

CLEAN COAL TODAY

U.S. CLEAN COAL TECHNOLOGY DEMONSTRATION PROGRAM — OFFICE OF FOSSIL ENERGY, U.S. DEPARTMENT OF ENERGY

PROJECT NEWS BYTES

Construction of the 250-MW **Tampa Electric Integration Gasification Combined-Cycle Project** is 99 percent complete. First fire of the gasifier occurred in mid-July, and a total of 35 hours of gasifier operation on Pittsburgh #8 coal was achieved by the end of July. Check-out of the syngas cleanup system and the sulfuric acid plant are ongoing. The project is on schedule to begin its demonstration phase in the fall of 1996. *Look for a full article on this project in the Winter Issue of Clean Coal Today!*

In August, the **Piñon Pine IGCC Power Project** had a smooth first firing on natural gas of the GE-6FA advanced gas turbine, representing a major milestone achieved on schedule. The turbine, the first of its type in the world, posed no problems. See "Project News Bytes" on page 14. . .

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CQ INC. SOFTWARE TOOL EASES UTILITY DECISION-MAKING

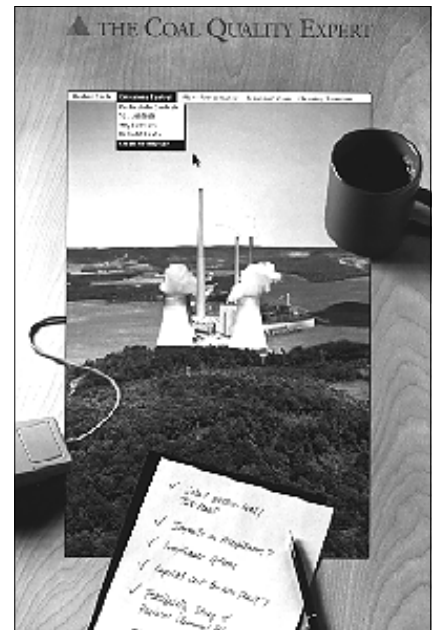
Compliments of the Clean Coal Technology (CCT) Program, electric utilities worldwide now can make wiser fuel purchasing and plant operating decisions, helping them to remain competitive while meeting increasingly stringent clean air laws. The Coal Quality Expert (CQE), which was developed by ABB Combustion Engineering, Inc., and CQ Inc. (Homer City, PA) in their Round I CCT project, is a state-of-the-art, PC-based software tool capable of projecting all fuel-related impacts on power plant performance and cost.

To date, 35 of the largest U.S. utilities, and one in the United Kingdom, have received the initial commercial version (Version 1.0) of CQE through their membership in the Electric Research Power Institute (EPRI), one of the project's sponsors. A beta version of CQE was released in May 1995 for evaluation by several utilities, followed by commercial distribution in December 1995. In addition, a CQE module — the Acid Rain Advisor (ARA) — was developed in 1992 to assist utilities in making Clean Air Act (CAA) compliance choices. Two commercial sales of ARA, which quantifies cost and emission allowance needs for compliance strategies, have been made to Utility Engineering Corporation (a subsidiary of Southwestern Public Service) and Virginia Power.

Black & Veatch signed a commercialization agreement with CQ Inc., giving them nonexclusive worldwide rights to sell users' licenses and to offer consulting services using the CQE software. CQ Inc. is seeking additional regional commercialization partners throughout the world to license CQE and offer consulting services.

CQE, one of the Pittsburgh Energy Technology Center (PETC) CCT projects, brings a new level of sophistication to power plant decision-making

See "CQ Inc." on page 2. . .

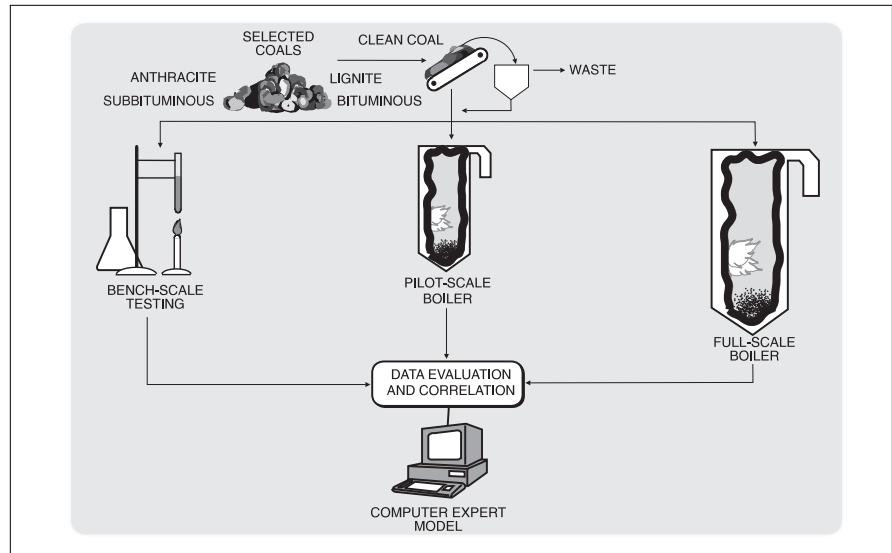


... "CQ Inc." from page 1 by taking into account the impact of fuel purchases on power generation and environmental costs. CQE is capable of assessing a variety of issues associated with fuel procurement and plant operations, including the impact of fuel choice on overall power plant performance and economics.

The CQE project recently was ranked as the major accomplishment thus far of a cost-shared utility R&D partnership between DOE and EPRI called "Sustainable Electric Partnership." DOE Secretary Hazel O'Leary and EPRI President Richard Balzhiser ranked the project as the best of nine partnership activities since the program was initiated a year ago.

PERFORMANCE ENHANCED BY FLEXIBILITY

CQE began with EPRI's Coal Quality Impact Model (CQIM), developed for EPRI by Black & Veatch, Inc., and introduced in 1989. CQIM was endowed with a variety of capabilities, including evaluating CAA compliance strategies, evaluating bids on coal contracts, conducting test-burn planning and analysis, and providing techno-economic analyses of plant operating strategies. CQE, which combines CQIM with other existing software and databases, extends the art of model-based fuel evaluation established by CQIM in three dimensions: new flexibility and application, advanced technical models and performance correlations, and advanced user interface and network awareness. Using object-oriented programming, CQE's flexibility has been developed to the greatest extent practical. It includes the ability to address the engineering and analytical needs of fuel-purchasing specialists, plant engineers, op-



erations support staff and planners. It performs and standardizes many detailed calculations necessary to evaluate specific plant/fuel scenarios.

CQE's design philosophy underscores the importance of flexibility by modeling all important power plant equipment and systems and their performance in real-world situations. This level of sophistication allows new applications to be added by assembling a model of how real-world objects interact. Because the real world is always changing, updating information records that can be readily shared among all affected users is an ongoing process. Meeting this challenge, CQE is network-aware, enabling users throughout an organization to share data and results. The CQE object-oriented design, coupled with an object database management system, allows different views into the same data. As a result, staff efficiency is enhanced when decisions are made.

PLANNING FOR THE FUTURE

CQE also can be expanded without major revisions to the system. Object-oriented programming allows new objects to be added and old objects to be deleted or enhanced

easily. For example, if modeling advancements are made with respect to predicting boiler ash deposition (i.e., slagging and fouling), the internal calculations of the object that provides these predictions can be replaced or augmented. Other objects affected by ash deposition (e.g., ash collection and disposal systems, and soot blower systems) do not need to be altered; thus the integrity of the underlying system is maintained.

CCT TESTING SPAWNS ASSESSMENT TOOL

The CQE software evolved from the CCT Program, with DOE funding almost half of the \$22 million project, and private industry participants paying the balance. Five U.S. utilities served as host sites to provide test data for the CQE project, and tests were conducted by commercial testing services companies. These companies conducted bench-scale combustion tests and developed improved algorithms to predict boiler slagging and fouling, and pilot-scale tests to develop improved correlations for assessing the impact of various coal properties on combustion and power plant performance. Full-scale testing involved

burning a baseline coal in six utility boilers ranging from 250-880 MWe. Representative boiler designs and coal types from across the country were used. The baseline coal was used to characterize the operating performance of the boiler, and an alternate coal of improved quality was burned to assess the impact of coal properties on plant performance. Data from the full-scale tests were used with data from the bench- and pilot-scale combustion tests to for-

mulate over 100 new and improved algorithms forming the basis of CQE.

An update of CQE, Version 1.1, incorporates a number of enhancements to the program suggested by the early utility users of CQE, and should be available soon. To enhance user acceptance, the project team also is considering migrating CQE to a Windows platform from its current OS/2 operating system.

The CQE team developed a Home Page that can be found on the World

Wide Web (<http://147.182.5.102/cqe/cqe.htm>) to promote CQE, facilitate communications between the CQE developers and users, and eventually allow for software updates to be distributed over the Internet. It also was developed to provide an online, updatable users manual. Putting CQE on the World Wide Web will help attract the interest of international utilities and consulting firms that the project team's marketing is unable to reach. ☆

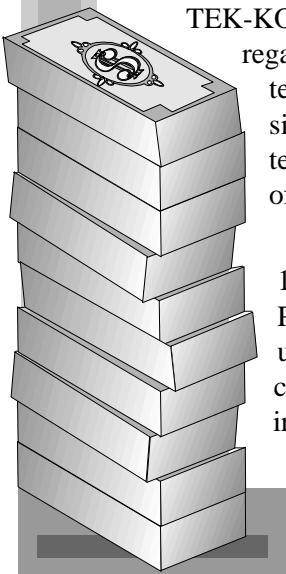
COMMERCIALIZATION UPDATES

Customs Coals International has gone public on the NASDAQ stock exchange. Custom Coals Corporation also has received approvals from the China State Planning Commission and State Council to proceed (under a cooperative agreement signed with the Chinese in 1994) with the building of a nearly \$1 billion project involving a coal cleaning plant, a 500-mile underground slurry pipeline, and a port facility. Custom Coals will use a coal cleaning technology developed under the CCT Program to reduce total mineral impurities in Chinese coals, including sulfur and heavy metals, from 30 percent to 6 percent.

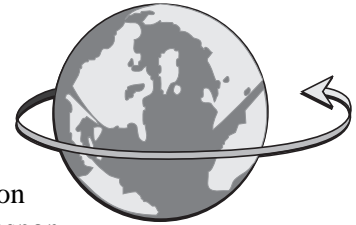
TEK-KOL, whose Liquids-From-Coal (LFC) process is being demonstrated at the DOE Clean Coal Technology Program ENCOAL Mild Coal Gasification Project, entered into an agreement in June 1996 with Japan's Mitsui SRC Development Co. to use the technology in Japan. The LFC process converts low-Btu coal into Process Derived Fuel (PDF), a cleaner-burning, solid fuel with reduced sulfur and moisture contents, and Coal Derived Liquid (CDL), a low-sulfur hydrocarbon liquid, which can be used as an industrial fuel or can be further refined as a source of chemical feedstocks and transportation fuels. Mitsui will conduct a market assessment to evaluate the Japanese electric utility, industrial, and steel manufacturing markets for PDF and CDL. TEK-KOL anticipates that the two products would be produced by one of several potential LFC plants in Asia, which are being evaluated by the two firms. In February 1996, an agreement was signed between

TEK-KOL Partnership and Mitsubishi Heavy Industries to conduct advanced feasibility studies regarding prospective engineering and construction of commercial plants using the LFC clean coal technology, including three projects underway in East Kalimantan and South Sumatra, Indonesia, and Central Siberia in Russia. This represents growing opportunities where the clean coal technology demonstrated at ENCOAL can be applied to low-rank coals in developing regions of the world.

ENCOAL continues to develop new applications for their projects, with a recently successful 10,000 ton test burn of PDF at a major power plant partially owned by the American Electric Power Company. This has led to additional orders of this compliance fuel by other Midwest utilities. Further, tank car quantities of CDL have been successfully injected by USX into a commercial-size blast furnace, confirming the fuel's acceptability as a supplemental fuel in the iron-making process. (PDF may also have possibilities as a blast furnace injectant.) ENCOAL also has initiated a sales agreement with a Louisiana refinery that will blend its normal crude oil slate with CDL for conventional upgrading into a commercial suite of co-products. This purchase order is expected to acquire around 1 million gallons of CDL produced at the demonstration project. ☆



INTERNATIONAL INITIATIVES



In July, the DOE Office of Fossil Energy (FE) co-sponsored a workshop with the United States Energy Association at the Independent Power Production Conference in Rio de Janeiro, Brazil. The workshop dealt with the roles, responsibilities, and regulatory functions of state utility commissions, and was designed for the State of São Paulo representatives who are charged with organizing and establishing a Public Utilities Commission for their State. Barbara McKee, FE's Director of International Program Coordination, spoke on "Independent Power Production in Brazil: Creating a New Reality."

The Conference is a followup to a conference co-sponsored by DOE last December in Rio entitled "Fossil Fuel Power Generation: Clean Applications for Brazil." Since that time, DOE has signed statements of intent with the Brazilian states Rio Grande Do Sul and Santa Catarina. Additionally, a U.S. company, Coopers and Lybrand, was hired by Brazil to study the restructuring of the country's utility sector. A delegation from Brazil visited the U.S. to investigate clean coal technologies, current mining techniques, and engineering and other services available to Brazil.

U.S./AUSTRALIA CCT INTERESTS IN SYNC

In May, Fossil Energy officials departed on a fact finding mission to Australia to investigate opportunities and obstacles to U.S. exports of clean coal technologies, and to explore opportunities for cooperation on R&D. The goal was to develop a strategy for a government/industry partnership to develop the Australian market for U.S. CCTs.

Australia is the world's biggest coal exporter, and has conducted its own R&D and clean coal technology demonstrations. U.S. firms already have enjoyed some success participating in the increasingly privatized Australian utility sector, competing successfully for equity participation in distribution companies in Victoria, for example, and in winning contracts for operating plants in other Australian States where privatized utilities buy competitive power from independent power producers.

Australia has excess electric generating capacity, and no near-term baseload facilities will be needed. For environmental and economic reasons, natural gas is most likely to be used to satisfy general growth and added demand. Both countries have a commonality of interest in environmental concerns, and are opening up new markets in the developing countries of the Asia-Pacific region. Required investment in new generating capacity in this area is placed at \$1.3 trillion through 2010. The challenge is to develop CCTs that will bring down the cost of electricity sufficiently to be competitive.

During the mission, DOE Assistant Secretary for Fossil Energy, Pat Godley, spoke at the 1996 Australia Coal Conference in Queensland. She stated that through advanced technology, it will be coal that electrifies the world well into the 21st century. Citing the advances achieved through the DOE CCT Program, she pointed to the rise in plant efficiency to nearly 50 percent, compared to 35-38 percent for conventional technology, as well as significant reductions in fly ash, NO_x, CO₂, and SO₂ emissions.

Preliminary discussions for bilateral talks between Australia and the United States are scheduled to start in October 1996.

FOSSIL ENERGY ACTIVITY IN CHINA

The U.S. DOE Office of Fossil Energy has had a long relationship with the Chinese government. A protocol agreement was signed in 1985 with the Ministry of Coal, and since then 12 annexes have been initiated and two are in development. The most active of these is with the Chinese State Science and Technology Commission for joint activities relating to clean coal technology. Other annexes include coal mine safety, climate data for analysis of global climate change, and coal bed methane. The new annexes under development address production of liquids and chemicals from coal and the management and regulation of coal mine operations in a market environment.

The clean coal activities over the past two years have focused on supporting the Ministry of Electric Power with the assessment of an Integrated Gasification Combined Cycle (IGCC) demonstration project in Beijing. China issued Agenda 21, a plan for sustainable development, and identified IGCC and pressurized fluidized-bed technology as the top priorities for the future. The plan is to develop demonstration projects to be in operation in the early part of the next decade, leading to commercial replication by 2010.

Other activities of the Department have involved conducting several missions to China with industry to promote U.S. technology, and missions to the U.S. by Chinese delegations interested in gasification, fluidized-bed combustion, hot gas cleanup, and coal fire prevention. A workshop on project financing also is planned to be held in China, and the U.S. and China are conducting market analyses for IGCC, coal preparation, sulfur removal, and coal liquids. A joint U.S.-Chinese seminar on coal mine fires was held in June 1996 in Beijing. It was so successful that in July, China sent a delegation to the United States for more detailed discussions on the subject.

Another activity sponsored by DOE's Office of Clean Coal Technology, EPA, and the Chinese Government is a U.S.-China Center for Energy and Environment in Beijing. DOE and EPA signed an interagency agreement to establish the Center in September 1995. The Center will have three primary functions: 1) identify and develop business opportunities; 2) assist with development of energy policy for China; and 3) conduct technical, business, and financial education programs. In connection with the Center, DOE and EPA have been working with the Yixing Environmental Industrial Park in Yixing, China to develop opportunities for U.S. business. The *Annual Report — Joint United States and People's Republic of China Clean Coal Activities* (DOE/FE-0348) has just been published and is available from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, (703) 487-4650.

NEW CHINA LAWS TO REDUCE SO₂

Sharon K. Marchant, the Pittsburgh Energy Technology Center Regional Manager for the Pacific Rim shown speaking with Madame Deng Nan, Vice Minister of State Science and Technology Center, and translator, presented a paper on the DOE CCT Program at the Conference on Energy and Sustainable Development in Beijing, China, in July 1996. Seventy-five participants attended the session on clean coal, which focused on technology improvements for the efficient generation, transmission, and distribution of electricity to support China's short-term needs for rapid economic development.



China has shown a key interest in U.S. CCTs to reduce SO₂, and is looking for affordable solutions to its pollution problems. At the conference, China characterized its environmental issues as: pollution from coal use and heavy transportation in urban areas; serious acid rain in the south of China; and high overall CO₂ emissions. China has recently passed two laws, extending environmental regulation beyond



control of particulates: the “Law on Pollution Control and Prevention” passed in August 1995, and the “Law on Power Generation” passed last December. The latter, for the first time, introduces the concept of environmental protection into power planning.

Overall, the Chinese government has taken a series of important steps since 1990 to deal with SO₂ emissions. In 1995, China’s National Environmental Protection Agency proposed that SO₂ emissions in the year 2000 should remain at 1995 levels. Present government actions include levying fees on SO₂ emissions; mapping zones of SO₂ and acid rain concern; analyzing costs and benefits; setting standards and establishing policies to control SO₂ in the zones of concern; and tightening standards for emissions from thermal power plants, cement plants, and coke ovens. Current activities include laying the groundwork for SO₂ emissions quotas at the provincial level, and addressing mitigation options for SO₂ emissions. Lastly, the Chinese Government is working toward setting standards for limits on sulfur and ash content for coal consumed, as well as technologies to lower sulfur and ash content.

FE INTERNATIONAL ON-LINE

The latest addition to the Fossil Energy Home Page-related services is an FE-International Internet Worldwide Web Site, which can be accessed by clicking on the “International” hyperlink at the Fossil Energy Home Page (<http://www.fe.doe.gov>). This new international web site contains summaries of DOE Fossil Energy international activities, and has links to country-specific information on business-related topics in seven regions of interest (Africa, Eastern Europe, Western Hemisphere, Russia and Newly Independent States, Pacific Rim, South Asia and Near East, and Western Europe). It also has links to international organizations in the energy and finance sectors. The site is intended to become a “one-stop” information resource for anyone wishing to do business in the international marketplace.



In addition, DOE soon will be offering the Fossil Energy International Fast Track E-Mail Information Service. This service routes breaking news on clean coal technologies, U.S. offerings, trade activities, and project opportunities to the Internet e-mail address of subscribers. The Fast Track E-Mail service is free, and is available by registering either through the FE-International Internet Home Page at: <http://www.fe.doe.gov/int/interna2.html>, or by registering via fax, 301-903-1591. The registration form requests information on area of technology interest (for coal, this includes technologies for existing power plants, for new plants, and for other applications), as well as for oil and natural gas.

INTERNATIONAL CCT FINANCE SEMINAR

A Clean Coal Technology Finance Seminar was held in May 1996 at DOE Headquarters with the purpose of receiving views and advice from the U.S. clean coal technology industry on the international marketplace, and to gain better insight and understanding on how to strengthen the relationship between the coal industry and the finance community on technologies, markets, and projects. This seminar was one of a series of financial discussions being held in the various DOE energy program areas by the newly formed DOE Finance Task Force, which is tasked with building the capacity within the finance community to evaluate and price technical risks associated with clean energy options, and to assist in the mobilization of technical and financial resources for clean energy projects.

Opening remarks and introductions were delivered by the Fossil Energy (FE) Assistant Secretary Patricia Fry Godley; Director Sun W. Chun of the Pittsburgh Energy Technology Center; and Ben Yamagata, Executive Director, Clean Coal Technology Coalition, followed by six speakers from the coal industry and finance community. David Jhirad, Deputy Assistant Secretary, Office of International Energy Policy, made closing remarks.

Recognizing that America's ability to compete successfully in the international marketplace is critical to the future of our fossil energy fuel industry, FE is an active participant in Finance Task Force efforts. An integral part of FE's international strategy is the leveraging of limited Departmental resources to promote U.S. trade and investment in the electric power sector. As the electric power sectors of many nations undergo radical reform, it is crucial to coordinate efforts that maximize U.S. industry participation in these burgeoning markets. The changes in the electric power sectors in developing countries also present the Department with timely opportunities to promote trade and investment in clean energy solutions, such as renewable energy systems, energy efficiency and clean fossil technologies.

The Finance Task Force will continue to look at project financing in different energy sectors such as renewables and energy efficiency. It also will address financing by international region (a Western Hemisphere Roundtable also is planned). As articulated by Deputy Assistant Secretary Jhirad, the best project ideas will not come to fruition if financing is not secured. ★

PROFILE OF CCT PROGRAM PARTICIPANTS AND TEAM MEMBERS

The Clean Coal Technology (CCT) Program has approximately 273 stakeholders participating in the projects of the CCT program. The approximate number of stakeholder participants and percent of funding contributed to each of the 40 projects is shown below. In addition, the CCT Program participates actively with many stakeholder organizations, trade associations, energy organizations, and many individuals.

Project Stakeholders	Approximate Number	Percent of Contribution
Investor-Owned Utilities	55	40
Nonutility Generators	2	9
Technology Owners	55	6
Industry	10	4
State Agencies	8	3
Municipal Utilities	2	2
Equipment Vendors	100	1
R&D Organizations	8	<1
Cooperative Utilities	3	<1
Project Developers	10	<1
Other	20	<1
Total	274	66%

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PURE AIR PROJECT COMPLETED

Following three years of successful operations, the Advanced Flue Gas Desulfurization (AFGD) Clean Coal Technology (CCT) demonstration project was completed and the Technical Final Report was issued in June 1996. The AFGD will continue to operate for an additional 17 years under a novel business concept whereby Pure Air on the Lake L.P. (a general partnership between Air Products and Chemicals, Inc. and Mitsubishi Heavy Industries America, Inc.), and not the utility, will own and operate the AFGD unit.

The project was selected in September 1988 to receive cooperative funding under the DOE CCT Program for the design, construction, and operation of an AFGD facility at Northern Indiana Public Service Company's Bailly Generating Station, Units 7 and 8, in Chesterton, Indiana. The facility was built to scrub all the flue gas from Bailly's two coal-fired boilers, which have a nameplate capacity of 600 MW (permitted for 528 MW). The objective was to demonstrate removal of 90-95 percent or more of the SO₂ at approximately half the cost of conventional scrubbing technology, while at the same time reducing space requirements.

OPERATING RESULTS

Variable	Expected	Achieved
SO ₂ Emissions	90% removal or 0.6 lb/million Btu	Avg 94.71% (during demonstration tests) up to 98+% or 0.382 lb/million Btu
Power Consumption 24-hr avg (kW)	<8,650	5,275
Availability (%)	95	99.47
Gypsum Moisture (%)	<10	6.64
Gypsum Purity (%)	93	97.2
Average Water Consumption (GPM)	3,000	1,560

The AFGD Clean Coal project demonstrated a number of unique features that are likely to become the standard for scrubbers in the future.

- A *Single Large Absorber*, offering 95 percent availability, is used in place of several SO₂ absorbers and spare modules. At the time the AFGD facility at Bailly began to process flue gas in 1992, it was the largest capacity single SO₂ absorber in the United States.
- The *Single Loop Scrubber With In-Situ Oxidation* (instead of several separate vessels) is another space saving feature of the AFGD facility. The SO₂ absorber performs three separate functions: pre-quencher, absorber, and oxidizer of scrubber liquid (calcium sulfite) to gypsum (calcium sulfate). The AFGD system at Bailly produces a gypsum by-product suitable for commercial uses such as wallboard and cement, instead of the scrubber sludge, which requires landfilling.

- The *High Velocity, Co-Current SO₂ Absorber* moves the scrubbing slurry in the same direction as the flue gas flow. Operation at a relatively high flue-gas velocity of approximately 20 feet per second allows for a more compact scrubber.
- *Direct Limestone Injection* into the SO₂ absorber also is used. The pulverized limestone was purchased from a limestone supplier, eliminating the need for on-site wet grinding systems.
- The *Air Rotary Sparger* combines the functions of mixing and air distribution within the absorber, facilitating the oxidation of scrubber liquid to gypsum.

SO₂ REMOVAL AND GYPSUM PRODUCTION

A major parameter investigated in the test program was the sulfur content of the coal. Six short-term tests were conducted during the three-year demonstration program, and were used to evaluate the performance of the AFGD system with coals of a sulfur content ranging from 2-4.5 percent. This sulfur range permitted the use of many coals from the Illinois basin, many of which otherwise would not have been usable due to restrictions of the Clean Air Act Amendments of 1990.

High-range sulfur coal offers the challenge of meeting design requirement for the scrubber, and tests the accuracy of design correlations. The prediction of a lower-than-actual performance causes higher capital expenditures to be made; conversely, a model that predicts higher-than-actual performance will cause insufficient capital to be spent. Higher sulfur coal also produces a higher quality gypsum due to the production of more pounds of calcium sulfate per pound of fly ash.

The average sulfur removal efficiency was 94.71 percent resulting in removal of 76,679 tons per year of SO₂ while providing a commercial gypsum by-product. Some of the by-product gypsum was agglomerated and flaked into PowerChip™ gypsum to enhance its transportation and marketability to gypsum end-users. The product was delivered and tested in full-scale trials at a number of wallboard and cement plants. In most cases, the PowerChip™ gypsum material flow properties were acceptable to the plant operator without modification.

Exposure of PowerChip™ gypsum to weather conditions was evaluated in lab-accelerated weathering tests and also in outside pile placements. The product endured exposure to rain, snow, and freeze/thaw cycles, but it is preferable to provide a simple shed roof over the chips for storage outside.

The average production rate of gypsum was 207,623 tons/year with a total of 622,871 tons being produced over the duration of the demonstration project. The National Association of Home Builders suggests that an average 2,085-square-foot house requires 6,144 square feet of interior wall material. Based on that assumption, the AFGD facility has produced enough gypsum to manufacture the wallboard needed to construct approximately 32,500 new homes annually.

WASTEWATER EVAPORATION SYSTEM

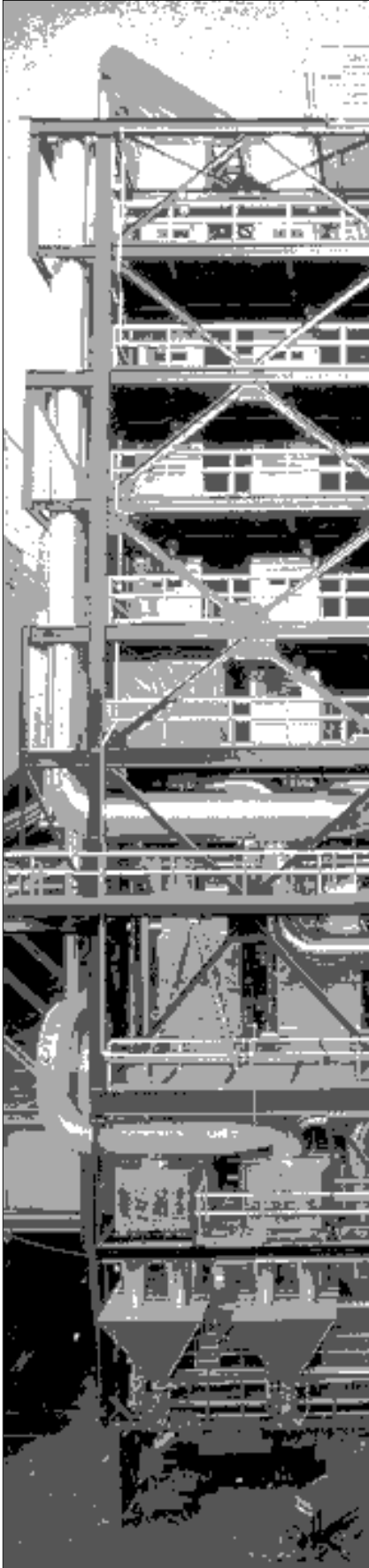
The AFGD project at Bailly included testing of a novel *Wastewater Evaporation System* (WES). Wastewater disposal often poses a difficult problem for scrubber operators, particularly where oxidation of scrubber liquid to gypsum is employed. In

the WES process, wastewater is injected into the flue gas ductwork upstream of the existing electrostatic precipitator (ESP). The hot flue gas evaporates the wastewater, and dissolved solids in the wastewater solidify so that they are collected by the ESP along with the fly ash. The WES was tested successfully on one boiler unit at Bailly, showing that scrubbers of the future could produce a usable gypsum by-product and no wastewater effluent.

The overall objectives of the WES testing were to evaluate the performance of the nozzles, the extent to which a closed-loop system (which decreases water use) could be accomplished using the WES, and the effect of wastewater injection on system performance (i.e., ESP and FGD performance). The WES was operated continuously for a nine-month period between July 1, 1994, and March 31, 1995.

COMMERCIAL SUCCESS

In the first commercial sale of the process, Pure Air of Manatee, L.P., entered into a contract in April 1994 to provide 1,600 MW of SO₂ scrubbing capability at Florida Power & Light Company's Manatee power plant, located near Bradenton, FL. The Manatee scrubber will feature two 800-MW absorber vessels, gypsum recycling, and wastewater evaporation. Florida Power & Light is converting the Manatee power plant from oil to low-cost Orimulsion fuel. Even with the added cost of the new scrubber, the fuel conversion is expected to save the utility (and its ratepayers) approximately \$4 billion over 20 years. ☆



SCR SUCCESSES: CATALYST PERFORMANCE & NO_x REDUCTION

Selective catalytic reduction (SCR) has lowered nitrogen oxide (NO_x) emissions from burning pulverized, high-sulfur U.S. coal by 80 percent or better during two years of testing at Gulf Power Company's Plant Crist near Pensacola, Florida. The technology was demonstrated through the DOE Clean Coal Technology (CCT) project, "Demonstration of Selective Catalytic Reduction Technology for Control of NO_x Emissions from High-Sulfur-Coal-Fired Boilers."

A number of successful commercial SCR installations that use catalysts demonstrated in this project are now operational in the United States. Further, as a result of this demonstration, utilities now have a flue gas NO_x removal technology that has the flexibility and removal capabilities of 80 percent or better to assist them in meeting both Title IV (acid rain) and Title I (ozone non-attainment) provisions of the Clean Air Act Amendments of 1990.

The \$23 million CCT project took place at Unit 5, a commercially operating 75-MWe tangential-fired dry-bottom boiler equipped with hot- and cold-side electrostatic precipitators (ESP) for particulate removal. For the project, nine slip streams were removed from the stack gas duct and routed to nine test reactors. Eight reactors operate on high-dust flue gas, while the ninth reactor operates on low-dust flue gas using a slip stream at the exit of the host unit's side precipitator. Testing began in July 1993 and ended in July 1995. Final reports are in preparation.

Project participant, Southern Company Services, Inc., and team members, the Electric Power Research Institute, Ontario Hydro, and Gulf Power Company, paid 60 percent or \$13.8 million of the \$23 million CCT project cost, with DOE paying the remaining 40 percent.

For the CCT demonstration, three 2.5-MWe-equivalent SCR reactors and six 0.20-MWe-equivalent SCR reactors supplied by separate slipstreams were installed at the Plant Crist facility. The slip streams were large enough to allow the process data to be scaled to commercial size. Catalyst suppliers (two U.S., two European, two Japanese) provided eight catalysts of several shapes and compositions. The eight different catalysts (seven high-dust and one low-dust) performed within or exceeded design specifications with respect to catalyst activity and life, although some differences in NO_x reduction, SO₂ oxidation, physical fouling, and pressure drop were noted.

SCR involves injecting ammonia into flue gas that is passed through a catalyst bed where NO_x and ammonia react to form molecular nitrogen and water vapor. Although several plant configurations are possible, the flue gas typically enters the SCR reactor at *economizer exit conditions*. Under typical design and operating parameters, NO_x control efficiency is directly proportional to the ammonia-to-NO_x ratio, with NO_x levels at approximately 80 percent. Not all of the injected ammonia reacts, and the unreacted ammonia is referred to as ammonia slip. It is usually desirable to keep ammonia slip below 5 ppm. Under baseline testing conditions, all catalysts performed well, with ammonia slips less than 2 ppm.

Clean coal demonstration testing showed that for these eight SCR catalysts, ammonia slip increased with increasing reactor flow rate (space velocity), as expected. However, overall ammonia slip was relatively minor, indicating the ability of catalysts to withstand significant increases in flow while meeting ammonia slip limits. Because reaction rate is controlled in part by mass transfer limitations, improvements in mass transfer coefficients are likely mitigating the effect of increased space velocity, demonstrating that the SCR system can follow load variations while meeting emissions specifications.

Because a catalyst is the heart of the SCR process, catalyst durability and life span are critical factors. Commercially available in the form of honeycombs or plates, several catalyst elements are bundled together to form a catalyst module. Commercial installations use multiple modules in several layers to fill an SCR reactor. Current formulations of catalysts typically employ vanadium pentoxide as the active material deposited on, or incorporated into, a substrate.

The Plant Crist test was important in demonstrating the applicability of SCR to U.S. coals. The technology has been widely and successfully used to meet stringent NO_x emissions regulations in Europe and Japan from boilers fueled by gas, oil, and low-sulfur coal. However, concerns about using the technology to curb NO_x levels from U.S. boilers burning domestic high-sulfur coals have stymied SCR's use in this country. Some of these concerns center around potential catalyst deactiva-

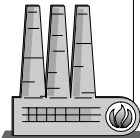
tion resulting from poisoning by trace metals found in some U.S. coals that are not present or are in minute concentrations in other fuels, as well as plugging of downstream equipment with ammonia-sulfur compounds resulting from ammonia slip.

the United States, representing a generating capacity of almost 300,000 MWe. Assuming that SCR were installed on dry-bottom boilers not equipped with other low-NO_x combustion techniques, such as low-NO_x burners or overfire air, the potential retrofit market is about 155,000 MWe, or about 650 boilers. In addition, SCR could be applied to about 35,000 MWe (70 boilers) of announced and already sited installations, and 145,000 MWe (290 boilers) of planned dry-bottom electric generating capacity in the United States.

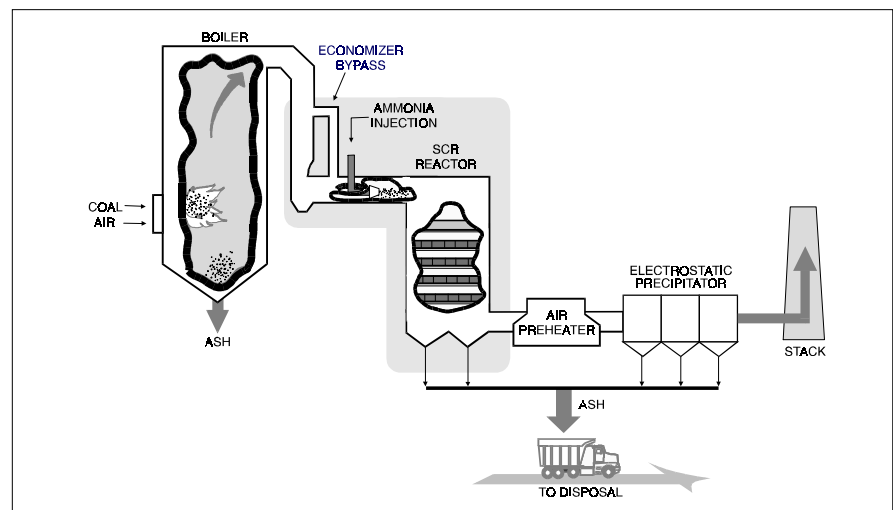
Economic studies at the U.S. Department of Energy Pittsburgh Energy Technology Center (PETC), confirmed by recent reports in the technical literature, have shown that an SCR unit achieving 80 percent NO_x control can be installed on a greenfield coal-burning power plant at a capital cost of about \$50/kW. For situations where a high degree of NO_x reduction is required, the SCR process offers favorable economics. ★

SCR PROJECT CATALYST SUPPLIERS

Catalyst Supplier	Reactor Size	Catalyst Configuration
Nippon Shokubai	Large	Honeycomb
Siemens AG	Large	Honeycomb
W. R. Grace	Small	Honey comb
W.R. Grace	Small	Honeycomb
Haldor Topsoe	Small	Plate
Hitachi Zosen	Small	Plate
Cormetech	Small	Honeycomb
Cormetech	Small	Honeycomb (low dust)



With the Clean Air Act Amendments of 1990 effectively limiting NO_x emitted from U.S. coal-fired utility boilers, the potential SCR market in the United States is large, particularly since the technology can be applied to new installations and adapted to existing boilers of virtually any size. There are approximately 1,000 coal-fired utility boilers in active commercial service in



O'LEARY HERALDS BRIGHT FUTURE FOR COAL

"Coal — A Fuel for the Future" was the topic of Energy Secretary Hazel O'Leary's speech before the semi-annual meeting of the National Coal Council (NCC) in Washington, D.C., this May. The Secretary underscored the important role that coal has in the prevailing and future global energy supply mix, and emphasized improvements in the efficiency and environmental performance of coal-using technologies to meet future market needs.

O'Leary addressed an audience of the 125-member NCC, as well as members of the general public and media. She praised the industry/DOE partnership in the research, development, and demonstration of technologies to enable stepwise reductions in the emissions of pollutants for coal-fired power plants, and in significantly advancing the efficiency of coal using such technologies. In particular, the Secretary cited the Clean Coal Technology (CCT) Program as a prime example of a public/private partnership in which successes can be measured in terms of tangible societal benefits, and emphasized the importance that the federal government continue with a sustained investment in energy research and in partnerships with industry to bring promising technologies to both the domestic and global marketplaces.

CCT Program —

A prime example of a public/private partnership in which successes can be measured in terms of tangible societal benefits.



The Secretary foresees an expanded role for coal both domestically, where demand is expected to grow 1.3 percent per year over the next decade, and internationally. The bulk of demand will be in developing countries. China, for example, is expected to double capacity by 2010. Worldwide, 1,190 gigawatts of new power capacity will be needed over the next 15 years, requiring an investment of \$1.4 trillion. Half of this investment is expected to be for coal-fired plants, since coal is expected to remain the baseload fuel of

choice. O'Leary said that "If we do not make the investments needed to make U.S. electric power and clean coal technologies competitive, then we will lose out on what we know will be a very lucrative market. Moreover, the U.S. may end up having to import foreign technology to fill its domestic needs." She added that the coal industry "must recognize its own investment in R&D is critical for its future survival in increasingly competitive global markets." O'Leary pointed out that every government dollar put into the CCT Program has resulted in an additional \$2 in private and/or state involvement.

Citing huge reductions in particulate and sulfur emissions, and progress made in nitrogen oxides reductions, O'Leary called the power plants of the 90s a "giant step ahead of the past." Further, the Department's goals for power plants coming on line between now and 2010 are 98 percent removal of SO₂ and 95 percent removal of NO_x, while achieving over 50 percent system efficiency. Still, the coal industry and the Department need to become more effective communicators of coal's successes, so that "... the public no longer associates the word 'dirty' with the word 'coal.'"



Energy Secretary Hazel O'Leary sees an expanding role for coal domestically and internationally.

NATIONAL COAL COUNCIL

The NCC was established by the Secretary of Energy in 1984, and chartered in accordance with the Federal Advisory Committee Act. It provides advice and makes recommendations to the Department on national policy matters relating to the domestic and international production, marketing, and use of coal. Its members are representative of the entire coal industry including coal production companies, electric utilities, independent power producers, equipment suppliers, and consulting service companies. The Council recently completed a study for DOE on the "Implications on Coal Markets of Possible Utility Deregulation and Restructuring" and is currently undertaking "Consumption Issues Affecting the Role of Coal in the U.S. Energy Strategy."

Copies of NCC reports can be obtained from the National Coal Council by calling (703) 527-1191. The Secretary's speech can be obtained from the DOE Office of Public Affairs at (202) 586-4940. ★



FAST FACTS

FROM SECRETARY O'LEARY

- Coal will continue to be the primary baseload fuel well into the next century.
- Coal contributes \$21 billion to our economy every year, with an added indirect contribution of \$132 billion.
- Coal exports are expected to rise from 71 million tons in 1994 to 130 million tons in 2015.
- CCTs can cut CO₂ emissions by almost 30 percent, and smog and acid rain can be cut to negligible levels by 2010 using today's clean coal technologies.
- 1,190 gigawatts of new power capacity is needed over the next 15 years, requiring a \$1.4 trillion investment. Half of this investment will go for coal.
- There is a \$128 billion world market for coal repowering and retrofits over next 15 years.
- U.S. sales of fluidized-bed combustion technology amount to \$6 billion, while foreign sales contributed \$2 billion to our economy.
- U.S. sales of low-NO_x burners amount to \$900 million, stemming from a \$40 million investment.
- The market for coal gasification is expected to be \$230 billion in the next decade, creating 250,000 jobs.
- Every \$1 invested by the government in the CCT program has resulted in additional \$2 private and/or State investment.



Fifth Annual Clean Coal Technology Conference

Powering the Next Millennium

January 7 — 10, 1997 • Tampa, Florida

The Fifth Annual Clean Coal Technology Conference will focus on presenting strategies and approaches that will enable clean coal technologies to resolve the competing, interrelated demands for power, economic viability, and environmental awareness associated with the use of coal in the post-2000 era. Recognition will be given to dynamic changes that will result from utility competition and industry restructuring, and to the evolution of markets abroad. Current projections for electricity confirm the preferential role that electric power has in accomplishing the long-range goals of most nations. These increased demands can be met by utilizing coal in technologies that achieve environmental goals while keeping the cost-per-unit of energy competitive. Promising results from projects in the DOE Clean Coal Technology (CCT) Program confirm that technology is the pathway to achieving these goals.

The industry/government partnership, cemented over the past 10 years, is focused on moving clean coal technologies into the domestic and international marketplaces. The Fifth Annual Clean Coal Technology Conference will provide a forum to discuss these benchmark issues and the role and need for these technologies in the post-2000 era.

Registration Information

The registration fee of \$425 covers continental breakfasts, luncheons, breaks, tours, and the reception. The fee of \$60 for spouses includes the tours, dinner event, and reception on Thursday, January 9. For registration forms and information please contact: The Center for Conference Management, U.S. Department of Energy, 1000 Independence Avenue, Washington, DC 20585, or call (202) 586-7920. Registration should be completed by December 9, 1996.

Site Tours

Tours are scheduled to the Tampa Electric Integrated Gasification Combined-Cycle Project, located just south of Mulberry Township and to the Electric Technology Research Center, located near Busch Gardens.

Hotel Information

All other events will be held at the Hyatt Regency Westshore, 6200 Courtney Campbell Causeway, Tampa, Florida, approximately five minutes from Tampa International Airport. The Conference rate is \$100.00 per night plus tax (single or double). To guarantee this rate, **reservations must be made by December 9, 1996**, by calling 800-233-1234 or 813 874-1234. Mention the Fifth Annual Clean Coal Technology Conference.

... "Project News Bytes" from page 1 running at full speed. Transition to combined cycle and providing power to the grid is expected shortly, with the gasifier expected to start up in December 1996.

The **Wabash River Coal Gasification Repowering Project** is expected to follow Nucla CFB Demonstration Project and Tidd PFBC Demonstration Project in becoming a world showcase for clean coal technology. The project generated over 200,000 megawatt-hours of electricity in the first six months of 1996. Since commercial operation began in late 1995, the gasifier has achieved 100 percent of capacity and the gas turbine has achieved 100 percent of load, generating 192 MW of power. Emission rates of 0.06 pounds of SO₂ per million BTU of coal fired, equivalent to 97 percent sulfur removal, have been demonstrated as well.

The reactor installation for the Air Products Liquid Phase Conversion Company **Liquid Phase Methanol (LPMEOH™)** demonstration project was completed in

July. With the reactor now in place, construction of the 80,000 gallon-per-day unit at the Eastman Chemical Company complex in Kingsport, Tennessee, will proceed rapidly. A January 1997 start-up will begin a four-year operational period to demonstrate technical feasibility and to gain commercial acceptance of the technology.

Custom Coals International has produced 165,000 tons of Carefree™ Coal through July 1996 and is continuing to work on process optimization, testing, and analysis. Power plant testing of Carefree™ Coal is scheduled for September 1996. Production and power plant testing of Self-Scrubbing Coal™ is scheduled for the fourth quarter of 1996 and early 1997.

Rosebud Syncoal® Partnership's Advanced Coal Conversion Process Demonstration continues to showcase its technology and market the Syncoal® product to industrial and utility customers with cumulative sales topping 850,000 tons to date. An electrical engineer with the project has recently been notified

that his patent application for an improved rotary airlock control will be approved.

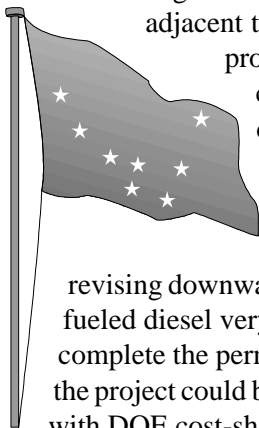
In August 1996, DOE agreed to terms for its final CCT project — **CPICOR Management Company's** first-of-a-kind technology that combines direct iron-making with an environmentally clean process for co-producing electricity. DOE will sign the agreement once Congress completes its required review. The project will be located at the Geneva Steel Plant in Vineyard, Utah. Watch for more details in subsequent issues of *Clean Coal Today!*

DOE and **American Electric Power Service Corporation** recently announced that they would not proceed with the PFBC Utility Demonstration Project, originally proposed for West Virginia and more recently considered for re-siting in Florida. Although the project will not be constructed, design work produced a significant amount of engineering data and other valuable information. ☆

COAL-FUELED DIESEL ENGINE DEMONSTRATION PROJECT RE-SITED TO ALASKA

In August 1996, DOE approved the Arthur D. Little (ADL) proposal to re-site the Coal-Fueled Diesel project adjacent to the existing University power plant at the University of Alaska in Fairbanks, Alaska. The project would demonstrate a 6.3-megawatt diesel engine operating on Alaskan subbituminous coals. The engine, manufactured by Cooper-Bessemer, would be modified with hardened components to handle the abrasive ash found in coal. The subbituminous coal, mined from the nearby Usibelli mine, would be cleaned and treated by an advanced hot-water drying process that removes most of the inherent moisture in the coal thereby increasing its heating value.

The earlier site host, Easton Utilities in Maryland, withdrew from the project last year after revising downward their estimates for future power demand. The high cost of fuel oil in Alaska makes the coal-fueled diesel very attractive for the area and will result in long-term savings to the University. ADL hopes to complete the permitting and the NEPA process in time to break ground in June 1997. Based on this schedule, the project could be producing power by late-1998. The project is estimated to cost approximately \$38.3 million, with DOE cost-sharing 50 percent or \$19.15 million.



STATUS OF CCT DEMONSTRATION PROJECTS

ADVANCED ELECTRIC POWER GENERATION

The Appalachian Power Co.

PFBC Utility Demonstration Project. The project has been withdrawn.

DMEC-1 Ltd. Partnership

PCFB Demonstration Project. In combination with the Four Rivers Project, this project is being restructured and re-sited. (Site under negotiation.)

Four Rivers Energy Partners, L.P.

Four Rivers Energy Modernization Project. The project is being restructured and re-sited. (Site under negotiation.)

The Ohio Power Co.

Tidd PFBC Demonstration Project. The project ended December 31, 1995. DOE released the Final Report and will close out the project after a final audit. (Brilliant, OH)

Tri-State Generation and Transmission Association, Inc.

NUCLA CFB Demonstration Project. The project was completed April 1992. (Nucla, CO)

York County Energy Partners

ACFB Demonstration Project. Discussions are under way with a major utility to re-site this project. (Site pending at Pennsylvania Electric Co. Seward Station pending DOE approval.)

ABB Combustion Engineering, Inc.

Combustion Engineering IGCC Repowering Project. The project has been withdrawn.

Clean Energy Partners, L.P.

Clean Energy Demonstration Project. The project is being restructured. (Site under negotiation for an east coast location.)

Sierra Pacific Power Co.

Piñon Pine IGCC Power Project. The project is in its construction phase. By fall of 1996, plant construction had reached the 90 percent completion point. The power island was operating in the natural gas combined cycle mode. The gasifier island was expected to begin firing by the end of 1996. (Reno, NV)

Tampa Electric Co.

Tampa Electric Integrated Gasification Combined-Cycle Project. Construction is 99 percent complete. The project is on schedule for fall 1996 startup. (Mulberry, FL)

Wabash River Joint Venture

Wabash River Coal Gasification Repowering Project. The project is in the commercial operations phase. (West Terre Haute, IN)

Alaska Industrial Development and Export Authority

Healy Clean Coal Project. Construction and engineering efforts are continuing. The erection of structural steel is virtually complete, and ducts proceeding ahead of schedule. On-site fabrication of the spray dryer absorber system is complete as is the erection of the stack, and installation of the coal handling, slagging combustor, and boiler systems. Mechanical, electrical, and structural tie-ins and the retrofit to Unit No. 1 are proceeding on schedule. (Healy, AK)

Arthur D. Little, Inc.

Coal-Fueled Diesel Engine Demonstration Project. Arthur D. Little (participant) and Cooper-Bessemer (technology vendor) requested and received DOE approval to re-site the project to the University of Fairbanks, Alaska. (Fairbanks, AK)

Pennsylvania Electric Co.

Externally Fired Combined-Cycle Demonstration Project. Project activity has stopped as DOE and Penelec assess the technical readiness of the ceramic air heater — the critical element of the power island. (Warren, PA)

ENVIRONMENTAL CONTROL DEVICES

The Babcock & Wilcox Co.

Demonstration of Coal Reburning for Cyclone Boiler NO_x Control. The project is complete. The Final Report has been received. (Cassville, WI)

The Babcock & Wilcox Co.

Full-Scale Demonstration of Low-NO_x Cell Burner Retrofit. The project was completed in September 1995. (Aberdeen, OH)

Energy and Environmental Research Corp.

Evaluation of Gas Reburning and Low-NO_x Burners on a Wall-Fired Boiler. Testing was completed in December 1995. The Final Report is in preparation. (Denver, CO)

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. During open- and closed-loop testing in early 1996, the Generic NO_x Control Intelligence System (GNOCIS) showed the ability to optimize plant performance in terms of NO_x emissions, unburned carbon in fly ash, and overall plant efficiency. Final testing of GNOCIS in a closed-loop configuration had been postponed due to unit unavailability. Testing was first initiated in Spring 1996 and will resume in the fourth quarter of 1996. Over 15 U.S. utilities and industries are discussing commercial GNOCIS installations. The Public Design Report was issued first quarter 1996 and will be updated for the Final Report. (Coosa, GA)

Southern Company Services, Inc.

Demonstration of Selective Catalytic Reduction Technology for the Control of NO_x Emissions from High-Sulfur Coal-Fired Boilers. The project was completed in December 1995. (Pensacola, FL)

Southern Company Services, Inc.

180-MWe Demonstration of Advanced Tangentially-Fired Combustion Techniques for Coal-Fired Boilers. The project was completed in June 1994. (Lynn Haven, FL)

AirPol, Inc.

10-MWe Demonstration of Gas Suspension Absorption. The project was completed in June 1995. (West Paducah, KY)

Bechtel Corp.

Confined Zone Dispersion Flue Gas Desulfurization Demonstration. The Final Report is being prepared for distribution. (Seward, PA)

LIFAC-North America

LIFAC Sorbent Injection Desulfurization Demonstration Project. The Final Report is in preparation. (Richmond, IN)

Pure Air on the Lake, L.P.

Advanced Flue Gas Desulfurization Demonstration Project. The Final Report has been prepared and is in review. (Chesterton, IN)

Southern Company Services, Inc.

Demonstration of Innovative Applications of Technology for The CT-121 FGD Process. The Final Report is in preparation. (Newnan, GA)

ABB Environmental Systems

SNOX™ Flue Gas Cleaning Demonstration Project. The project operations are complete. The Final Report was submitted in July. (Niles, OH)

The Babcock & Wilcox Co.

LIMB Demonstration Project Extension and Coolside Demonstration. The project was completed in November 1992. (Lorain, OH)

The Babcock & Wilcox Co.

SO_x-NO_x-RoxBox™ Flue Gas Cleanup Demonstration Project. The project was completed in September 1995. (Dilles Bottom, OH)

Energy and Environmental Research Corp.

Enhancing the Use of Coals by Gas Reburning and Sorbent Injection. Testing was completed for both Illinois Power, Hennepin Station, and City Water Light & Power, Lakeside Station. The Final Report is in preparation. (Hennepin and Springfield, IL)

New York State Electric & Gas Corp.

Milliken Clean Coal Technology Demonstration Project. Heat pipe performance testing was done during June. Evaluation is in progress. Design coal FGD testing began in mid-May and will continue until November. (Lansing, NY)

Micronized Coal Reburning Demonstration for NO_x Control. The project has been novated from TVA to NYSE&G in association with its scrubber project.

NOXSO Corp.

Commercial Demonstration of the NOXSO SO₂/NO_x Removal Flue Gas Cleanup System. Design engineering continues on piping, electrical, and instrument disciplines. Contracts have been issued for duct work and piping tie-ins, re-routing of underground piping, and vessel fabrication and erection. Construction began in mid-1996. (Newburgh, IN) All materials have been

received for the liquid SO₂ facility. Final assembly of piping, electricals, and instrumentation is under way. Commissioning activities are being completed as various systems are mechanically complete. (Charleston, TN)

Public Service Company of Colorado

Integrated Dry NO_x/SO₂ Emissions Control System. Initial testing of the newly designed urea injection lance on the west side of the boiler was promising, and another lance was ordered. Integrated testing of the baseline sodium system with two of the newly designed urea injection lances is planned for October 1996. (Denver, CO)

COAL PROCESSING FOR CLEAN FUELS

CQ Inc. and ABB Combustion Engineering, Inc.

Coal Quality Expert. CQE was released in December 1995 and is now being offered commercially. The Final Report is being prepared. See article on page 1.

Custom Coals International

Self Scrubbing Coal™: An Integrated Approach to Clean Air. The plant continues to increase its availability as various process optimization progresses. The plant had processed a cumulative 217,000 tons of raw coal through July 31, 1996, producing 165,000 tons of clean coal with a clean coal quality averaging 8.4 percent ash and .84 percent sulfur. Power plant testing of Carefree™ Coal was scheduled for September 1996. (Central City, PA; Lower Mt. Bethel Township, PA; Richmond, IN; Ashtabula, OH)

Rosebud SynCoal Partnership

Advanced Coal Conversion Process (ACCP) Demonstration. The ACCP demonstration facility continues to process raw subbituminous coal, producing over 850,000 tons of SynCoal® product to date. SynCoal® product is continually supplied to several customers, including industrials (primarily cement plants), and utilities. Development focus continues on an extended lime kiln test in Wyoming. (Colstrip, MT)

ENCOAL Corp.

ENCOAL Mild Coal Gasification Project. ENCOAL's plant continues to operate satisfactorily. To date, the plant has operated more than 10,500 hours on coal, and has shipped 2.6 million gallons of liquid product and 64,000 tons of solid product. (Gillette, WY)

Air Products Liquid Phase Conversion Company, L.P.

Commercial-Scale Demonstration of the Liquid-Phase Methanol (LPMEOH™) Process The liquid-phase reactor was installed in July of 1996. Installation of the remaining structural steel, process piping, and electrical and instrumentation continuing on schedule. Construction is scheduled to be completed in late-December of 1996 with startup expected to begin in mid-January of 1997. (Kingsport, TN)

INDUSTRIAL APPLICATIONS

Bethlehem Steel Corp.

Blast Furnace Granulated-Coal Injection System Demonstration Project. The plant is operating smoothly at new baseline coal injection rates of 275 lbs/net ton hot metal (#/NTHM) on "C" Furnace and 180 #/NTHM on "D" Furnace. The plant has evaluated one high-volatile and two low-volatile coal feedstocks. Coke rates on each furnace continue to decrease as operating experience improves. (Burns Harbor, IN)

CPICOR™ Management Company, L.L.C.

Clean Power from Integrated Coal/Ore Reduction (COREX®). Negotiations have been completed and the Comprehensive Report has been submitted to Congress. (Vineyard, UT)

Coal Tech Corp.

Advanced Cyclone Combustor with Internal Sulfur, Nitrogen, and Ash Control. The project was completed in September 1991. (Williamsport, PA)

Passamaquoddy Tribe

Cement Kiln Flue Gas Recovery Scrubber. The project was completed in February 1994. (Thomaston, ME)

ThermoChem, Inc.

Demonstration of Pulse Combustion in an Application for Steam Gasification of Coal. The project has been withdrawn. (Gillette, WY)