OFFICE OF FOSSIL ENERGY, U.S. DEPARTMENT OF ENERGY • DOE/FE-0215P-34 ISSUE NO. 34, SPRING 1999

CLEAN COAL TODAY

A NEWSLETTER ABOUT INNOVATIVE TECHNOLOGIES FOR COAL UTILIZATION

PROJECT NEWS BYTES

Rosebud SynCoal® Partnership, sponsor of the Advanced Coal Conversion Process Demonstration, has just completed successful testing of an innovative dedicated pneumatic feed system at Montana Power Company's 330- MW Colstrip No. 2 generation unit in Colstrip, Montana. The CCT project is now able to supply SynCoal®, its registered trademark coal, around the clock. SynCoal® is also supplied to four industrial customers. The new system also provides Rosebud with a secure business well beyond the end of the demonstration period. A flexible 8-year supply contract permits Rosebud to also build a market for its new product with industrial users. The Rosebud process consists of superheating integrated with physical cleaning to upgrade high-moisture, low-rank coals, producing a fuel with improved heating value, ash slagging potential, and low sulfur content.

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IN THIS ISSUE

CLEAN ENERGY DEMONSTRATION IGCC PROJECT PROGRESSING

On December 1, 1998, the Acting Assistant Secretary for Fossil Energy approved relocation of the Clean Energy Integrated Gasification Combined Cycle (IGCC) Demonstration Project to the Grand Tower Power Station, approximately 20 miles west of Carbondale, Illinois. The project initially had been planned for the C.P. Crane Generating Station of Baltimore Gas & Electric Company, but was moved due to lack of a firm power purchase agreement. The new site is owned by Central Illinois Public Service, a subsidiary of the AMEREN Corporation based in St. Louis, Missouri. The Clean Energy Project at Grand Tower will demonstrate scale up of the British Gas/Lurgi (BG/L) slagging, fixed-bed, oxygen blown gasification technology. The Project also will include a 1.25-MWe molten carbonate fuel cell, to be provided by Energy Research Corporation.

The Grand Tower Power Station is a mid-1950s vintage facility with 104-MW and 82-MW pulverized coal units. The owner has the capability of repowering each unit with a combined new capacity of approximately 477 MWe. The new repowered plant will provide for the continued use of local Illinois Basin coals for low cost power production. The Grand Tower Station is located on the Mississippi River, with significant infrastructure available for use in a future IGCC plant, as well as two existing steam turbines.

See "Clean Energy" on page 2...

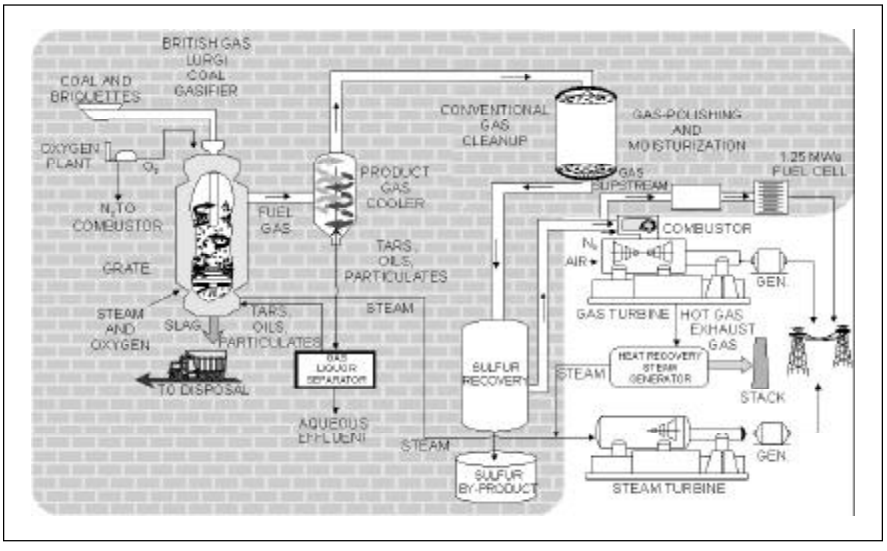
Southeast view of the 186-MW Grand Tower Plant

...Clean Energy continued

The Clean Energy Project will stepwise repower each unit with the BG/L gasification technology. The cold gas efficiency of the BG/L gasifier is 91 percent, the highest of any modern gasification technology. By demonstrating the use of local high-sulfur bituminous coal in this gasifier, this project will significantly expand the range of high efficiency, coal-fueled power generation options in the United States. The high heating value, hydrogen-rich coal gas produced by the BG/L gasifiers will be used to fuel both the gas turbines and a 1.25-MWe molten carbonate fuel cell. The technical aspects of the project are shown in the accompanying schematic. Specific arrangements and sizes of plant sections will be determined for the Grand Tower site over the next two years as part of normal project definition and preliminary design activities.

The BG/L gasifier is supplied with steam, oxygen, limestone flux, and coals having a high-fines content. During gasification, oxygen and steam react with coal and limestone to produce a raw, coal gas rich in hydrogen and carbon monoxide. Raw coal gas exiting the gasifier is washed and cooled. Hydrogen sulfide and other sulfur compounds are removed and reclaimed as elemental sulfur. Tars, oils, and dust are recycled to the gasifier. The resulting clean, medium-Btu coal gas is used to fuel the combustion turbine in the IGCC power island; a small portion of the clean gas is used for the fuel cell.

The fuel cell is composed of a molten carbonate electrolyte sandwiched between porous anode and cathode plates. Fuel (clean coal syngas) and steam are continuously fed into the anode; carbon dioxide-enriched air is fed into the cathode. These reactions produce a direct current that is converted to alternating current with an inverter. Individual cells are mechanically and electrically arrayed into stacks, the height of which is limited by shipping constraints to about 11 feet. The 1.25-MWe module for this project will consist of five stacks each with a nominal rating of 250 kW. Unlike heat engines that rely on combustion, fuel cells can achieve high efficiency energy conversion at practical temperatures. In addition, fuel cells are inherently modular, with the ability to be configured for a wide range of power outputs. The fuel cell's high efficiency is nearly independent of cells, stacks, and plant size.



— ADVANCED TURBINES — BUILDING BLOCKS OF VISION 21

Ultra-clean, integrated energy plants, as envisioned in the U.S. Department of Energy's (DOE) Vision 21 concept, represent DOE's profile of energy production well into the next century. In December 1997, the President's Committee of Advisors on Science and Technology endorsed the Vision 21 concept — a long-range, cost-shared, government-industry-academia partnership. Following the endorsement, the Office of Fossil Energy (FE) convened a workshop in Pittsburgh, Pennsylvania, to refine the Vision 21 concept by eliciting stakeholder input. Some 150 government and industry participants discussed the environmental challenges and integration issues facing implementation of Vision 21, and the status of various enabling and supporting technologies. Participants agreed that a broad range of plant types and configurations would need to be employed, and that configurations would be market- and site-specific. In the near term, the Vision 21 fuel of choice in the U.S. would probably be natural gas or low-cost opportunity fuels, but in the longer term, coal is likely to retain its stature as the market reacts to increased natural gas prices stemming from rising demand.

ATTRIBUTES OF VISION 21

Vision 21 integrates emerging concepts for high-efficiency power and alternate fuels production, as well as pollution controls into a new class of fuel-flexible electricity generation facilities. The strategy is to produce electricity, as well as high-value liquid fuels, chemicals, and process heat from coals and other feedstocks. Discrete technology modules will offer future plant designers the flexibility to choose their feedstocks, products, *and* environmental controls. This flexibility is the fundamental attribute of Vision 21, and plants will not be limited to a single feedstock or a single product. Coal will be a significant focus of Vision 21 facilities. Other fuels will play a role including natural gas, biomass, disadvantaged fuels (e.g., petroleum coke and other residues), and wastes. Vision 21 plants also will dramatically improve efficiency leading to competitive costs, and will have minimal to no environmental impacts.

Conventional pollutants (SO_2 and NO_x) will be captured and either disposed of or converted to marketable co-products. Carbon dioxide and other greenhouse gases will be reduced by virtue of inherent ultra-high efficiencies. Complementing Vision 21 technologies will be efforts aimed at capturing CO_2 emissions and either sequestering or recycling CO_2 into useful products.

At the core of Vision 21 are five technology efforts: gas separation, fuel-flexible gasification, fuel cell/turbine hybrids, high-performance combustion, and innovative coal conversion systems. To realize system goals, certain enabling technologies are required as well — more durable materials, effective catalysts and sorbents, fine-tuned instrumentation, virtual (computer simulated) plants, and low-cost CO_2 sequestration.

ADVANCED TURBINE DEVELOPMENTS

A key Vision 21 core technology is the advanced turbine system (ATS). By the year 2001, DOE anticipates that gas turbine systems will provide the most efficient, environmentally beneficial, and cost-effective option available for power generation and cogeneration. These attributes directly align with the Vision 21 goals, and support the option of fuel flexibility. DOE expects to use coal-derived synthesis gas, natural gas, or renewable biomass-based gas in advanced turbine systems.

A gas turbine is a heat engine that uses a high temperature, high pressure gas as the working fluid. Part of the heat supplied by the gas is converted directly into the mechanical work of driving the turbine blades. Traditionally, hot gases are generated by burning a fuel in air, hence, the term "combustion" turbines. These already are commonplace in jet aircraft and electricity generation. In these "simple cycle" gas turbine systems, electricity is derived only from the combustion turbine. However, most utility applications use combustion turbines in a combined-cycle mode, whereby the waste heat from the combustion turbine is used to generate steam for turbine electricity generation.

Combining the resources of government, turbine manufacturers, suppliers, and universities, an ATS program was initiated in 1992 as the shared responsibility of FE and the Office of Energy Efficiency and Renewable Energy's (EE) Office of Industrial Technologies (OIT). The goal has been to enhance efficiency and environmental and economic performance of combustion turbines at industrial and utility scale.

The DOE program has market applications in simple-cycle industrial gas turbines for distributed generation, industrial and cogeneration markets, and gas turbine combined-cycle systems for large, baseload central-station electric power generation. DOE expects to meet or exceed 60 percent system efficiencies in the utility market, and to increase efficiencies by 15 percent in the industrial

See "ATS" on page 4 ...

...ATS continued
market. Other goals include: less than 8 ppm NO_x, emissions, and 10 percent lower cost of electricity (relative to current technology).

The ATS program includes fundamental research efforts in several areas. Materials work includes extending single crystal casting capability to the large utility-scale combustion turbine blades, and improving the capabilities of thermal barrier coatings needed for ever-increasing turbine inlet temperatures. Combustion research focuses on achieving optimum combustion with natural gas and maintaining effective combustion with a variety of fuels and injectants (e.g., humid air). Studies are also being conducted on pollutant formation, primarily NO_x, and ways to mitigate its formation, such as staging combustion or using injectants. Thermodynamic cycle studies include examination of advanced gas turbine hybrid cycles, such as integration of gas turbines with fuel cells (another Vision 21 core technology).

INDUSTRY AND UTILITY ATS APPLICATIONS

The Industrial ATS Program, supported by FE, addresses development of simple cycle gas turbines in capacities less than 20 MW. Allison Engine Company is developing a "core" ATS turbine for applications in the 5-15 MW range, with an overall efficiency of nearly 41 percent (LHV). The approach is to raise the turbine inlet temperature to 2,400 °F.

In addition, Solar Turbine, Incorporated, is developing a 5-MW turbine using a modest 2,200°F inlet temperature in conjunction with a recuperator. The recuperator recovers heat of combustion and returns it to the fuel and compressed air entering the combustion chamber. A simple cycle efficiency of 43 percent (LHV) is anticipated.

In the area of utility applications, supported by EE's OIT, General Electric (GE) is one of two manufacturers developing a system greater than 400 MW. The GE system, MS7001H, is combined with a conventional steam turbine generator to generate efficiencies of over 60 percent (LHV) on natural gas. Nitrogen oxides (NO_x) emissions are reduced to less than half (from 25 ppm to less than 10 ppm) and electricity costs are reduced by 10 percent. Since higher temperatures are key to boosting overall efficiency, GE has focused on developing new materials and innovative cooling techniques that allow firing temperatures approaching 2,600 °F. Full-scale, high temperature testing of the GE system is currently being conducted.

The GE H Class ATS gas turbine

Siemens-Westinghouse also is developing a 400-MW system designed to exceed 60 percent efficiency (LHV), reduce NO_x to less than 10 ppm, and reduce electricity costs by 10 percent for a natural gas-fired system. In addition to lowering emissions and reducing energy production costs, Siemens-Westinghouse is focusing on minimizing water usage and maintaining the system's reliability-availability-maintainability (RAM) standard.

HIGH-TEMPERATURE COMBUSTION

High temperatures and the associated NO_x generation and materials degradation issues are drawbacks to advanced combustion and the newly developing combustion turbines. Using the Low Emissions Combustion Test and Research Facility at the Federal Energy Technology Center, FE has taken the lead to evaluate various temperatures and pressures representative of combustion turbine applications. The facility has been used to characterize operating and emissions characteristics of a small industrial lean premixed turbine.

MATERIALS ADVANCES

The ATS Program also boasts significant accomplishments in scaling up single-crystal turbine blade casting processes to ATS sizes. Advanced single-crystal alloy developments are enabling the scale-up of technologies used to produce high-temperature blades and vanes for aircraft engines. Other improvements include reduced levels of sulfur and defects in large production castings of these components, and future emphasis is being placed on the cost-effective and higher yield manufacturing of these components. Successful commercialization of these new processes is critical to achieving the cost of electricity goals established for the ATS Program. Currently, Howmet, General Electric, Siemens-Westinghouse, Solar Turbines, and General Electric-PCC Airfoils are participating in the new casting projects under the advanced alloys program.

In combination, these efforts have produced significant improvements in components and combined systems of the FE ATS Program. ATS is just one technology required for success of the Vision 21 concept. Discussions of other Vision 21 technologies will be provided in future issues of *Clean Coal Today*.

R&D MILESTONES

In February, the **U.S. DOE Office of Fossil Energy** issued a call for proposals to design an "Early Entrance Coproduction Plant" to convert a variety of feedstocks — including coal — into multiple products at a single facility. The new plant is envisioned as a cornerstone for an entirely new fleet of ultra-efficient, multi-purpose energy facilities in FE's Vision 21 program. The co-production facility would first convert fuel to synthesis gas, from which some combination of electricity, heat, fuels, and chemicals could be produced. The major goals of the Vision 21 program are to reach efficiencies of 85 percent, achieve near zero emissions, and lower the costs of producing products such as coal-based liquids. Under the Early Entrance Coproduction Plant solicitation, DOE expects to make multiple awards for a total of $20 million for design efforts. Private participants would be expected to share at least 20 percent of costs.

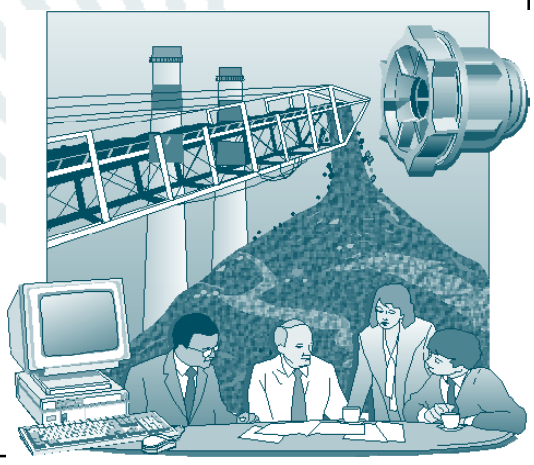
DOE's Office of Fossil Energy and the the Department of Interior's Office of Surface Mining have signed a Memorandum of Understanding (MOU) for a 5-year partnership focusing on mining and environmental issues. Two areas of particular interest will be cleanup and possible use of waste coal from mining and coal preparation (an area in which FE has done extensive R&D) and acid mine drainage control/ river cleanup. Some other areas of cooperation could include new approaches to control mine fires, dispose of coal combustion by-products, and restore the soil's hydrological balance. Many of the projects are directly supporting the Federal Energy Technology Center's Regional Environmental & Sustainable Energy Partnership, comprising West Virginia, Pennsylvania, Maryland, and Ohio.

A final report detailing the first three phases of a project for "Novel Fossil Fuel Combustion and Power Generation Technologies for Enhanced CO_2" was submitted in December 1998. The report was based on a technology being developed by the **CANMET Energy Technology Centre** for reduced CO_2 emissions. The technology features combustion of coal in an oxygen/CO_2 medium with flue gas recycling. Future work will focus on adding pure oxygen to the secondary air, species partitioning, and CO_2 separation. The work is being conducted as part of the International Energy Agency's Greenhouse Gas Implementing Agreement.

Under a University Coal Research grant, the **University of Washington** has developed a method to clarify the heavily contaminated water generated by coal washing facilities. Based on the application of electric fields, rotating anodes attract unwanted mineral particles and colloidal coal within the water mixture. This novel approach to water clarification could create a significant market for recovered coal from waste ponds.

Virginia Polytechnic Institute and State University has recently synthesized a novel catalyst using bimetallic oxynitrides (V-Mo-O-N) in order to remove heteroatoms such as sulfur, nitrogen, and oxygen from the products of co-processing coal, municipal solid waste, and petroleum. Simultaneous processing of coal and other fossil-derived fuels with tires, plastics, or waste oil would be an attractive method for disposing of wastes, while at the same time utilizing an important energy source.

The **Federal Energy Technology Center's (FETC's)** Coal Combustion By-Products Utilization Program has developed a homepage where external customers can obtain fact sheets on individual projects, descriptions of in-house research, and summaries of Federal and State regulations governing these by-products, as well as information on the newly formed Emission Control By-Products Consortium. Access to the homepage is through FETC's website at http://www.fetc.doe.gov/products/power/enviro/ccb/.



ROLE OF GASIFICATION FOR THE 21ST CENTURY

IGT INSTITUTE OF GAS TECHNOLOGY

The world's demand for energy is expected to double in the next 20-25 years. By most accounts, the primary energy mix for the next century is expected to remain strongly dependent on fossil fuels. With large worldwide coal reserves, coal will continue to play a major role in the world's energy mix for the foreseeable future, with the use of coal for power generation and chemicals expected to continue to increase. Therefore, it is very important that coal be used in a flexible, efficient, environmentally clean, and economic manner. The Institute of Gas Technology (IGT) U-GAS gasification process is an advanced gasification technology that can be used to meet such a challenge. In a plant in Shanghai, China, seven of the eight U-GAS gasification trains have been placed in service since the plant began operation in 1994. These are the first commercial-scale U-GAS gasifiers to be installed anywhere in the world.

TECHNOLOGY DEVELOPMENT

The Institute of Gas Technology has been developing the U-GAS technology to produce low- and medium-heating value synthesis gas from all ranks of coal, oil shale, peat, biomass, and waste with support from the U.S. Department of Energy (DOE), the American Gas Association, the Gas Research Institute, and industry for 25 years. The U-GAS process uses a simple single-stage, fluidized-bed gasifier where sized feed is gasified to produce a synthesis gas rich in hydrogen and carbon monoxide and free of tars and oils. Cold gas efficiency for the process ranges from 70-80 percent, with 98 percent carbon conversion.

The product gas can be used as an industrial fuel, as has been done in China, or as a chemical feedstock for the production of hydrogen, ammonia, and methanol. It can also be used as a fuel for advanced power systems such as integrated gasification fuel cells or integrated gasification combined-cycle power generation, or combinations of both.

CHINA SEEKS SOLUTIONS

China has vast coal reserves upon which it depends for the majority of its energy and chemicals production. China's Ministry of Coal Industry reported that, in 1996, China produced and consumed about 1.37 billion metric tons of coal. China's large coal consumption coupled with inefficient systems and poor environmental controls resulted in severe impacts on the environment. In 1995, China reported the following emissions: 3.0 billion t/a CO_2, 23.7 million t/a SO_2, 4 million t/a NO_x, and 28 million t/a particulates.

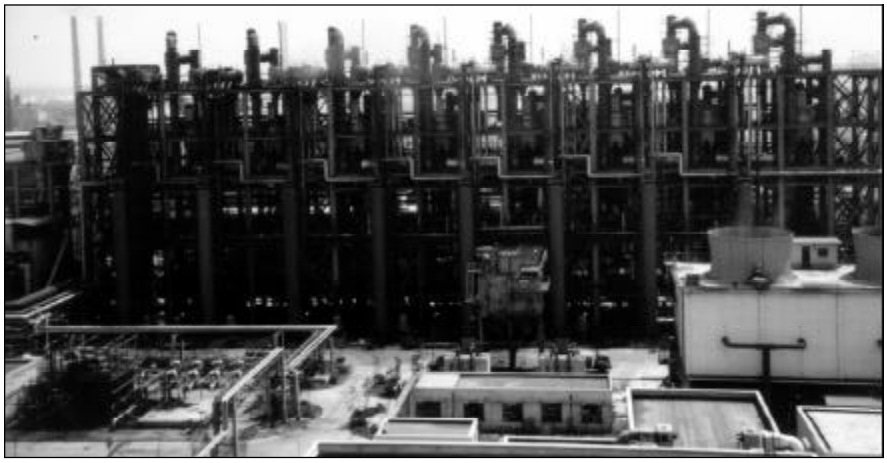
China began to look for solutions to its environmental problems, and in the early 1980s the trigeneration concept was proposed to streamline production of town gas, chemicals, and electric power from coal with advanced gasification technologies that will improve efficiency, reduce environmental impacts, and lower cost. Based on their study, this concept can improve coal conversion efficiency by 15 percent, thus reducing coal consumption by 15 percent, and at the same time providing major reductions in CO_2, SO_2, NO_x, and particulate emissions.

U-GAS IN CHINA

In 1984, Shanghai Coking and Chemical Corporation (SC), a large coal-to-chemical company, was selected by the central government of China to undertake the TRIGEN Project. The U-GAS process was selected to provide fuel gas for an existing battery of coke ovens, doubling the coke-oven gas capacity in the town gas system. Production goals for the project included 1,700,000 nm^3 per day of town gas and 200,000 metric tons per year of methanol in Phase 1. Phase 2 included adding production of 20,000 metric tons per year of formic acid, 100,000 metric tons per year of acetic anhydride, 50,000 metric tons per year of cellulose acetate, and 7 MWe of electric power.

IGT provided the process design for the gasification island, and Shanghai Chemical Design Institute performed the detailed design and construction for the entire U-GAS plant. There are eight low-pressure air-blown gasifiers, each capable of processing 130 metric tons per day and producing 500,000 nm^3 per day of low-heating value gas. Plant operation began in 1994, and by the end of 1998 the plant had logged over 50,000 hours of operation, consumed over 160,000 metric tons of coal, and delivered 700 million nm^3 of fuel gas to the end user. The longest continuous operation time was 3,200 hours.

The plant has achieved cold gas efficiencies of 71 percent, carbon conversion of 96 percent, and a heat production rate of 230 million Btu/gasifier/day at a product gas heating value of 126 Btu/scf. Both cold gas efficiency and heat output rates are about 90 percent of design, due primarily to the excess loss of fines throughout the plant. Carbon conversion and product gas heating values both have exceeded the design.



The Shanghai U-GAS Gasification plant, in operation since 1994

Substitution of the traditional coal and coal briquette burning with 1,700,000 nm^3 per day of town gas for commercial and industrial use has significantly reduced the pollution due to SO_2, NO_x, and particulates for the city of Shanghai. It also has helped reduce traffic congestion in Shanghai due to the reduced transportation of coal.

CURRENT AND FUTURE APPLICATIONS

With the support of U.S. DOE through the U.S.-China Energy, Environmental and Technology Center, IGT and SC are expanding the application of U-GAS gasification technology to include chemicals, fertilizers, and power. The team is performing a pre-feasibility study to retrofit existing small to medium size ammonia plants in China. The use of U-GAS technology has the potential to reduce the cost of ammonia production thereby becoming more competitive in the marketplace. This can be accomplished by the use of less expensive coal closer to the plant, more resource utilization by the use of coal fines, and more efficient coal utilization in terms of high conversions and overall heat management.

Another gasification project where IGT's gasification technology will be used is the Sanghi 60-MWe IGCC project in India. In this project, 1,000 tons per day of Indian lignite will be gasified via IGCC to produce efficient and clean power and steam for a cement plant.

IGT is also commercializing its biomass and waste gasification technology. A biomass-to-power project in Minnesota is underway where agri-waste from alfalfa will be gasified using IGT's RENUGAS process to produce electricity. In this co-production project, 1,200 tons per day of alfalfa stem will be gasified to produce 75 MWe of electricity using the latest in IGCC technology. Alfalfa is first processed in a deleafing plant where alfalfa leaves, a valuable animal feed material, are separated from the stems. The stems are dried and briquetted before feeding into the IGCC plant. This plant will integrate the advanced gasification system with hot gas cleanup followed by combined-cycle power generation. Plant design is under way, and is scheduled to begin operation by the year 2001. Upon completion, this will be the largest biomass IGCC power plant in world.

The gasification industry has come a long way from the early days of manufacturing gas to produce town gas for lighting, heating, and cooking to the modern day of power generation and chemical production. The advances in new technologies have kept pace with the demands on efficiency, environment, and economics. Several gasification technologies have demonstrated the potential to meet these demands. The future for the technologies will depend on market forces. The growing economy, aging facilities, and the need for more flexible, more efficient, and cleaner technologies at competitive costs are facts that will expand the markets for gasification. Gasification of fossil and renewable resources will play a major role in satisfying the world's energy and chemical needs well into the next millennium.

This guest piece was submitted by Mr. Francis S. Lau, Institute of Gas Technology (IGT). The IGT is a Clean Coal Technology Program Stakeholder, and a non-profit, information dissemination, and technology development organization dedicated to providing solutions to energy and environmental issues in the marketplace. For additional information, contact IGT at: 1700 S. Mount Prospect Road, Des Plaines, IL 60018-1800; e-mail: lau@igt.org or phone: 847-768-0592.

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INTERNATIONAL INITIATIVES

MEXICO FBC OPTIONS

From left to right: Don Bonk, FETC's Product Manager for Combustion Systems; Maria Reidpath, FETC's Western Hemisphere Regional Coordinator; Darren Mollot, Program Manager, DOE Office of Power Systems; and Mark Williams, FETC's Product Manager for Fuel Cells

Representatives from the U.S. DOE Office of Fossil Energy (FE) participated in the "International Seminar on Combustion Technologies for Clean Energy Generation," held in Mexico City in December 1998. This activity was part of the U.S.-Mexican Bilateral Agreement for Energy Cooperation, under the Hemisphere Energy Initiative's Clean Energy Working Group program. Mexican sponsors included the National Commission on Energy Savings (CONAE) and the Institute of Electric Research.

An important part of the seminar was FE's presentation entitled "Fluidized Bed Combustion (FBC) Repowering for Mexico," which was delivered to more than 100 Mexican energy officials. Presently, 60-70 percent of Mexico's power is generated from fossil fuels, 80-90 percent of which comes from oil, with the rest generated from natural gas and two pulverized-coal plants that burn high ash (~50% ash) Mexican coal. A new coal plant being built will run on imported, low-sulfur coal. Approximately 17 percent of Mexico's power is generated by hydro and the remaining national demand is met by two 650-MW nuclear units, supplemented by some geothermal, wind, and solar units.

The presentation focused on four FBC repowering options for Mexico's aging oil-fired power boilers. These options included replacement of existing units with atmospheric fluidized bed boilers, conversion of existing units into fluidized bed boilers using compact separator designs, and replacement of existing boilers with either first generation or second generation (topped) pressurized fluidized bed combustion units. The fuel flexibility of FBC was stressed. Particular attention was devoted to petroleum coke in recognition of Mexico's global position as a major oil producing nation. The audience asked a number of questions concerning burning of petroleum coke in the United States. Examples were provided from the NIBSCO 300-MW petroleum coke-fired plant in Lake Charles, Louisiana. The NIBSCO plant is completing its sixth year of successful operation, which includes the sale of all produced ash by-product for use in highway construction.

FE's final technical presentation was on the Vision 21 program. Audience questions focused on the continuing use of fossil fuels, especially coal, into the next millennium. The Mexican audience was surprised to see that such focused and careful attention is still being given to fossil-based power technologies. The FE presentor indicated that, with the exception of nuclear, which is politically not an option in many countries, fossil is the only viable energy source to meet the bulk of the world's demand for power. The presentor stressed the need to develop and deploy technologies that will allow use of fossil fuels as cleanly and efficiently as possible.

On December 4, 1998, a followup meeting was held at the offices of Mexico's Secretariat of Energy, which generated further questions about FBC operations. CONAE indicated that it would take the lead to promote future FBC activities between FE and Mexico. Discussions on funding a joint study to repower the older oil-fired power plants in Mexico should begin in early this year.

MULTI-FUEL REBURNING HOLDS PROMISE FOR UKRAINE

U.S. and Ukrainian participants are expected to meet in April in Research Triangle Park, North Carolina to discuss progress to date on an EPA and DOE-sponsored fuel reburning project in Ladyzhin, Ukraine. A multi-fuel reburn system (capable of using natural gas, coal, heavy fuel oil, or combinations thereof) is being installed to reduce NO_x emissions from Unit 6, a 300-MW wet-bottom coal-fired boiler at Ladyzhin Power Station, 200 miles south of Kiev. Under an interagency agreement, funding is provided by EPA's Environmental Technology Initiative. Technical guidance for process design and operation are provided jointly by EPA's National Risk Management Research Laboratory and FE. Ladyzhin Power Station is owned by GAEK Zapadenergo.

The project follows an earlier collaboration effort in 1992 (in which DOE did not participate) in which a natural gas reburning system was installed at Unit 4. This operation reduced NO_x emissions by more than 50 percent. The success of this early demonstration encouraged the Ladyzhin Power Station and the Ukrainian Power Ministry to extend the application of this technology to other units. These units were needed to help meet pending regulations that will place a tax on all emissions. Fuel cost, availability, and distribution problems in Ladyzhin made a multi-fuel approach desirable.

In the reburn method, 5-20 percent of total boiler fuel is injected downstream of the main burners to create a fuel-rich zone, followed by injection of burnout air, and can remove 50 percent or more of uncontrolled NO_x emissions. The technology is very promising for Ukraine and Russia, where 50 percent of all boilers are of a slagging or wet-bottom design — for which conventional low-NO_x burners are not generally applicable.

Energy and Environmental Research Corporation of Irvine, California is supporting system design. Component design, fabrication, and installation are being done by Ladyzhin Power Station staff. To date, the plant has installed separate coal mills for supplying the reburn fuel and has conducted preliminary tests of the coal reburn system. NO_x reductions of 25-35 percent have been achieved compared to operation without injection of reburning fuel, i.e., using only the overfire air ports component of the reburning system. During operation with coal as the reburning fuel, this performance translates into total NO_x reductions of 50 percent. Additional system optimization is currently underway to improve the reburn coal feed rate and NO_x reduction capacity.

FE OUTREACH IN SLOVAKIA

Director Krupa and Deputy Director Turcaniova (right to left) with speaker at Slovak Clean Coal Technology Conference in Kocise, Slovakia.

In November 1998, two FE representatives were invited to chair panels and present papers at the conference "Trends in Development in Mining and Power Production From the Point of View of Future Applications of Clean Coal Technologies," held in Kocise, Slovakia. The conference was hosted by the Slovak Academy of Sciences Institute of Geotechnics, with broad sponsorship by the mining and power industry in Slovakia. FE, under a U.S. Department of State Science and Technology grant, has collaborated with the Academy on research focusing on the region's high ash, high-arsenic coals, specifically the process of cleaning the coal using the concept of triboelectrostatic charging. This process avoids expensive dewatering. Slovakian brown coal is currently used for power generation in pulverized coal plants with few environmental controls and is also used extensively for district heating and rural home stoves. Coal supplies are dwindling and expected to last for only another 20 years.

The conference, attended by some 75 key representatives from the academic, mining, power, district heating, chemical, steel, and environmental sectors in Central and Eastern Europe, addressed various technical issues common to this area, particularly cost issues of environmental compliance and power production. Currently, 60 percent of Slovakia's power comes from older nuclear plants, 30 percent from coal plants, and 10 percent from natural gas. Slovakia is under pressure to shut down the Chernobyl-type nuclear plants and must find replacement capacity, or it will have to import electricity. There is hesitancy to become over dependent on natural gas, and strong interest (including employment in the mining sector) in continuing to use indigenous coal supplies while they last. In general, the country seeks a better balance between nuclear-, coal-, and natural gas-fired power plants.

Coal-fired plants in Slovakia are slowly being converted to circulating fluidized bed combustion boilers. A definite market exists for cleaner coal technologies for district heating, small combined heat and power plants, and for chemical raw materials. Conference participants were most interested in the presentation on CCT projects, particularly the Nucla and JEA atmospheric fluidized bed combustion projects, Piñon Pine IGCC, Liquid Phase Methanol, and granulated coal injection as demonstrated by the Bethlehem Steel project, because these technologies could have application throughout all of Central and Eastern Europe.

In all, Slovakia and other countries in the region have been keenly watching coal R&D advances, and seek opportunities to deploy new technologies applicable to their reserves.

FOSSIL ENERGY COMMITTED TO INTERNATIONAL ENERGY AGENCY GOALS

The DOE Office of Fossil Energy (FE) has been a strong supporter of International Energy Agency (IEA) goals since the IEA was established in the early 1970s. FE participates in IEA committees, advisory boards, and several important implementing agreements. The IEA, based in Paris, was formed by the 23 member countries of the Organization for Economic Cooperation and Development (OECD) after the oil shortage of 1973-74, as a response to energy security concerns.

FE plays an important role in IEA's technology innovation activities. Development and widespread deployment of safer, more efficient technologies is necessary for energy security, environmental protection, and economic growth. International collaboration fostered by IEA affecting investments in fossil energy technology research, development, and demonstration avoids duplication of effort, cuts costs, and speeds progress.

FE is a key participant in the Working Party on Fossil Fuels (WPFF), an advisory body to the IEA Committee on Energy Research and Technology. FE also participates in two major IEA Implementing Agreements: IEA Coal Research-The Clean Coal Center, and the Greenhouse Gas R&D Programme. Other implementing agreements with FE participation are in the area of multiphase flow to gain understanding in the transport of solid-liquid mixture such as coal slurries; coal combustion science, including modeling activities and high-temperature phenomena; and gas technology information and enhanced oil recovery.

IEA COAL RESEARCH-THE CLEAN COAL CENTER

The Clean Coal Center, based in London, UK, was established in 1975 and is a collaborative project currently involving 13 countries and the European Commission. Its objective is to enhance innovation and the development of coal as a clean source of energy by gathering, assessing, and disseminating information on efficient coal supply and use.

The Center produces reports covering coal use and analysis; the environment; and supply, transport, and markets. In the last six months, the Clean Coal Center has published reports dealing with effluents from coal-fired power stations, fine particulate emissions from coal-fired power plants, and air pollution control and coal-fired power generation in India. Other published reports covered coal supply, demand, and related issues in Bulgaria, Czech Republic, and South Korea. Among the topics to be covered in future reports are trends in coal-fired power generation in non-OECD countries, advanced materials for coal-fired plants, and opportunities for coal preparation to lower emissions. Clean Coal Center reports are publicly available through their world wide web home page (www.iea-coal.org.uk).

The Center also maintains major databases of coal related information that are accessible through the home page. This year, a series of interlinked databases will cover clean coal technologies, clean coal demonstration plants, the world's coal-fired power stations and their units, environmental abatement and control systems, emission standards, and the names and addresses of utilities and companies active in clean coal technologies.

IEA GREENHOUSE GAS R&D PROGRAMME

Another key Implementing Agreement involving FE participation is the Greenhouse Gas R&D Programme, started in 1991 and based in Cheltenham, UK. The Programme aims to: evaluate technologies for reducing emissions of greenhouse gases from fossil fuel use; disseminate information; prepare research, development, and demonstration solicitations; and, where appropriate, conduct R&D projects. Programme activities initially focused on the capture and disposal of CO_2 from power stations, and have since broadened to explore a range of opportunities for countries and the European Commission, as well as private industry participating in this Implementing Agreement, to reduce emissions of greenhouse gases.

Joint research currently underway includes studies of geological and ocean sequestration of CO_2. A result of this research was the recent report, *Enhanced Coal Bed Methane Recovery Using CO_2 Injection: Worldwide Resource and CO_2 Sequestration Potential*. This report provided an overall estimate of CO_2 sequestration costs in unmineable coal seams and a ranking of basins by their potential for this application.

The Programme's information dissemination component includes a regular newsletter (*Greenhouse Issues*), published reports, international conferences, and a home page (www.ieagreen.org.uk). Work under the Agreement has helped demonstrate the opportunity for continued use of fossil fuels, even under scenarios involving deep reductions in emissions of greenhouse gases.

...Project News Bytes continued

The **Alaska Industrial Development and Export Authority's Healy Clean Coal Project** in central Alaska successfully completed its first year of demonstration operations in December 1998. Following an aggressive start-up and testing program that began with the first test firing of the combustors on coal in January 1998, results from initial environmental compliance testing performed in June 1998 found that nitrogen oxide emissions — a pollutant known to contribute to smog and acid rain — were limited to only 0.26 pounds per million Btus of run-of-mine coal burned, nearly 25 percent lower than the permit limit of 0.35 pounds per million Btus. Emissions of sulfur dioxide were also lower than permit allowances, 0.01 pounds per million Btus compared to the permit limit of 0.10 pounds per million Btus on low-sulfur, run-of-mine coal burned. Since completion of the initial environmental compliance testing, demonstration operations have focused on blending the run-of-mine coal with up to 65 percent waste coal. By the end of its first year of demonstration operations, the plant had logged over 4,900 hours of operation and converted 156,000 tons of Alaskan run-of-mine and waste coals into 231 gigawatts (gross) of electricity for Alaskan consumers. The average capacity factor for the year including coal start-up and testing was 44 percent.

In December 1998, members of the State Development and Planning Commission of the People's Republic of China, together with FE representatives, visited the **Wabash River Coal Gasification Repowering Project** in Indiana. A series of meetings and visits have taken place subsequent to the U.S.-China Energy and Environment Cooperation Initiative signed by President Clinton and President Jiang in 1997. This particular group was part of the Oil and Gas Forum, a new Initiative activity.

The ***Seventh Clean Coal Technology Conference*** will focus on the ability of clean coal technologies to ensure continued use of coal as an essential component of the United States and global energy supplies and meet increasing environmental demands.

A site tour will be taken to the Liquid Phase Methanol Project, hosted by Air Products Liquid Phase Conversion Company, L.P.

Accomodations and Reservations: Call the Hyatt Regency Knoxville, (800) 233-1234.

Additional Information: Contact Faith Cline at (202)-586-7920 (phone), (202) 586-8488 (fax), or check web site (http://www.fe.doe.gov).

—Mark Your Calendar—
June 21-24, 1999
Knoxville, Tennessee

UPCOMING EVENTS

May 16-19, 1999 — *15th International Conference on Fluidized Bed Combustion*
Location: Savannah, Georgia
Co-Sponsors: DOE/FETC and ASME
Contact: Conference Services (412) 892-4763; (800) 441-9927 (outside Pennsylvania); (800) 441-0875 (inside Pennsylvania)

May 25-27, 1999 — *Prospects for Cleaner Fossil Fuels Systems in Sustainable Development: Communicating their Strategic Value in the Euro-Asian Region*
Location: Ankara, Turkey
Co-Sponsors: USEA, World Energy Council, Turkish National Committee, U.S. DOE
Contact: Ritchie Williamson
Phone: (202) 331-0415
Fax: (202) 331-0418

June 21-24, 1999 — *Seventh Clean Coal Technology Conference*
Location: Knoxville, TN
Co-Sponsors: DOE, CEED, CIBO, EPRI, NMA
Contact: Faith Cline
Phone: (202) 586-7920
Fax: (202) 586-8488

September 13-17, 1999 — *Thirteenth U.S.-Korea Joint Workshop on Energy and Environment*
Location: Reno, NV
Co-Sponsors: DOE, Korea Institute of Energy Research
Contact: Dr. Sun Chun
Phone: (412) 892-6007
Fax: (412) 892-5917

GEOLOGICAL CO_2 SEQUESTRATION TO BENEFIT COAL'S FUTURE

BACKGROUND

Emissions of industrial greenhouse gases have increased the total load of carbon in the atmosphere, and although long-term consequences of these emissions are hotly debated, one projected outcome is the alteration of global climate as greenhouse gases trap heat at the earth's surface. One possible method of reducing carbon added to the atmosphere is to sequester the industrial greenhouse gases, such as carbon dioxide (CO_2), in various sinks such as the ocean, aquifers, or underground reservoirs. Sequestration represents a long-term R&D approach that, if successfully developed, could offer a new option for dealing with greenhouse gases, most likely in the post-2015 time frame. It may take 15-20 years for the type of sequestration concepts envisioned by the U.S. Department of Energy (DOE) to move from the drawing board to widespread commercial use. However, enough is known today to provide optimism that the long-term potential for sequestration will greatly reduce CO_2 emissions. Sequestration may be key to keeping energy prices as low as possible for consumers and maintaining profitability and long-term survival of the fossil fuel (particularly coal) industry, while improving environmental and climate conditions.

Sequestration of CO_2 in geological formations builds on related experience gained over nearly a century of oil and a gas production, groundwater resource management, and more recently, natural gas storage. In some cases, sequestration may even be accompanied by economic benefits such as enhanced oil recovery, enhanced methane production from coalbeds, enhanced production of natural gas from depleted fields, and improved natural gas storage efficiency through the use of CO_2 as a cushion gas.

The main obstacle to underground disposal of CO_2 from fossil fuel-fired power plants is cost, most of which is incurred by the necessity to separate CO_2 from, or concentrate it in, the flue gas. This cost is expected to vary widely, depending on the type of power plant and separation technology considered current. Estimated costs of $40-50 per ton of CO_2 collected and sequestered would increase electricity generation cost by about 2 cents/kWh, 40 percent above current levels, but research in this area is expected to result in a significant decrease in these costs.

DOE'S ROLE

DOE's Office of Fossil Energy last year awarded 12 Novel Concepts contracts to develop greenhouse gas mitigation technologies, three of which are for geological sequestration. Building on this action, DOE has proposed short-term milestones for several key carbon sequestration R&D elements, including: initiating pilot-scale test geologic sequestration in 2000; adopting oil and gas reservoir models to coal seams and saline reservoirs by 2001; developing revolutionary CO_2 capture technologies by mid-2001; and completing the Novel Concepts awards by 2003.

Field testing already is under way on several coal seam CO_2 sequestration projects. One project, supported jointly by DOE, the Alberta Research Council, Environment Canada, and a number of industry partners, is building on the synergy between natural gas production from coalbeds and sequestration of CO_2 in these coalbeds. This involves testing the process of injecting CO_2 into Alberta's vast deep unminable coalbeds, where the gas is adsorbed by the coal and stored, while at the same time displacing the trapped methane. With the abundance of deep coalbeds in the U.S. and Canada, geological storage of CO_2 in these coals would be applicable to many of the areas where coal-burning power plants are located. Elsewhere, CO_2 sequestration is already taking place at Sleipner Vest off the coast of Norway, where approximately one million metric tons of CO_2 are sequestered annually as part of an off-shore natural gas production project.

GEOLOGIC OPPORTUNITIES

The preferred underground storage concept is to inject CO_2 via wells into deep reservoir rocks, which then are capped by very low permeability seals such as shales or claystones. Much of the CO_2 will be stored in a free state or dissolved in water within reservoirs. Advantages of underground disposal include retention of the CO_2 for long periods. Potential effects of leaks from storage reservoirs may have to be assessed on a site-specific basis. At a minimum, it may be possible to store CO_2 for several hundred years, with confidence that most of it will stay in place. Work is planned under the IEA Greenhouse Gas R&D Programme to monitor this commercial project.

Deep unminable coalbeds, active and depleted oil and gas reservoirs, and deep saline formations are the most attractive approaches for geological sequestration. As of mid-1998, about 60 million m^3/day of pure CO_2 were being injected at 67 commercial enhanced oil recovery (EOR) projects, mostly in west Texas. EOR from CO_2 flooding

totals about 24,000 tons/day (180,000 barrels/day). Other geologic formations, such as marine and arctic hydrates, CO_2 reservoirs, and mined cavities in salt domes and oil-shale, may increase sequestration capacity or provide site-specific opportunities, but are likely to be developed only after the other targets are explored. One or more of these formations is found within 500 km of every fossil fuel-burning power plant located in the United States.

The range and uncertainty in estimates of geological CO_2 storage potential are large (see table, above). For the near term there is sufficient capacity, diversity, and broad geographic distribution to confidently pursue geologic sequestration as a potential solution to the greenhouse gas dilemma.

OIL AND GAS RESERVOIRS

Oil and gas reservoirs usually occur under structural or stratigraphic traps. Since the oil and gas originally accumulated in these traps did not escape over time, these reservoirs should also securely contain the CO_2. Furthermore, the geologic structure and physical properties of most oil and gas fields usually have been extensively characterized. Computer models have been developed to predict displacement behavior and trapping of CO_2 for enhanced oil recovery.

DEEP SALINE RESERVOIRS

Saline formations are the most common underground fluid reservoir. Deep saline reservoirs may be the best long-term underground storage option for CO_2 sequestration, with potential capacity estimated at 5-500 billion metric tons, compared to annual U.S. power plant emissions of about 1.7 billion metric tons. About 65 percent of the CO_2 captured from U.S. power plants could be injected successfully into deep reservoirs without the need for long pipelines because the potential host reservoirs are located near the plants.

The distinction between sequestration of CO_2 in saline reservoirs and in oil and gas reservoirs is that oil and gas reservoirs occur by virtue of the presence of a structural or stratigraphic trap. Also, injection of CO_2 into a saline reservoir formation is unlikely to be accompanied by removal of water from the formation, which may lead to an increase in formation pressure over time.

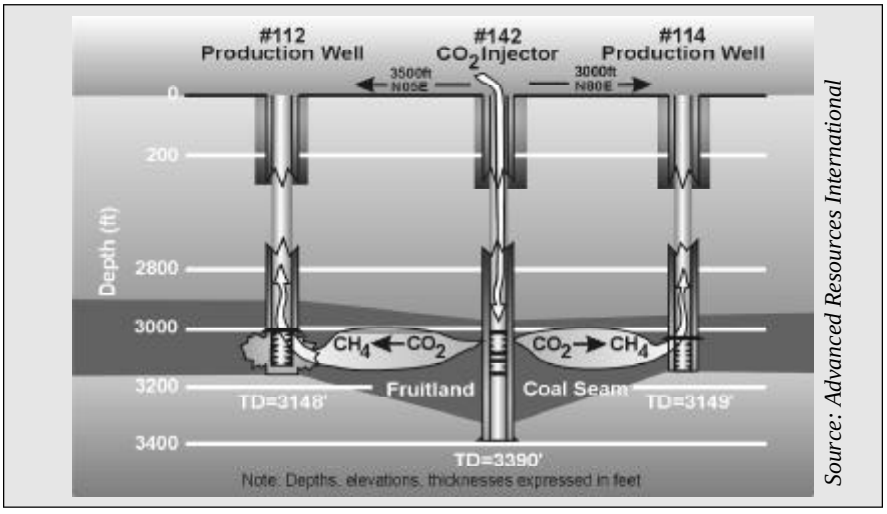
COAL SEAM FORMATIONS

In the United States, estimated coal resources to a depth of 6,000 feet total nearly six trillion tons. Some 90 percent of this amount is considered economically unminable with current technology as either too thin, too deep, or unsafe. These unavailable coal deposits represent a widely dispersed potential option for CO_2 storage, with many of the coals potentially producing methane for commercial use.

For the past 25 years, DOE and its predecessor agencies have been facilitating the evolving recognition and development of coalbed methane resources and technologies. The concept of using injected CO_2 to enhance coalbed methane production is already being field-tested by industry. Much of the data gathered from these tests is proprietary; however, unpublished information supports the retention of the CO_2 in coalbeds. Since 1996, Burlington Resources, a major producer of coalbed methane, has conducted a commercial pilot test for CO_2 injection to enhance coalbed methane recovery. As a spin-off, the pilot sequesters CO_2 as part of its routine operation. Burlington's pilot is located within the northern San Juan basin, in New Mexico, which is the most successful coalbed methane development in the world (see graphic below).

LEAKAGE CONSIDERATIONS

A final concern about sequestration in geological formations is the definition of an acceptable leakage rate from the target formation to overlying strata. In some cases, leakage from the strata in which the CO_2 is placed into overlying geologic strata actually increases the opportunity for enhanced storage capacity. However, the potential long-term leakage rate into the atmosphere is an unknown factor. Therefore, evaluating general and site-specific acceptable leakage rates must be part of a long-term strategy for CO_2 sequestration in geologic formations.



Cross sectional view of Burlington's Allison Unit

STATUS OF ACTIVE CCT DEMONSTRATION PROJECTS

ENVIRONMENTAL CONTROL DEVICES

Southern Company Services, Inc. – *Demonstration of Advanced Combustion Techniques for a Wall-Fired Boiler.* Long-term testing of the advanced overfire air (AOFA), low-NO_x burners (LNB) and combined LNB+AOFA systems are complete. Final testing of GNOCIS is complete. A Draft Final Report for Phase 4 has been approved. (Coosa, GA)

New York State Electric & Gas – *Milliken Clean Coal Technology Demonstration Project.* All testing has been completed. The Draft Final Report has been reviewed, and the Final Report should be published by the end of the first quarter of 1999. The project was a complete success. All demonstration goals were met or exceeded. The unit is currently in operation and is scheduled to stay in operation as part of the plant's compliance strategy. (Lansing, NY)

New York State Electric & Gas – *Micronized Coal Reburning Demonstration for NO_x Control.* All testing has been completed at the Kodak site in Rochester, New York. The goals and objectives for the Kodak site have been met or exceeded. The system is in operation and will remain in operation, allowing Kodak to effectively reduce NO_x in accordance with their agreement with the State of New York. Testing at the Milliken site is still ongoing. Final testing is scheduled to be completed by the end of March 1999. The final report should be published by late summer of 1999. (Lansing, NY and Rochester, NY)

NOXSO Corporation – *Commercial demonstration of the NOXSO SO_2/NO_x Removal Flue Gas Cleanup System.* Project is on hold pending results of bankruptcy proceedings.

ADVANCED ELECTRIC POWER GENERATION

City of Lakeland, Department of Water & Electric Utilities – *McIntosh Unit 4A PCFB Demonstration Project and McIntosh Unit 4B Topped PCFB Demonstration Project.* Projects have been restructured and re-sited to Lakeland, Florida. The City of Lakeland continues to negotiate with Foster Wheeler on the turnkey contract. A public scoping meeting on the environmental impact statement is planned for the near future. DOE will use this meeting to hear the public's environmental concerns. DOE will address these concerns in the Environmental Impact Statement for this project. (Lakeland, FL)

JEA (formerly York County Energy Partners) – *ACFB Demonstration Project.* On September 29, 1997, DOE signed an agreement with JEA to cost-share refurbishment of the first (Unit 2) of two units at Northside Generating Station. Construction is planned to begin in October 1999, with operation in early 2002, followed by two years of operations. Activities are underway to draft an Environmental Impact Statement. (Jacksonville, FL)

Clean Energy Partners, LP – *Clean Energy Demonstration Project.* The Clean Energy Partners (CEP) and AMEREN Holding Company have selected the Grand Tower Power Plant near Carbondale, Illinois for repowering with an integrated gasification combined cycle technology. The Clean Energy Project will demonstrate scale up of the British Gas/Lurgi (BG/L) slagging, fixed-bed, oxygen blown gasification technology. The project will also include a 1.25-MWe molten carbonate fuel cell (MCFC) provided by the Energy Research Corporation. The coal gas produced by the BG/L gasifiers will be used to fuel both the gas turbines and the MCFC. Activities are underway to begin the NEPA process. (Grand Tower, IL).

Sierra Pacific Power Co. – *Piñon Pine IGCC Power Project.* This project continues to make progress achieving integrated operation of all systems. Some earlier problems (related to measuring solids levels) in the fines handling system have been resolved; however, other non-gasifier problems, such as fines bridging in vessels, have occurred that prevent feeding coal for more than 6-8 hours continuously. The gasifier continues to operate smoothly through numerous startup-turndown cycles, with reproducible production of specification-quality syngas. Sierra continues to operate the plant normally in the gas combined cycle mode. (Reno, NV)

Tampa Electric Co. - *Tampa Electric Integrated Gasification Combined-Cycle Project.* Tampa's Polk Power Station has completed two years of successful commercial operation. As of the end of the fourth quarter of 1998, the unit has achieved an over 70% gasifier on-stream factor, the gasifier has operated 10,301 hours, and the combustion turbine has operated 9,168 hours, producing over 2,944,278 MWh. The gasifier and combustion turbine set continuous operating records of over 49 and 51 days respectively. (Mulberry FL)

Wabash River Joint Venture – *Wabash River Coal Gasification Repowering Project.* The Project has demonstrated very impressive operating statistics for 1998 and is considered a success story for DOE. In its third year of commercial operation, the plant continues to demonstrate IGCC's ability to operate as part of an electric utility power grid. The syngas facility operated for 5,281 hours in 1998, processing over 560,000 tons of coal and producing over 8.8 trillion Btu's of syngas. The syngas facility contract capacity was about 68 percent for the year, with an availability of over 72 percent. Some of the initial technical difficulties with the first commercial application of several novel technologies have been resolved. Since beginning commercial operation in December 1995, the facility has operated on coal for over 10,000 hours and processed more than one million tons of coal. (West Terre Haute, IN)

Alaska Industrial Development and Export Authority – *Healy Clean Coal Project.* In December 1998, the Healy Clean Coal Project successfully completed its first year of demonstration operations. Slag buildup problems that were experienced in the plant's precombustors when feeding high blends of run-of-mine and waste coal were greatly reduced by air flow modifications, limestone fluxing, and coal pile management. Precombustor slag buildup has not caused any unplanned outages since August 1998. Emissions from the plant when operating at full load or 62 MWe (gross) continued to be within permit levels. Following the plant's annual maintenance outage, demonstration operations resumed on January 18, 1999. (Healy, AK)

Arthur D. Little, Inc. – *Coal-Fueled Diesel Engine Demonstration Project.* The 18-cylinder diesel arrived in Fairbanks on January 30, 1999. Off-loading the engine from the railcar was delayed nearly three weeks due to the extremely cold (-50 °F) temperatures. The engine was successfully moved into the facilities building by the end of February. The delay is not expected to impact the start of the coal-fuel diesel demonstration. (Fairbanks, AK)

COAL PROCESSING FOR CLEAN FUELS

Custom Coals International – *Self Scrubbing Coal™: An Integrated Approach to Clean Air***.** In September, the Federal Bankruptcy Court held a hearing on conditions necessary to close the sale between Custom Coals Laurel and Tanoma Energy. Tanoma and the Pennsylvania Department of Environmental Protection were unable to reach agreement on important issues, and Custom Coals' plan for reorganization was determined to be void. In September, an application to retain Hunyady Auction Company as auctioner to auction off portions of the Custom Coals Laurel facility was filed with the Federal Bankruptcy Court. The auction took place in December. C.J. Betters Enterprises of Monaca, Pennsylvania purchased the facility in place for $3 million dollars and has approached DOE about continuation of the project. (Central City, PA; Martin Creek, PA; Richmond, IN; Ashtabula, OH)

Rosebud SynCoal® Partnership – *Advanced Coal Conversion Process (ACCP) Demonstration.* The Rosebud SynCoal® Project in Colstrip, Montana has processed nearly 1.9 million tons of raw subbituminous coal. Over 1.3 million tons of SynCoal® has been supplied to customers, including industries (primarily cement and lime plants) and utilities. Rosebud SynCoal® Partnership has constructed a Pneumatic SynCoal® Fuel Project at Montana Power's Colstrip power plant. The project injects SynCoal® directly into three of the five pulverizers that feed coal into Unit No. 2 of the power plant. The system will enable the advanced Coal Conversion Process (ACCP) facility to operate full time as Unit No. 2 will take delivery of SynCoal® on a steady basis and will take excess capacity produced. (Colstrip, MT)

Air Products Liquid Phase Conversion Company, L.P. – *Liquid Phase Methanol Process Demonstration Project.* The Liquid Phase Methanol (LPMEOH™) Process Demonstration Facility continues to experience stable operation on coal-derived synthesis gas. The reactor is being operated at a temperature of 235 °C, somewhat lower than the design temperature 250 °C. Fresh catalyst additions made to the reactor have increased the catalyst loading to over 151 percent of design without indications of mass transfer limitations. The rate of decline in catalyst activity continues to either meet or exceed the design target of 0.4 percent per day. Since being restarted with fresh catalyst in December 1997, the demonstration facility has operated at greater than 99 percent availability. The LPMEOH™ Process Demonstration Facility has produced over 34 million gallons of methanol since its startup in April 1997, all of which was accepted by Eastman Chemical Company for use in downstream chemical processes. Following a maintenance outage in early March, demonstration facility operations resumed on March 4, 1999. (Kingsport, TN)

INDUSTRIAL APPLICATIONS

Bethlehem Steel Corporation – *Blast Furnace Granulated Coal Injection System Project.* The Western coal trials have been completed using Colorado Oxbow high volatile granular and pulverized coal. Tests clearly demonstrated that granular coal can be used in a large blast furnace with good results. In addition, the furnace operation shows that low volatile coal replaces more coke than does lower-carbon-content, high volatile coal. The high volatile coal required 31.4 kWh/ton to pulverize during this trial and only 19.6 kWh/ton to granulate. Providing granulated coal reduces the cost of power for size reduction by 40 percent. (Burns Harbor, IN)

CPICOR™ Management Company, L.L.C. – *Clean Power From Integrated Coal/Ore Reduction.* CPICOR™ continues the design activities for a nominal 3,000 metric ton-per-day liquid metal direct iron reduction project using the HIsmelt® Process. The CPICOR Management Company (CMC) has identified a preferred location for the direct iron reduction portion of the demonstration project within the Geneva Steel Company's plant in Vineyard, Utah. Using this footprint, CMC has provided a draft environmental information volume to DOE which is proving helpful for inititiating the NEPA process. CMC team members are also designing the power production end of the project which will be physically separated from the iron production section. (Vineyard, UT)

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