gas.

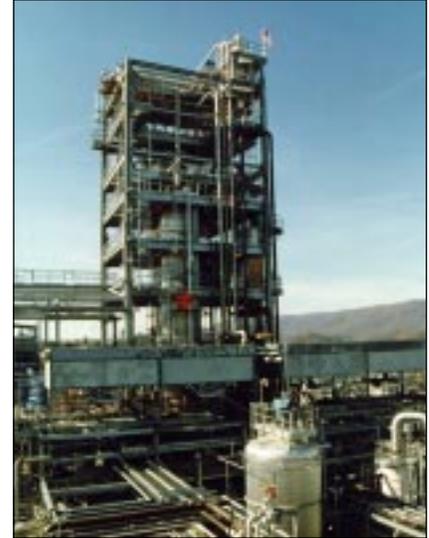
The unique ability of the LPMEOH™ process to remove catalyst from the reactor during operation allowed scientists to examine catalyst samples for clues about the deactivation mechanism. Based on results of the examinations, the reactor was drained and recharged with fresh catalyst in December 1997.

Catalyst performance since the December 1997 restart has been excellent, achieving an average deactivation rate as low as about 0.4 percent per day. Methanol production again exceeded nameplate capacity, and the availability of the LPMEOH™ Demonstration Plant exceeded 99.9 percent through the

first three months of 1998. A record-setting 65-day period of continuous operation was completed in late April.

The encouraging results obtained to date from the four-year demonstration program are expected to generate significant commercial interest in the technology. Because of its operational flexibility, the LPMEOH™ process can be effective for converting a portion of an integrated gasification combined cycle (IGCC) electric power plant's coal-derived synthesis gas to methanol. The process can handle wide variations in synthesis gas composition, and has excellent quick start, stop, and ramping capabilities. It can be designed to operate in a continuous, baseload manner, converting synthesis gas from oversized gasifiers or from a spare gasifier. Alternatively, the process can be designed to operate only during periods of off-peak electric power demand, consuming the excess synthesis gas resulting from

reduced electricity output from the combined-cycle power unit. In this scenario, the gasification unit continues to operate at full baseload capacity, so that the IGCC facility's major capital asset is always fully used.



The LPMEOH™ project demonstrates production of methanol from coal-derived synthesis gas, for added flexibility in IGCC facilities.

...News Bytes continued

Authority's Healy Clean Coal Project site in central Alaska, the plant has been operating satisfactorily at full-load with the limestone injection, spray dryer absorber, and baghouse systems on line. This 50-MWe, coal-fired power plant will demonstrate advanced combustion and flue gas cleanup technologies developed by TRW Inc. and The Babcock & Wilcox Company. Preliminary performance measurements indicate that the stack opacity is predominately less than one percent, with NO_x levels less than 0.35lb/million Btu. An 18-month demonstration test program, comprising performance guarantee tests, environmental compliance tests, major system characterization tests, and integrated commercial operating tests, is currently being carried out.

The Wabash River Coal Gasification Repowering Project, a joint venture between Destec Corporation and Public Service of Indiana, produced one trillion Btu of synthetic gas in March 1998. No other single-train coal gasification plant in the world has attained such a production level in a calendar month. The most environmentally friendly facility of its kind in the world, the Wabash facility emits zero particulates, has a sulfur removal capability greater than 99 percent, about 90 percent reduction in NO_x emissions over conventional power plants, and a stack opacity of zero percent.

The Coal-Fueled Diesel Engine Demonstration Project has passed several important milestones. A 60 percent design review was conducted in March 1998 at the University of

Alaska (UAF), Fairbanks. Representatives from Coltec, A.D. Little, UAF, DOE, and GHEMM (construction contractor) were in attendance. Overall, the design is on schedule. The new design eliminates the sorbent injection system, since Usibelli was able to locate a very clean coal seam with less than 0.2 percent sulfur in the ash. The sorbent injection system originally proposed for the coal diesel was designed for use with bituminous coals with greater than 2.0 percent sulfur levels. Coltec is working with the diesel engine manufacturer to design the new injector with sapphire orifices sized for the higher volume of low-rank coal-water fuel required to operate the engine. Earlier designs and tests were developed for bituminous coal-based slurries with higher energy densities.

MONITORING EFFORT INITIATED UNDER PM_{2.5} PROGRAM

The U.S. electric utility industry has made considerable strides in reducing emissions of SO₂, NO_x, and particulates since passage of the 1970 Clean Air Act and its subsequent amendments. Full implementation of Title IV of the Clean Air Act Amendments of 1990 (CAAA) will result in an annual cap on power plant SO₂ emissions of 8.9 million tons, down from a 1990 baseline level of over 14.5 million tons. In addition, NO_x emissions during Phase I of CAAA Title IV will be reduced by 400,000 tons/yr between 1996 and 1999, while Phase II will reduce emissions by another 1.2 million tons/year. Finally, installation of controls on essentially the entire fleet of coal-fired boilers has caused a dramatic decrease in primary particulate emissions, down from 3 million-plus tons/year in early-1970 to less than 430,000 tons/year in 1990. Despite such successes, emissions from coal-fired power plants continue to be targeted for further reductions in light of concerns about fine particulates, ozone, acidification, air toxics, and other environmental issues.

In July 1997, the U.S. Environmental Protection Agency (EPA) revised the National Ambient Air Quality Standards (NAAQS) to address ambient air concentrations of particulate matter with a diameter of 2.5 micrometers or less (PM_{2.5}). This new standard establishes a 24-hour average concentration limit of 65 ug/m³ and an annual mean concentration limit of 15 ug/m³ to protect human health from both chronic and acute effects associated with respiration of fine particulates. EPA Administrator Carol Browner has stated that the promulgation of the new PM_{2.5} standard, together with a revised ozone NAAQS, is "...one of the most important decisions I will make to protect public health in this country." EPA also proposed regional haze regulations that focus on the impact of PM_{2.5} on visibility impairment in Class I ("pristine") areas of the United States.

However, there are numerous uncertainties regarding the link between coal-fired boiler emissions and the visibility and health-related impacts that have been associated with ambient fine particulates. Ambient fine particulate matter originates from a wide variety of emission sources, both man-made and natural. The combustion of coal to generate electricity produces both primary PM_{2.5} (fly ash, carbon soot, associated trace metals), gaseous precursors (SO₂ and NO_x), and secondary fine particles (ammonium sulfates and nitrates). A recently released report by the National Research Council recommends that there is a high-priority need to develop a better understanding of the relationship between actual personal exposure to fine particulate matter and the ambient concentrations of PM_{2.5} measured at stationary outdoor monitors. The Council also recommends that research be conducted to better define the chemical speciation of ambient PM_{2.5} and improve the understanding of biologically important components and characteristics of particulate matter.

NAAQS IMPLEMENTATION

As shown in *Table 1*, the PM_{2.5} NAAQS implementation schedule requires collection and analysis of much information on ambient air quality prior to any regulatory decision making. Starting

in late 1998, ambient fine particulate data will be gathered over a four-year period from a nationwide network of monitoring sites. The results will support scientific review of the efficacy of the fine particulate NAAQS to be completed in 2002. The data also will serve as the basis for compliance/non-compliance determinations that will be made by 2005. States then will have three years to develop and submit their plans to bring non-attainment areas into compliance with the new standard. The DOE Office of Fossil Energy (FE) fine particulate research program is closely linked to this schedule and these milestones.

FE FINE PARTICULATE RESEARCH

FE's PM_{2.5} research program is directed at providing timely, high-quality technical and scientific data that will address key uncertainties, such as source-receptor relationships, fine-particle composition, and human-exposure and visibility impacts related to coal-fired power plant emissions. This research is necessary to preclude implementation of costly and potentially ineffectual management strategies that target the wrong emission sources. It also will help to ensure that coal-based elec-

Table 1: PM_{2.5} NAAQS Implementation Schedule

Timeframe	Activity
1997	EPA issues final PM _{2.5} NAAQS
1998-2000	Nationwide ambient monitoring network established
1998-2003	Collect monitoring data
2002	EPA completes 5-year scientific review of the standard
2002-2005	EPA designates non-attainment areas
2005-2008	States submit implementation plans for meeting the standard
2012-2017	States have up to 10 years to meet standards plus two 1-year extensions

tric power remains a viable, environmentally sound component of the U.S. energy mix.

THE UPPER OHIO RIVER VALLEY PROJECT

FE will actively contribute to EPA's monitoring effort through the installation of several monitoring "supersites." These monitoring stations will be equipped with filter-based and continuous ambient monitoring devices (*Figure 1*) to

Figure 1: An ambient $PM_{2.5}$ monitor



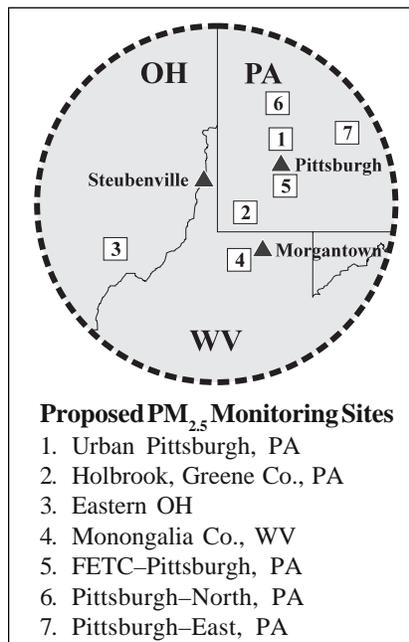
collect samples for detailed chemical characterization. Meteorological information, such as wind speed and direction, temperature, and relative humidity, also will be collected to allow for source attribution and regional-transport modeling.

Similar research programs are being supported by North American Research Strategy for Tropospheric Ozone, the electric-power industry, and others. EPA, Electric Power Research Institute, and local and state environmental agencies are working closely with FE in designing and implementing its monitoring program to ensure that it addresses the most critical research needs, including those identified in the NRC report.

The Upper Ohio River Valley Project (UORVP) represents the largest part of FE's ambient monitoring activities, and will involve installation and operation of ambient fine particulate monitoring sites in an area encompassing eastern Ohio, northwestern West Virginia, and western Pennsylvania. The purpose of the UORVP is to better understand the relative contribution of local and regional anthropogenic and biogenic emission sources in the upper Ohio River valley region on downwind ambient air quality. These sites could be used to monitor other pollutants, such as ozone or mercury. EPA has projected that the region is susceptible to high mercury deposition.

Final siting of the monitoring stations is currently being determined. One site will be upwind of the upper Ohio River industrial corridor to provide an air quality "baseline." Other monitoring sites, as shown in *Figure 2*, are being considered at key downwind locations. The network would include rural (non-urban) sites and an urban site in Pittsburgh, Pennsylvania.

Figure 2: UORVP candidate monitoring sites



nia. In addition, ambient monitoring will be carried out at the FETC facility located about eight miles south of Pittsburgh. The UORVP monitoring network should be installed and operating by early 1999.

Through an Interagency Agreement with the Tennessee Valley Authority (TVA), FE will continue its collaborative efforts with the electric power industry through $PM_{2.5}$ monitoring projects in the Great Smokey Mountain National Park in Tennessee and in Atlanta, Georgia. This research is aimed at providing a better understanding of regional haze issues and human exposure to fine particulates in the southeastern United States. It also will provide an excellent opportunity to compare variations in ambient $PM_{2.5}$ concentration and composition with the data from the geographically and climatically distinct UORVP.

FE CONTROL AND EMISSIONS RESEARCH

The FE program will continue developing cost-effective emissions control technology for coal-fired utility boilers. This will include an R&D portfolio of advanced technologies for controlling both primary particulate matter and secondary fine particulate precursors, should further restrictions be placed on coal-based power systems. In addition, under the TVA Interagency Agreement, FE will investigate formation and transport of secondary fine particles in the plume of a large coal-fired power station. This effort will also assess the impact of low- NO_x burners and wet flue-gas desulfurization technology on emissions of secondary $PM_{2.5}$ precursors and their subsequent conversion to fine particulates. Finally, the FE program will include characterization of primary particulate emissions in a 10-MWe pilot-scale coal facility.

CARBON OFFSETS CREATE BUSINESS OPPORTUNITIES FOR CCTs

Trading of CO₂ credits with developing countries, in order to meet emissions caps mandated by the Kyoto Protocol, could represent a “win-win” option for countries and technology suppliers such as the United States, according to speakers at the Sixth Clean Coal Technology Conference. The primary flexible mechanism in the Kyoto Protocol that would permit such trade between Annex I industrialized countries and developing countries is the Clean Development Mechanism (CDM). However, provisions for emissions trading would not, at the earliest, be defined until COP-4 in Buenos Aires this coming November. To be implemented, the Kyoto Protocol must be ratified among a subset of countries including the United States.

The Kyoto Protocol provides a framework for important market-based instruments for CO₂ emission control, such as emissions trading and CDM. Global emissions trading is envisioned as similar to the U.S. acid rain trading program, while CDM would give offset credits for specific projects. The Clinton Administration estimates that international emissions trading could cut U.S. compliance costs by some 60-75 percent, with CDM providing another potential 20-25 percent reduction in these costs, creating a \$14-23/ton trading price for carbon equivalent emissions. CDM is seen as having the most incentives for CCTs since it is project-based and would permit investment in the fastest growing developing countries. However, formalization of rules, i.e., how credits would be counted and claimed, must occur before there will be reason for much optimism about implementation. Rules of trading would be determined by 168 countries, 130 of which are not affected by the Protocol, and according to some conference participants, may not fully understand market principles. Attendees reported that, at the present time, only the United States and Japan support CDM.

David South of Energy Resources International, Inc., emphasized that trading is not in itself a method to reduce emissions, but rather a way to bring about these reductions more cost effectively. Without trading, more stringent command and control-type regulations would be required to achieve compliance with Kyoto, as well as sequestration and other advanced technologies beyond what we have today.

South described both the buyer and suppliers of offsets as capturing part of a “surplus” created by a cost to the buyer that is less than CO₂ abatement costs in his own country. The developing country seller obtains access to improved technology with local/regional environmental benefits, such as particulate control, which may be more important to him than greenhouse gas reduction. From a coal perspective, the developing country wants advanced technologies that increase conversion efficiencies, and provide fuel and product flexibility. Buyers of offsets, on the other hand, are looking for good investment opportunities and to make sure they are getting what they paid for in terms of CO₂ reduction, along with a good system for certifying these credits.

Two conference speakers described mechanisms being implemented at the World Bank that could allow the Bank to play an important role in a CO₂ trading scheme as a possible broker, although conference attendees expressed concern that the Protocol does not endorse these mechanisms. The Bank’s Charles

Feinstein described the seven-year-old Global Environmental Facility (GEF) and Prototype Carbon Fund as two mechanisms for financing greenhouse gas emissions reductions. Feinstein pointed out: “Because large investments in coal are routinely made by the private sector in the developing world, GEF might be able to apply judiciously some of its very limited resources to reorient investments relating to coal to something more compatible with climate change concerns.” GEF might provide, for example, the incremental cost of IGCC over a standard pulverized coal power plant in cases where coal is clearly the fuel choice. GEF could grant the difference in life cycle costs of the two options after comparing present values.

The Bank’s Prototype Carbon Fund, seen by South as a powerful tool for implementing Kyoto, was in planning before the Protocol was signed and builds on experience in financing voluntary CO₂ reductions. To implement Kyoto, the fund is envisioned as a trust fund structured similarly to a closed end mutual fund. Dividends would be in tons of CO₂ equivalent instead of dollars. Feinstein anticipated that the Prototype Carbon Fund would be able to buy one ton of carbon equivalent at between \$10 to \$20, whereas projected abatement costs for a ton of carbon equivalent in OECD countries could range up to \$60 and even higher as the global market develops.

Although the opportunity, prospects, and timing will not be known until the rules for trading mechanisms are defined, coupling CCT investment with a CO₂ credit could, as South noted, keep coal “in the mix of generation,” and a savings in the range of \$10 to \$30 a ton could make coal projects potentially financeable.

INTERNATIONAL INITIATIVES



DOE SUPPORTING SOUTH AFRICA ENERGY INITIATIVES



FETC's Mark Freeman trains a community leader to check the carbon monoxide levels of a paraffin stove.

This summer, the Gore/Mbeki Binational Commission (BNC) will meet in the United States to discuss the progress of various joint activities, including several energy projects in which DOE Office of Fossil Energy (FE) has played an important coordinating and technical advisory role.

FE's involvement began in 1995 as part of President Clinton's Mission to South Africa on Sustainable Energy and Empowerment. Since then, FE has been closely involved in four activities — low-smoke fuels, integrated energy efficient housing, coal bed methane, and the southern African regional power pool. Only 55 percent of Republic of South Africa (RSA) homes have access to electricity, prompting the country to undertake a massive electrification program. Since RSA has vast reserves of coal, the expanding electricity market presents opportunities for advanced U.S. coal burning technologies.

Low-smoke fuels — particularly processed solids for residential burning — are closely allied to the RSA program for energy efficient housing. FE is working with other DOE offices and the U.S. Agency for International Development (USAID) to assist RSA in fully integrating their house-building and electrification programs into the overall energy planning framework. FE supports RSA's low-smoke fuels program through the RSA Department of Minerals and Energy (DME). The goal is to develop policies to stimulate household use of low-smoke fuels, which currently represent only one percent of the low-grade coal burned in RSA townships. FE also supports simple intervention efforts, such as repairing existing stoves or using improved stoves, and educating residents about carbon monoxide and other household energy environment safety and health issues. In 1996, joint workshops to explore low-smoke fuel issues were held in Pittsburgh and Pretoria, and involved over 60 U.S. and RSA organizations.

With USAID travel support, an FE engineer provided on-site technical support for a portion of DME's macro-scale 30-day evaluation of social acceptability and ambient air quality as three low-smoke fuels were introduced in Qalabotjha township during July 1997. The engineer also visited both shack-type dwellings and DOE- and USAID-supported energy-efficient housing projects in Kutlwanong township in Kimberley to evaluate the suitability of existing stoves for new, more air-tight energy efficient housing.

Data from the township demonstration and FE experts' findings have helped identify necessary follow-on activities. The International Institute for Energy Conservation (IIEC), Pretoria Office indicated that its March 1998 workshop, funded by USAID — "Identifying Avenues of Intervention on Indoor Air Quality in Low-Income South African Households" — was held largely in response to the FE survey findings.

Elsewhere, FE has been cooperating with U.S. Trade and Development Agency (TDA) and DME in the Lebowa Minerals Trust Project, a first-ever TDA- and private sector-funded feasibility study for coalbed methane recovery in the RSA. The recovery process also has potential to provide clean water for household and agricultural use. In addition, at FE's urging, RSA has agreed to evaluate their coal bed methane resources as they pursue their overall coal resource evaluation. A final RSA activity is the South African Region Power Pooling Project where DOE acts as technical advisor in a USAID-funded effort by Purdue University in regional electricity trade modeling.

TDA JOINS DOE IN SUPPORTING BRAZIL'S QUEST FOR CLEAN ENERGY



Governor Underwood of West Virginia (center) and Brazilian industrialists confer on coal investment opportunities at Atlanta conference.

Following over a year's effort, during which the DOE Office of Fossil Energy (FE) provided significant guidance, support, and advice, the U.S. Trade Development Agency (TDA) announced a grant of \$470,000 for a feasibility study for a new coal-fired power plant in Brazil. The grant will be awarded to Copelmi Mineracao, S.A., one of Brazil's largest coal producers.

Recently, U.S. DOE's Office of Import and Export and the Southern States Energy Board (SSEB) co-sponsored a Conference in Atlanta, Georgia, to promote the many business opportunities involved in the multi-million dollar projects planned in Brazil. The Conference was opened by the Honorable Luis Lauredo, the Presidential Appointee and Federal Representative to the SSEB. The Honorable Cecil Underwood, Governor of West Virginia and Chairman of the SSEB, gave the keynote address. During the

conference, Robert Kripowicz, Principal Deputy Assistant for FE, said that Brazil's demand for coal-fired power generation could require billions in investment by 2015. "The positive steps you are taking toward privatization and reform...bode well for attracting foreign capital," he added. Barbara McKee, Director of FE's Office of Imports and Exports, presented a paper on the Memorandum of Understanding being developed between the United States and Brazil on clean coal technologies.

The new coal-fired powerplant is to be located near the Seival coal mine in Rio Grande do Sul. The area is Brazil's third most populous and industrialized state, and is experiencing rapid industrial growth. Average energy consumption for the state is at approximately 3,000 MW while it only produces 700 MW. Total cost of the new mine-mouth plant is estimated at \$400 million.

When the project is finally approved, engineering, new generation equipment, instrumentation, controls, construction, and management services will all be open for bidding to U.S. firms. TDA also recently approved another grant in the amount of \$140,000, cost-shared with mine owner Copelmi Mineracao, to study Seival coal mine development options.

UKRAINE CONFERENCE HIGHLIGHTS FINANCIAL RECOVERY, OBSTACLES TO POWER SECTOR DEVELOPMENT

On April 21-22, 1998, some 160 attendees (30 from the U.S.) participated in the Ukraine/U.S. Joint Conference on Ukraine Clean Coal Power Plant Upgrade Opportunities, held in Kiev. The conference was co-sponsored by U.S. DOE, U.S. Agency for International Development, and the Ukrainian Ministry of Energy and Electrification (MINENERGO). The conference was held to report on the recently finished study on upgrading the anthracite-fired Lugansk Power Station in eastern Ukraine with the goal of obtaining World Bank financing, and to provide a forum for exchange of information among Ukrainian government and power sector officials and western companies interested in rebuilding that country's aging coal-fired power sector.

The Lugansk plant, like most other coal plants in the Ukraine, is in worn condition due to its age and operation with high-ash anthracite coal. The joint-country Clean Coal Task Force has recommended one of the plant's eight 200-MW plant boilers be refurbished to burn specification coal, while two new 62.5-MW circulating fluidized bed boilers be equipped to burn waste fuel. A new wastewater treatment facility and upgraded coal handling system would be installed. Under the Task Force's scenario, a World Bank loan would cover 60 percent of project costs. The completed Lugansk engineering and economic study, however, will not be reviewed by the World Bank until Ukraine comes into compliance with provisions contained in existing loans from the Bank.

Office of Fossil Energy Assistant Secretary Patricia Fry Godley spoke at the conference, commending officials for their effort to revitalize the Ukrainian power sector through privatization, and drawing parallels between the Ukrainian and U.S. efforts to increase competition in the power sector. The Ukrainian government recently decided to sell a significant share of its holdings in generating companies to private investors, which should help the utility sector raise capital for plant improvements. Donbassenergo, a utility collaborating in the Lugansk study, has been selected to be one of the first generating companies to allow private investors to buy shares.

Speaking at the conference, First Deputy Minister of MINENERGO Vladimir Luchnikov assured investors that his government is committed to change and to an “investor-friendly” climate in the power sector. A Financial Recovery Plan is in progress for the power sector, which would reduce costs of electricity production and sales, reduce transmission losses including electricity theft, change pricing to allow for profits to generators, and improve payment systems/reduce barter. Foreign investors spoke of the severe problem of non-payment in the cash-short countries of the former Soviet Union. In Kazakhstan, for example, newly privatized generating companies curtail generation until payment is received. It was reported that this drastic action had the desired effect of increasing payment for electricity.

An exhibit showing technologies developed under the DOE Clean Coal Technology Demonstration Program was displayed during the conference. This presented several technologies that could be implemented to accomplish MINENERGO goals for the Ukraine power sector. Following the conference, U.S. and Ukrainian officials agreed to develop a Memorandum of Understanding to permit continued cooperation in fossil energy research and development.

UNITED NATIONS CCT STUDY TOUR

At the request of the United Nations Economic Commission for Europe, the U.S. DOE Office of Fossil Energy conducted a study program for 11 coal technology specialists from Central/Eastern Europe and Russia (9 from Czech Republic, 1 from Poland, and 1 from Russia). The program consisted of attendance at the Sixth Clean Coal Technology Conference in Reno, Nevada, followed by site visits to Babcock & Wilcox facilities in Ohio, Wabash River IGCC Project in Indiana, the DOE Power Systems Development Facility in Alabama, and Homer City Coal Preparation and Ebensburg CFB Projects in Pennsylvania. The visitors were given the opportunity to hear energy and environmental policy presentations regarding fossil fuel use in advanced power plants both in the United States and abroad. The final day of the tour was spent at DOE, Office of Fossil Energy headquarters discussing future joint activities, such as workshops and conferences.



FETC CELEBRATES 50TH ANNIVERSARY

DOE's Federal Energy Technology Center (FETC), in conjunction with the Department of Labor's Mine Safety and Health Administration, and the Department of Health and Human Services' National Institute for Occupational Safety and Health, hosted 1,500 visitors during a site-wide open house on May 15-16, 1998, which included tours, demonstrations, and exhibits at the FETC Bruceton Research Center in Pittsburgh, Pennsylvania. Visitors included 14 school groups on May 15, followed by the general public on May 16. The open house marked the 50th anniversary of FETC. On May 21, 1948, the former U.S. Bureau of Mines (a predecessor agency) held a dedication ceremony for the Bruceton Center, which consisted of synthetic liquid fuel laboratories and pilot plants. From those beginnings, the site has become a preeminent center for mining and energy resources.

◆◆◆ NOVEL CONCEPTS AWARDS ◆◆◆

On April 29, 1998, the Department of Energy (DOE) announced the selection of 12 research projects that will receive grants for CO₂ sequestration projects to explore cost-effective capture and permanent disposal of greenhouse gases. In announcing the grants, Secretary of Energy Federico Peña noted that this first step may lead to realistic technologies that may "make it easier for the United States and other nations to implement effective greenhouse gas reduction strategies." The request for proposals was announced last September, and 62 were received. In the Administration's proposed Fiscal Year 1999 budget, DOE recommends expansion of carbon sequestration research, focusing on the science of carbon management as well as on the application of innovative techniques for removing and permanently storing carbon gases.

The dozen selected projects include the use of CO₂ absorbing algae growing on artificial reefs or encased in bioscrubbers, disposal of greenhouse gases in deep aquifers on the ocean floor, and innovative chemical processes and membranes that separate CO₂ from the flue gases of fossil fuel power plants and factories. Each project will receive approximately \$50,000 for the initial phase, with those projects that proceed into development receiving up to \$1.5 million each. The projects and their sponsors are:

- ◆ *pH-Neutral Concrete for Attached Microalgae and Enhanced Carbon Dioxide Fixation* – Louisiana State University, Baton Rouge, LA — Study of capture of CO₂ by microalgae supported on artificial reefs. A portion of the carbon in the biomass will be permanently sequestered in the deep ocean.
- ◆ *Large-Scale CO₂ Transportation and Deep Ocean Sequestration* – McDermott Technologies, Inc., Alliance, OH — Study the viability of large-scale CO₂ transportation and disposal, to extend application of pipe-laying technology well beyond current depth limit of 1,300 meters.
- ◆ *Recovery of Carbon Dioxide in Advanced Fossil Processes Using a Membrane Reactor* – Research Triangle Institute, Research Triangle Park, NC — Develop an inorganic, palladium-based membrane device that re-forms hydrocarbon fuels to mixtures of hydrogen and CO₂ while separating the high-value hydrogen.
- ◆ *Low Cost Bioscrubber for Greenhouse Gas Control* – Michigan Technological University, Houghton, MI — Develop a novel, algae-growing bioscrubber that could be retrofitted to existing power plants or applied to new plants, to consume CO₂ (and possibly other greenhouse gases).
- ◆ *Novel Systems for Sequestering and Utilizing CO₂* – University of North Dakota Energy and Environmental Research Center, Grand Forks, ND — Develop new chemistry and catalysts to convert CO₂ to useful polymers in industrial quantities.
- ◆ *Sequential Carbon Dioxide Removal from Stack Gases and Sequestration Using Coal Seams* – Northwest Fuel Development, Inc., Lake Oswego, OR — Develop a unique system to remove and sequester CO₂ by injecting power plant flue gas into abandoned coal mines and using residual coal in the mines to filter out and retain the carbon dioxide.
- ◆ *Optimal Geological Environments for Carbon Dioxide Disposal in Saline Aquifers in the U.S.* – The University of Texas at Austin, Austin, TX — Study the potential for long-term disposal of CO₂ in saline aquifers in the United States where geological conditions promote the greatest probability of success.
- ◆ *Experimental Evaluation of Chemical Sequestration of Carbon Dioxide in Deep Aquifer Media* – Battelle, Columbus, OH — Study deep-well injection of supercritical phase CO₂ in aquifers deeper than 800 meters with no known economic resources; determine the fate of injected CO₂ in different aquifer settings.
- ◆ *CO₂ Capture from Industrial Process Gases by High-Temperature Pressure Swing Adsorption* – Air Products and Chemicals, Inc., Allentown, PA — Develop low-cost technology to capture CO₂ from flue gases and other process gases (including new water-tolerant, high-temperature sorbent materials and new processes).
- ◆ *The Removal and Recovery of Carbon Dioxide from Syngas and Acid Gas Streams in an IGCC Power Plant for the Reduction of Greenhouse Gases* – Tampa Electric Company, Tampa, FL — Evaluate the technical and economic merits of alternative systems that could be demonstrated at the Polk Power Station Integrated Gasification Combined Cycle (IGCC) plant (since IGCC provides an opportunity for CO₂ capture when oxygen rather than air is used).
- ◆ *A Novel CO₂ Separation System* – TDA Research, Inc., Wheat Ridge, CO — Develop a sorbent energy transfer system in which fossil fuel (either gasified coal or natural gas) transfers its energy to reduce a metal oxide, producing steam and high-pressure CO₂ that can be sequestered with little additional compression energy.
- ◆ *Landfill Operation for Carbon Sequestration and Maximum Methane Emission Control* – Institute for Environmental Management, Inc. (IEM), Palo Alto, CA — Accelerate production of and capture methane from landfills using surface membrane covers. Techniques will promote decay of landfill wastes to provide more rapid and complete methane generation.

UPCOMING EVENT

July 21-23, 1998 *Advanced Coal-Based Power & Environmental Systems Conference*
 Location: Morgantown, West Virginia
 Sponsor: U.S. Department of Energy, FETC
 Contact: FETC Conference Services, 1-800-553-7681

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 in a closed-loop configuration is continuing. The project was extended to allow completion of the Final Report. The Final Report for Phases 1-3 has been received and is being reviewed. (Coosa, GA)

New York State Electric & Gas – *Milliken Clean Coal Technology Demonstration Project.* High-sulfur (4%) coal testing began in May 1998. Reports on ESP performance and LNCF-3 testing have been completed. (Lansing, NY)

New York State Electric & Gas – *Micronized Coal Reburning Demonstration for NO_x Control.* Preliminary testing was performed in early February. Short-run tests showed that NO_x could be reduced an additional 35-40% at the Milliken demonstration unit. Further testing with different LNCF III primary and overfired air settings is rescheduled until the July-August timeframe. Long-term testing at Kodak was scheduled to begin in June 1998. (Lansing, NY and Rochester, NY)

NOXSO Corporation – *Commercial Demonstration of the NOXSO SO₂/NO_x Removal Flue Gas Cleanup System.* Discussions are ongoing with a major utility to re-site this project. (Site pending)

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.* These projects have been restructured and resited to Lakeland, Florida. Foster Wheeler gave the City of Lakeland a turnkey proposal to build a PCFB plant at Lakeland's McIntosh Power Plant. The City of Lakeland and DOE have signed both cooperative agreements. The City of Lakeland is negotiating with Foster Wheeler on the turnkey contract. (Lakeland, FL)

Jacksonville Electric Authority (formerly York County Energy Partners) – *ACFB Demonstration Project.* On September 29, 1997, DOE signed an agreement with Jacksonville Electric Authority to cost-share refurbishment of the first (Unit 2) of two units at North Side Generating Station. Capital cost of repowering Unit 2 is \$309 million, of which DOE's cost-share is \$74.7 million, or 24%. Construction is planned to begin in March 1999, with operation in early 2002, and two years of operations. Activities are underway to draft an Environmental Impact Statement. (Jacksonville, FL)

Clean Energy Partners, L.P. – *Clean Energy Demonstration Project.* Clean Energy Partnership is restructuring the Project Team to incorporate a new site and host in central Illinois. (Site pending.)

Sierra Pacific Power Co. – *Piñon Pine IGCC Power Project.* Sierra Pacific Power Company has achieved short-term operation of gasifier island on Utah coal. Various mechanical, instrument, and control issues are being addressed to improve operation. The plant continues to operate in the gas combined cycle mode. (Reno, NV)

Tampa Electric Co. – *Tampa Electric Integrated Gasification Combined-Cycle Project.* Between January and March 1998, the unit was in operation 1,600 hours and operated on syngas 94% of the time. The unit is currently undergoing a maintenance outage and was scheduled to return to operation in June 1998. (Mulberry, FL)

Wabash River Joint Venture – *Wabash River Coal Gasification Repowering Project.* The plant produced its one trillionth Btu of synthetic gas for the month of March. This milestone is significant in that no other single train coal gasification plant in the world has reached such a production level in single calendar month. Also in March, Wabash set a record of continuous hours of coal operation at 478 hours. (West Terre Haute, IN)

Alaska Industrial Development and Export Authority – *Healy Clean Coal Project.* Since startup of the entrained combustion system on coal in January 1998, the plant is operating well at full-load, or 62 MW (gross). Continuous emissions monitoring system certification testing was completed, and entrained combustor characterization testing at

full load, in conjunction with the NO_x and SO₂ reduction system tuning and trimming, is underway. (Healy, AK)

Arthur D. Little, Inc. – *Coal-Fueled Diesel Engine Demonstration Project.* A 60% design review was held at the University of Alaska. The project is on schedule for delivery of the 18-cylinder coal-diesel engine in November 1998. (Fairbanks, AK)

COAL PROCESSING FOR CLEAN FUELS

Custom Coals International – *Self Scrubbing Coal™: An Integrated Approach to Clean Air.* The plant has temporarily halted operations due to financial and environmental constraints. Tanoma Coal Sales, Inc., of Latrobe, Pennsylvania, has offered to buy the site and continue the project. The project was recently resturctured and negotiations are continuing. The plant has processed over 650,000 tons of raw coal and shipped over 400,000 tons of clean coal product. (Central City, PA)

Rosebud SynCoal® Partnership – *Advanced Coal Conversion Process (ACCP) Demonstration.* The ACCP facility continues to process raw subbituminous coal, producing over 1.4 million tons of SynCoal® product to date. Nearly 1.3 million tons has been supplied to customers, including industries (primarily cement and lime plants) and utilities. Rosebud SynCoal Partnership has signed a letter agreement with Montana Power Company's Colstrip Unit No. 2 to design, install, commission, and operate a pneumatic injection system for Colstrip Unit No. 2. The pneumatic injection system would inject SynCoal® product on a steady basis to Colstrip Unit No. 2. (Colstrip, MT)

Air Products Liquid Phase Conversion Company, L.P. – *Liquid Phase Methanol Process Demonstration Project.* The LPMEOH™ Process Demonstration Facility completed its first year of operation on April 2, 1998. A record setting, 65-day period of continuous operation was completed later in the month. Since being restarted with fresh catalyst in December 1997, the demonstration facility has operated at greater than 99 percent availability. The rate of decline in catalyst activity since the restart is generally less than 0.4 percent per day. Process variable studies are currently underway. In its first year of operation, the

LPMEOH™ Process Demonstration Facility produced over 15 million gallons of methanol, nearly all of which was accepted by Eastman Chemical Company for use in downstream chemical processes. (Kingsport, TN)

INDUSTRIAL APPLICATIONS

Bethlehem Steel Corporation – Blast Furnace Granulated Coal Injection System Project. The “Pulverized Coal Trial” was initiated in April as planned. During the entire month of May, operating personnel struggled to keep the coal conveying lines open to the tuyeres. The instability of the furnace operation and

the variable coal flow caused the trial to be suspended in early June. The “Pulverized Coal Trial” data is currently being evaluated. The Sanborn coal, a Colorado “B” seam coal has been selected for “Western Coal Trial.” (Burns Harbor, IN)

CPICOR™ Management Company, L.L.C. – Clean Power From Integrated Coal/Ore Reduction. CPICOR™ continues to pursue licensing issues regarding direct ironmaking technology, in order to proceed with project design and permitting activities. (Vineyard, UT)

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COMPLETED CCT DEMONSTRATION PROJECTS FINAL REPORTS

Environmental Control Devices

- 10-MWe Demonstration of Gas Suspension Absorption – *AirPol, Inc.* NTIS #DE960003270
- Confined Zone Dispersion Flue Gas Desulfurization Demonstration – *Bechtel Corporation* DOE/PC/90546-T10
- LIFAC Sorbent Injection Desulfurization Demonstration Project – *LIFAC-North America (Vol. II only)* NTIS #DE96004421
- Advanced Flue Gas Desulfurization Demonstration Project – *Pure Air on the Lake, L.P.* NTIS #DE96050313
- Demonstration of Innovative Applications of Technology for the CT-121 FGD Process –
Southern Company Services, Inc. In Preparation
- Demonstration of Coal Reburning for Cyclone Boiler NO_x Control – *The Babcock & Wilcox Company* In Review
- Full-Scale Demonstration of Low-NO_x Cell Burner Retrofit – *The Babcock & Wilcox Company* NTIS #DE96003766
- Evaluation of Gas Reburning and Low-NO_x Burners on a Wall-Fired Boiler –
Energy and Environmental Research Corporation Not Yet Available
- Demonstration of Selective Catalytic Reduction Technology for the Control of NO_x Emissions
from High-Sulfur Coal-Fired Boilers – *Southern Company Services, Inc.* NTIS #DE97050873
- 180-MWe Demonstration of Advanced Tangentially Fired Combustion Techniques for the Reduction
of NO_x Emissions from Coal-Fired Boilers – *Southern Company Services, Inc.* NTIS #DE94011174
- SNOX™ Flue Gas Cleaning Demonstration Project – *ABB Environmental Systems* NTIS #DE94018832
- LIMB Demonstration Project Extension and Coolside Demonstration – *The Babcock & Wilcox Company* NTIS #DE93005979
- SO_x-NO_x-Rox Box™ Flue Gas Cleanup Demonstration Project – *The Babcock & Wilcox Company* NTIS #DE96003839
- Enhancing the Use of Coals by Gas Reburning and Sorbent Injection –
Energy and Environmental Research Corporation In Preparation
- Integrated Dry NO_x/SO₂ Emissions Control System – *Public Service Company of Colorado* In Preparation

Advanced Electric Power Generation

- Tidd PFBC Demonstration Project – *The Ohio Power Company* NTIS #DE96000650
- Nucla CFB Demonstration Project – *Tri-State Generation and Transmission Association, Inc.* DOE/MC/25137-3046

Coal Processing for Clean Fuels

- Development of the Coal Quality Expert™ – *ABB Combustion Engineering, Inc., and CQ Inc.* In Preparation
- ENCOAL® Mild Coal Gasification Project – *ENCOAL® Corporation* #DE98002007*

Industrial Applications

- Advanced Cyclone Combustor with Internal Sulfur, Nitrogen, and Ash Control –
Coal Tech Corporation NTIS #DE92002587/92002588
- Cement Kiln Flue Gas Recovery Scrubber – *Passamaquoddy Tribe* NTIS #DE94011175/94011176

Publications are available to the public from the National Technical Information Service (NTIS), U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, (703) 487-4600. For a copy of the “DOE/MC” report, contact: Library, FETC-Morgantown, 3610 Collins Ferry Road, Morgantown, WV 26507-0889, (304) 285-4184. For a copy of the “DOE/PC” report, contact: Library, FETC-Pittsburgh, 626 Cochran Mill Road, Pittsburgh, PA 15236-0940, (412) 892-6819. * ENCOAL Report is available on the Internet at www.doe.gov/bridge