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CLEAN COAL TODAY

A NEWSLETTER ABOUT INNOVATIVE TECHNOLOGIES FOR COAL UTILIZATION

NEWS BYTES

Two new awards were made in January 2003 under the U.S. Department of Energy's **Power Plant Improvement Initiative**. At the Holcomb Station power plant in Finney County, Kansas, Sunflower Electric Power Corporation will test an "integrated combustion optimization system" — an array of state-of-the-art sensors, controls, and clean-burning combustion modifications, all linked to sophisticated "neural network" software. Testing is scheduled to begin in April. In March, Universal Aggregates, LLC broke ground on their ash-to-aggregate recycling plant at Mirant's

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FE ASSISTANT SECRETARY MIKE SMITH VISITS CHINA

ASFE Mike Smith and SDPC Vice Chairman, Zhang Guobao, meet just prior to the signing of the new Clean Fuels Annex

In November 2002, Assistant Secretary for Fossil Energy, Carl Michael Smith, together with a U.S. delegation, made his first visit to the People's Republic of China (PRC) to promote activities under the protocol signed in April 2000 by the DOE Office of Fossil Energy and the Ministry of Science and Technology (MOST) of the People's Republic of China. Smith is Co-Chair of the Permanent Coordinating Committee. The productive three-day visit resulted in Smith signing two new agreements under the Protocol. During his visit, Smith also met with U.S. Ambassador to China Clark Randt, and discussed fossil energy R&D initiatives with the Secretary General of MOST, Mr. Shi Dinghuan, and the Vice Chairman of the State Development Planning Commission, Mr. Zhang Guobao. Smith also met with the Vice Mayor of the Beijing Municipal Government, Ms. Lin Wen Yi, to discuss the potential role of clean coal technology in achieving the environmental objectives established for the 2008 Olympics, which will be held in that city.

Smith's visit involved the signing of an important new Annex II, for cooperation in the area of clean fuels, that includes coal conversion, advanced separation processes/innovative coal preparation, coproduction of chemicals and power, and ultra clean transportation fuels such as hydrogen. Four annexes already had been signed in the areas of power systems, energy and environmental technology, climate change, and oil and gas.

The new agreement was signed by Mr. Smith and Mr. Wang Jung, Deputy Director of the PRC's State Development and Planning Commission (SDPC), and by the two Annex Co-Coordinators, DOE's Dr. Lowell Miller, and SDPC's Mr. Xu Yong Sheng. Although no specific projects are yet listed, one activity envisioned is a pre-feasibility study for a polygeneration project proposed by the Yan Zhou Mining Group, which could produce power and clean fuels. A direct liquefaction project proposed by the Shenhua Group Corporation, Ltd. is also in progress. A study proposed by West Virginia University in conjunction with the Shenhua Group Corporation would seek to determine the social/economic impact of the liquefaction plant.

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"China" continued...

During Smith's visit, a new Annex III (oil and gas) task agreement on coalbed methane was signed. Coalbed methane is plentiful in the PRC, but technology for developing the resource is lacking. Advanced technologies for prospecting, and for identifying the location of resources are of immediate interest.

The Annexes and other activities will be topics of discussion at the upcoming Second Joint U.S.-People's Republic of China Conference on Clean Energy, which will be held in Washington, DC in conjunction with the annual Clean Coal/Clean Energy Conference. The conferences, scheduled for November 17–19, 2003, will focus on political, environmental, economic, and social issues associated with satisfying the growing global demand for energy, and will explore the significance of coal as a viable source of energy for meeting future global energy needs.

In terms of protocol activities for the future, MOST suggested to Assistant Secretary Smith the drafting of a Clean Energy Action Plan for developing clean technologies under Annex IV, Energy and Environmental Technologies. MOST is the lead PRC group for development and application of fossil energy. While the focus of the new Annex is copro-duction, MOST also considers integrated gasification combined-cycle (IGCC) for power a priority. Last September, the PRC selected a U.S. technology, the Chevron-Texaco gasifier, as its choice for a proposed 300- to 400-MW IGCC.

MOST also suggested discussing an Energy Security Action Plan to be drafted under Annex III, Oil and Gas. China is particularly concerned about the vulnerability of its liquid fuels supply and sees the importance of a synfuels and oil storage strategy.

DOE ANNOUNCES NEW HYDROGEN-SEQUESTRATION EFFORTS

At a ceremony on February 27, 2003, Secretary of Energy Spencer Abraham and Under Secretary of State for Global Affairs Paula Dobriansky announced plans to pursue ambitious initiatives in technology for CO_2 sequestration. One would couple production of power and hydrogen from coal with geological sequestration of the CO_2 released in the process. The U.S. Department of Energy (DOE), with the Office of Fossil Energy in the lead role, will spearhead a public-private consortium to develop "FutureGen" — the world's first coal-based, zero emissions electricity and hydrogen plant. DOE and the Department of State also are organizing an international ministerial-level Carbon Sequestration Leadership Forum (CSLF) to promote technology transfer and cooperative sequestration projects, including possible international participation in implementing the FutureGen plant.

The CSLF and FutureGen build on the existing initiatives on climate change and hydrogen fuels — the National Climate Change Technology Initiative announced in June 2001, the Global Climate Change Initiative announced in February 2002, and the Hydrogen Fuels Initiative announced in January 2003. The climate change efforts are intended to strengthen research and provide an aggressive strategy for reducing greenhouse gas emissions by 18 percent over the next 10 years. The hydrogen initiative envisions a transportation system based on clean-burning hydrogen fuel, rather than imported petroleum. All of these activities recognize the importance of technology development in the effort to stabilize greenhouse gas emissions.

BUILDING A PLANT OF THE FUTURE

FutureGen is a $1-billion sequestration and hydrogen production research effort that will result in construction and operation of a pollution-free coproduction power plant in the not-too-distant future. It will be designed and managed by a private consortium that will build and test the 275-MW coal-based electricity and hydrogen plant, a size large enough to provide commercially relevant data. Although no timetable will be set until a solicitation is issued by DOE and an industry team has been formed, FutureGen is envisioned as a 10-year effort, with operation starting five years after the project definition phase has been initiated.

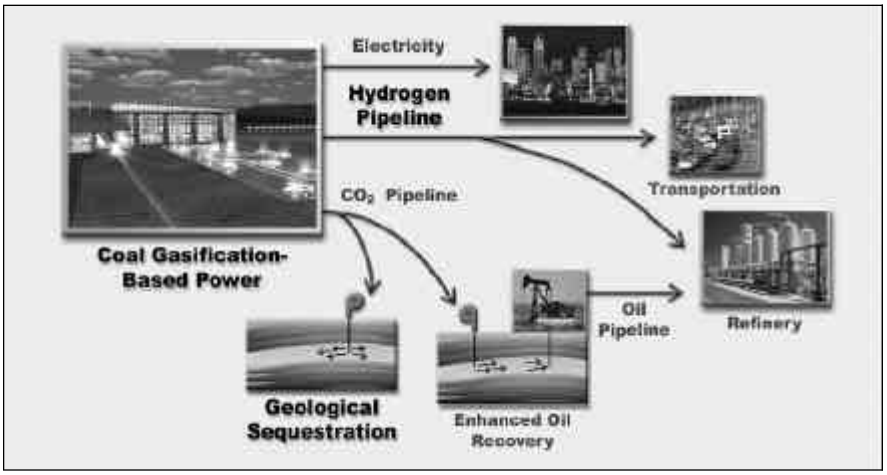
Today's technology is capable of producing hydrogen from coal, our most abundant domestic energy resource; but costs are high and demand is comparatively low. Lack of infrastructure for a national hydrogen system, and public perception of safety issues in hydrogen-powered cars are also concerns that must be addressed. Hydrogen used in the United States today in the chemical and refining industries is produced mainly by "reforming" natural gas, which currently is less costly than hydrogen from coal. It is anticipated that as natural gas prices rise, coal will become more competitive for hydrogen production, particularly with advanced technologies to be developed under the FutureGen effort. FutureGen also could bring hydrogen production costs down by offsetting these costs with electric power production.

While the configuration of the FutureGen facility would be left up to the consortium, it would be based on coal gasification as part of an integrated gasification combined-cycle (IGCC) system, with the synthesis gas from coal

powering the IGCC. Advanced technology would be used to react the synthesis gas with steam to produce hydrogen, and a concentrated stream of CO_2 capable of being sequestered. The hydrogen could be used in a fuel cell to power automobiles (as in the DOE Office of Energy Efficiency's FreedomCAR program), or burned directly in a hybrid-type engine. Hydrogen also could be used to fuel another turbine for further production of electricity beyond the combined-cycle, or it could be used as a refinery feedstock. As indicated in the schematic (at right), CO_2 could be either sequestered in geological formations, or used for enhanced oil recovery. Pollutants such as sulfur dioxide and nitrogen oxides would be cleaned from the coal gases and turned into useful by-products such as fertilizers and soil enhancers. Mercury also would be removed by technologies now being developed under DOE sponsorship.

Challenges facing the consortium will be the need to develop cutting edge technologies for all stages of the process, from gasification to hydrogen separation. Hydrogen production from coal using current technology would employ established gasification techniques followed by water gas shift reactor technology to increase the amount of hydrogen generated and to convert carbon monoxide to carbon dioxide. Hydrogen subsequently would be separated from the mixed gases using existing pressure swing adsorption technology. More advanced processes could include advanced water gas shift reactors, novel separation membranes, as well as novel catalysts and materials. Improvements will be needed in other aspects of the coal gasification process, such as advanced ion transport membrane technology for oxygen separation, advanced cleaning of raw synthesis gas, and improvements in gasifier design.

The consortium also must address infrastructure and delivery issues for the prototype plant. Knowledge obtained from addressing site-specific problems will contribute to the overall experience base, and promote a hydrogen economy by helping to solve similar problems on a wider scale. Determinations will have to be made as to whether hydrogen will be transported in liquid or gaseous form, and the extent to which the existing infrastructure could be used.



Proposed FutureGen hydrogen and CO_2 sequestration options

WORLDWIDE COLLABORATION

DOE's Office of Fossil Energy is an active participant in two important international sequestration projects. At the Weyburn enhanced oil recovery project in Canada (see Fall/Winter 2002 *Clean Coal Today*), DOE is cooperating with Canada and other countries, as well as the International Energy Agency (IEA), in demonstrating new techniques to determine how CO_2 behaves in a depleted oil reservoir. The goal is to store the CO_2 permanently. The Sleipner North Sea Project, to store CO_2 in a deep saline aquifer, is another IEA-facilitated project, where DOE is cooperating with Norway and other countries.

The new Carbon Sequestration Leadership Forum would provide a springboard for further projects. Members would be Ministerial-level delegates from major coal-, oil-, or natural gas-producing countries. Potential participants with the United States include: Australia, Brazil, Canada, China, Colombia, the European Commission, India, Italy, Japan, Mexico, Norway, the Russian Federation, South Africa, and the U.K. All have an interest in coal for power generation and have an expressed concern about environmental issues and sustainable development. Cooperation is expected to take the form of data gathering, information exchange, and joint projects. Data gathering would be based on questionnaires circulated to participating countries. Information exchange would take place in regularly scheduled workshops and seminars on focused topics. Joint projects would be identified as defined in the charter to be developed.

Current plans are for the Forum to meet twice a year for the next several years. The first meeting is scheduled for June 2003 in northern Virginia. Country representatives will discuss their goals for the Forum, and the group is scheduled to develop a charter.

NETL HOLDS CLEAN COAL POWER INITIATIVE PREAWARD MEETING

On February 5, 2003, the U.S. Department of Energy's National Energy Technology Laboratory (NETL) held a "Preaward Meeting" to start the process to secure cooperative agreements for eight projects selected in January 2003 in the initial phase of President Bush's Clean Coal Power Initiative (CCPI). The CCPI is a government-industry, cost-shared program that will demonstrate advanced coal-based, power generation technologies. The goal of CCPI is to accelerate commercial deployment of advanced technologies to ensure clean, reliable, and affordable electricity. The meeting focused on partnering with the participants and reviewing steps required to award the cooperative agreements. NETL Director Rita Bajura gave an opening address on the overarching need for coal to meet our country's energy needs and CCPI's role in addressing key issues (e.g., environmental protection, energy security, and climate change). CCPI Product Manager Mike Eastman discussed performance goals and special features of the CCPI, in particular, the requirements for Federal-private sector partnership, commercial-scale projects, at least 50 percent private cost-sharing, and repayment obligations. Eastman stressed the importantance that partnerships play in project success. Breakout meetings were held for each project team. Some 40 representatives from the eight CCPI projects attended the meeting.

Projects valued at more than $1.3 billion were announced in January 2003, and cooperative agreements are expected to be finalized within eight months for:

- *City of Colorado Springs*, Colorado will team with *Foster Wheeler Power Group, Inc*. to tie together a circulating fluidized-bed (CFB) combustor with a fully integrated emission control technology at a 150-MW power plant south of Colorado Springs.
- *LG&E Energy Corporation* will install an advanced pollution control system (the "Airborne Process") on a 540-MW unit near Carrollton, Kentucky.
- *Wisconsin Electric Power Company* will test the "TOXECON" process for removing mercury and other emissions at its plant in Marquette, Michigan.
- *Great River Energy* will team with the *Electric Power Research Institute* to test a process for enhancing the fuel value of lignite at their station in Underwood, North Dakota.
- *NeuCo., Inc*. will apply sophisticated computational integrated control techniques to achieve peak plant performance. Testing will take place at a *Dynegy Midwest Generations* plant in Baldwin, Illinois.
- *Univ. of Kentucky Research Foundation will team with LG&E Energy Corporation* to separate, recycle, and upgrade unburned carbon from power plant ash and ash ponds; testing to take place at a plant in Ghent, Kentucky.
- *Waste Management and Processors, Inc*. will build and operate a co-production (electric power and liquid fuels) plant fed with raw anthracite wastes at its plant in Gilberton, Pennsylvania.
- *Western Greenbrier Co-Generation, LLC* will team with several research and engineering firms to demonstrate an innovative CFB combustor linked to an advanced multi-pollutant control system at a site in West Virginia.

Current CCPI project fact sheets and other information are available on the CCPI Web site: www.netl.doe. gov/coalpower/ccpi/index.html.

"News Bytes" continued...

Birchwood Power Facility in King George, Virginia. The PPII solicitation was issued in early 2001 to target new technologies to help coal plants improve their efficiency, environmental performance, or cost competitiveness.

DOE is accepting nominations for the **Homer H. Lowry Award in Fossil Energy**, which recognizes scientific and technological achievements in coal, petroleum, and gas. The deadline for submitting nominations is June 13, 2003. For more information see the FE home page http://www.fe.doe.gov

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One of the Department of Energy's most successful Clean Coal Technology demonstration projects, **Air Products Liquid Phase Conversion Company, L.P.'s Liquid Phase Methanol (LPMEOH™) Process Demonstration Project**, Kingsport, Tennessee, has completed its government-funded demonstration tests, achieving an impressive 97.5 percent mark for operational availability. The facility that converts coal-derived synthesis gas into methanol could be the early forerunner of future coal plants that coproduce clean liquid fuels and chemicals in addition to generating power — one of the goals of the recently announced FutureGen project (see article on page 2). During 69 months of operations, the facility produced nearly 104 million gallons of methanol for the Eastman Chemical Company. The tests demonstrate that methanol can be coproduced with electric power for less than 50 cents per gallon. The facility now is being operated in a commercial mode by Eastman.

KENTUCKY PIONEER IGCC/FUEL CELL PROJECT UNDERWAY

Following a favorable environmental Record of Decision (ROD) signed in February 2003, Kentucky Pioneer Energy, LLC (KPE) will begin the detailed design of the first Clean Coal Technology (CCT) project that efficiently and cleanly gasifies a blend of coal and refuse-derived fuel (RDF) to produce electricity. Kentucky Pioneer is a subsidiary of Global Energy USA Limited, of Cincinnati, Ohio. The ROD completes the National Environmental Policy Act process, and allows KPE to move forward with the 540-MW integrated gasification combined-cycle (IGCC) plant to be located in Trapp, Kentucky. As part of the project, KPE also will test a 2-MW molten carbonate fuel cell (MCFC) powered by coal-derived synthesis gas (syngas) at the Wabash IGCC plant in Terre Haute, Indiana. The Wabash plant was the site of a successful CCT Program IGCC demonstration, which completed operations in December 1999 and now operates in commercial service. The scheduled test marks the first time a fuel cell will operate on syngas from a CCT project.

The project will receive DOE financing of $78 million, which includes a little more than $17 million for the fuel cell portion. KPE, Global Energy, and FuelCell Energy will provide the balance of funding for the project, valued at almost $432 million. The IGCC facility in Kentucky is scheduled to begin operations in 2005, while the MCFC will begin operations in Fall 2003. The IGCC and MCFC each will be demonstrated for one year.

The IGCC will be equipped with four British Gas/Lurgi (BGL) fixed-bed gasifiers that consume a feedstock composed of a blend of coal and RDF. The plant will feature a modified feed system to accommodate the feedstock, which is a low-moisture, pelletized municipal solid waste product primarily consisting of high-thermal items like plastics and, to a lesser degree, paper. If needed, the plant can switch to other low-cost opportunity fuels such as petroleum coke, biomass, or old tires. Though BGL technology is a proven means of generating electricity, this project would be the first commercial application of this feedstock and feed system modification. Furthermore, this first-of-its-kind IGCC will generate 40–50 percent more capacity than any other BGL unit now in operation.

FUEL CELL UNIT

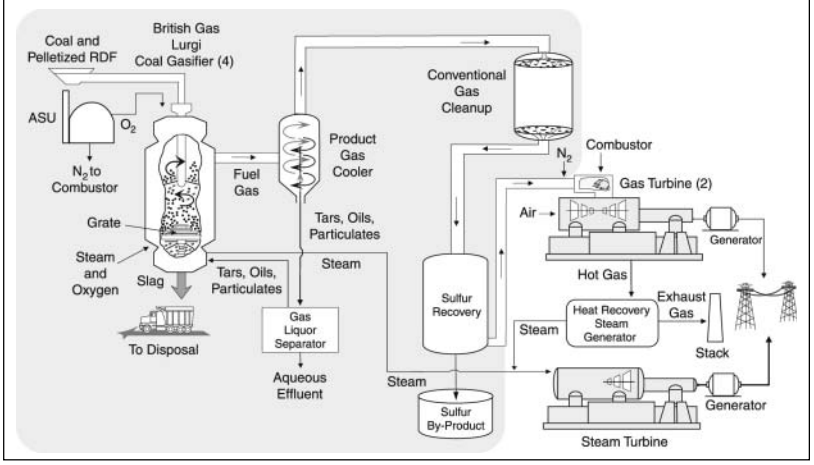
The MCFC will use the "Direct FuelCell" technique developed by FuelCell Energy and DOE's National Energy Technology Laboratory. The MCFC originally was intended for the Kentucky site, but was moved in order to speed up testing. Before the MCFC arrives at the Wabash plant, it will be assembled and tested at FuelCell Energy's fabrication plant in Torrington, Connecticut. Testing of the fuel cell, which features a modular design that allows multiple units to be combined, will further DOE's support of clean energy systems — fuel cells offer very high efficiency and are virtually pollution free.

THE BGL PROCESS

The project includes a gasification island and a power island. Tracking the process shown in the schematic, the major components are (from left to right): RDF pellets and coal receipt and storage facilities; air separation unit (ASU); gasification plant (four BGL gasifiers); sulfur removal and recovery facilities; and a combined-cycle system.

RDF pellets will be procured from an RDF pellet manufacturer. Operation will commence on 100 percent coal, with slowly increasing levels of RDF until a maximum of 50 percent RDF is reached. The ASU provides oxygen for the gasification process and nitrogen that, along with water, lowers gas turbine flame temperatures and thus lowers thermal-NO_x formation.

BGL Process Schematic



Each BGL gasifier is a long, vertical, 12-foot diameter pressure vessel filled with a bed of high carbon content feedstock — in this case coal and RDF pellets along with steam, oxygen, and limestone flux. The feedstock is fed into the vessel through a series of feed lock hoppers, lock valves, and level gauges located near the top of the gasifier. The individual pieces of coal and

See "IGCC Fuel/Cell" on page 6...

"IGCC Fuel/Cell" continued...

RDF pellets descend down the gasifier in a continual stream, ultimately reaching the bottom of the gasifier, where they are consumed and converted to syngas at 3,600 °F. At this point, a series of rapid reactions occur that produce a gas rich in hydrogen and carbon monoxide.

Since the amount of oxygen is strictly controlled, NO_x emissions are held at extremely low levels. Though individual pieces of coal and RDF constantly descend during gasifier operation, the column of materials is kept at a fixed height — a "fixed bed." Raw fuel gas leaving the gasifier is washed and cooled in a heat exchanger to about 100 °F; a separator recovers tars, oils, and dust that may have carried over from the gas. Solids exit from the bottom of the gasifier as a glassy, non-leaching vitreous frit, or "slag." The syngas is then cooled and cleaned using conventional petrochemical processes.

The sulfur compounds are removed from the raw syngas in two steps, acid gas cleanup and sulfur recovery. The acid-gas cleanup is generally accomplished by using a selective amine-type solvent. The sulfur recovery units use a process unit that employs a Claus chemical reaction to generate elemental sulfur. The "sweet" sulfur-free syngas then passes through a bed of activated carbon to further remove mercury and other constituents.

The sweet gas fuels two gas turbines, whose efficiency approaches 51 percent. In addition, hot exhaust gas from the turbines will be used to generate steam, adding to the plant's capacity and efficiency. Commercial application of the KPE project is expected to operate at an efficiency of 42.5 percent compared to the 33 percent efficiency of conventional coal plants.

ENVIRONMENTAL BENEFITS

The technology to be installed by KPE offers one of the highest solid fuel conversion rates available (92 percent), and emits less than 10 percent of the emissions allowed by the New Source Performance Standards. NO_x limits would be held at 0.072 lbs/10^6 Btu, about 50 percent lower than the 0.15 lbs/10^6 Btu emission rate requirement beginning in 2008.

Other emissions are curtailed even more. Carbon monoxide and sulfur dioxide emissions individually would be 0.032 lbs/10^6 Btu. Higher efficiency means that carbon dioxide emissions, tied to potential climate change impacts, would be slashed by at least 20 percent compared to emissions from a conventional similar sized coal power plant.

Finally, waste minimization benefits also will be realized. The RDF, which would otherwise be landfilled, is converted into energy. The technology also does not produce traditional waste ash (some 1.5 million tons/year from a comparable plant) to be landfilled. Sulfur also is put to beneficial use. The gasifier converts sulfur in the feedstock to hydrogen sulfide that is removed downstream and converted to elemental sulfur, which can be used in a number of chemicals and in fertilizer. The frit from the gasifier also can be used in a range of commercial applications. Both frit and sulfur products could be sold to offset project operating costs.

The environmental and efficiency advantages offered by the KPE gasification and fuel cell system make it an important element of DOE's Vision 21 Program for producing power for the 21st century. The program envisions a fleet of highly advanced, fossil-fuel-based power plants that are flexible enough to use a variety of fuels and produce a range of products, while practically doubling the efficiencies of today's coal and gas units in a near-zero emissions environment. Advanced technologies like KPE's BGL gasifier, IGCCs, and fuel cells move the Vision 21 program closer toward reality.

DOE CLEAN COAL AND POWER — CONFERENCE ANNOUNCEMENT —

The U.S. Department of Energy will be holding a Clean Coal and Power Conference on November 17, 2003, in Washington, DC, with a theme of *"Coal's Role in the Coming Decades — Energy Security in an Insecure World."* The DOE conference will be held in conjunction with the Second Joint U.S.-People's Republic of China Conference on Clean Energy on November 18–19, 2003. The Clean Coal and Power conference topics will focus on political, environmental, economic, and social issues associated with the growing global demand for energy. Speakers will address coal as a potential solution and as a viable source of energy to meet the global energy demand. The conference also will feature an exhibit area and poster session.

For conference information, contact: Faith Cline, Conference Manager, (202) 586-7920, faith.cline@hq.doe.gov; poster session contact: Kim Yavorsky, (412) 386-6044, Kimberly.Yavorsky@netl.doe.gov; exhibition information contact: Scott Miles (301) 670-6390 ext. 30, smiles@tms-hq.com.

INTERNATIONAL INITIATIVES

NEW ZEALAND'S NATIONAL HYDROGEN WORKSHOP

NETL Fuel Cell Product Manager, Dr. Mark Williams, speaking at New Zealand Hydrogen Workshop

At the request of the New Zealand Ministry for the Environment, U.S. Department of Energy Fossil Energy Fuel Cell Product Manager, Dr. Mark Williams, participated recently in the New Zealand Hydrogen Workshop in Wellington, New Zealand. The Hydrogen Workshop, organized by New Zealand's Ministry for the Environment and the Energy Efficiency and Conservation Authority, was held at the Wellington Town Hall Conference Center on February 28, 2003. Dr. Williams met ministry officials and other sponsors, and presented a paper on the DOE stationary fuel cell program.

New Zealand is developing a roadmap to transition to a hydrogen economy and is welcoming input from outside experts. The country has 8 billion tons of coal lignite on the South Island, as well as plentiful hydropower, wind, and photovoltaic resources. New Zealand is over 60 percent hydro powered. It has limited petroleum resources, and the 4 million population is dependent on imported oil for their transportation fuel.

The preliminary results of a study by Unitec (affiliated with Stanford University), a company hired by New Zealand to help develop a Hydrogen Plan for the government to consider, are expected to show that the 8 billion tons of known coal resources on the South Island should couple with FutureGen concepts as key components of any New Zealand hydrogen economy (see related article on page 2). This coal resource could be used in power plant configurations that use IGCC or solid oxide fuel cells (SOFCs) and other technologies to produce both hydrogen and electric power.

The Unitec study will be examining present and advanced technologies to produce hydrogen from coal. The report is expected to rely on a study conducted for DOE by Mitretek. That report showed that hydrogen can be produced from coal with current gasification technology at about 64 percent efficiency (HHV basis) for an estimated cost of production in the range $6.50 to $7.00 per MMBtu. If hydrogen is produced in an advanced gasification coproduction facility that also generates electric power, the production costs of the coproduced hydrogen can be reduced significantly depending on the value of the power.

If the coproduced electric power is valued at $35.6/MWh (the cost of producing power from a natural gas combined-cycle plant (NGCC)), it is envisioned that hydrogen can be produced for about $5.50/MMBtu. In a coproduction facility where carbon dioxide is sequestered, the cost of hydrogen is only slightly increased if the coproduced power is valued at $53.6/MWh (the cost of producing power from a NGCC plant that includes sequestration). Utilization of advanced membrane separation technology has the potential to reduce hydrogen production costs to about $4.00/MMBtu.

The Mitretek study concluded that the greatest potential for reducing the production cost of hydrogen from coal is in configurations that include SOFCs. Coproduction facilities that use SOFC topping cycles to produce electric power and hydrogen have the potential to reduce the production cost of hydrogen to an estimated range of $2.50 to $3.00/MMBtu. These costs could be achieved in facilities that sequester carbon dioxide at efficiencies of around 65 percent. Costs of producing hydrogen from traditional steam methane reforming of natural gas are dependent on fuel costs. If natural gas costs $3.00/MMSCF, then the resulting cost of hydrogen is estimated to be $4.80/MMBtu.

DOE ADDRESSES EMERGING ELECTRIC UTILITY WATER ISSUES

Electricity production requires a reliable, abundant, and predictable source of water — a resource that is in limited supply in parts of the United States and much of the world. The process of thermoelectric generation from fossil fuels such as coal, oil, and natural gas (as well as nuclear power) is water intensive; each kWh generated requires an average of 25 gallons of water. This equates to indirectly using as much water turning on lights and running appliances as for watering lawns and taking showers. The electricity industry is second only to agriculture as the largest domestic user of fresh water, accounting for 39 percent of all freshwater withdrawals in the nation. At the same time, while large amounts of water are required for electric generation (more than 97 billion gallons per day used for cooling purposes in 1995), some 97 percent is recycled in some manner, while only about 3 percent of what is withdrawn is *not* returned to the source water body. However, as the growing U.S. economy drives the need for more electricity, so will it increase pressure on the use of water for power generation. Electric utility sector water demand will increasingly compete with demands from other sectors of the economy, as well as in-stream use such as boating and fishing, and protection of habitat.

As such, the availability of adequate supplies of water to produce electricity and the impact of power plant operations on water quality are receiving increased attention. From a regulatory standpoint, current and future requirements under the U.S. Clean Water Act (CWA) and Safe Drinking Water Act (SDWA) have the potential to impact the design and operation of fossil fuel-fired electric generators. One concern is the expanded definition of non-point sources under the CWA Total Maximum Daily Load limits program, to include air emissions deposited in a watershed. In addition, the U.S. Environmental Protection Agency (EPA) has recently proposed regulations under Section 316(b) of the CWA that could limit the amount of water used by power plants by requiring installation of wet or dry closed-loop cooling systems. Drinking water regulations requiring additional limits on arsenic could affect the way power plants dispose of coal by-products. Further, on a state or regional basis, the lack of available fresh water has prevented the siting and permitting of new power plants.

Shown above, a typical power plant cooling tower

It is likely that existing and new power plant operations may be faced with increasingly stringent restrictions on water use and water quality in the not too distant future. Some permits for new plants already are being denied due to inadequate supplies of water. Coupled with continuing drought conditions in the east and particularly in the western regions of the United States, which may force power plants to reduce load in order to save water, progressively more stringent environmental regulations for water could challenge the nation's ability to meet future needs for power.

ELECTRIC UTILITIES AND WATER WORKSHOP

In response to these issues, DOE's National Energy Technology Laboratory (NETL) is now addressing water issues as part of its Innovations for Existing Plants (IEP) program. The overarching goal of the IEP program is to develop advanced technology to enhance environmental performance of the existing fleet of coal-fired power plants.

The first large forum for stakeholder input to the water program was a workshop held in July 2002, "Electric Utilities and Water: Emerging Issues and R&D Needs," co-sponsored by NETL, and Los Alamos and Sandia National Laboratories. The workshop brought together 55 representatives from government, the electric-utility and coal industry, EPA, EPRI, academia, state agencies, energy commissions, and research organizations. Speakers discussed a broad spectrum of local, regional, and national issues. Breakout sessions provided an opportunity for stakeholders to identify water and energy production issues that will need to be addressed in the near and mid terms. A number of areas were identified that are relevant to the utility/water interdependency, including advances in cooling system technology, development of alternative cooling water sources, improving the understanding of the relationship between power plants and watersheds, and integrated water use planning.

A number of specific research opportunities were identified in breakout sessions as good candidates for concerted public/private research.

- Advanced wet-cooling and dry-cooling systems, including novel wet-dry hybrids and exotic systems (such as ocean cooling or cryogenic cooling);

John Veil of Argonne National Laboratory summarized current regulatory issues

Breakout group discussed research and development needs

- Improved intake structure protection equipment;
- Improved and/or advanced water treatment technologies;
- Data development and testing of nontraditional sources of cooling water for power plants, including underground mine pools, industrial and municipal wastewater, and coalbed methane-produced water
- Novel technology for treating/upgrading nontraditional water for use by power plants;
- Pilot-scale projects demonstrating water-quality trading and carbon capture/sequestration, coupled with mine land reclamation;
- Watershed models to aid in water-use planning and regulatory development; and
- Potential beneficial uses for discharge waters from power plants, such as waste heat for aquaculture or process heating.

Proceedings from the workshop can be found at http://www.netl.doe.gov/coalpower/environment/index.html.

MOVING FORWARD

Based on input received at the workshop as well as discussions with key stakeholder groups, a targeted solicitation, "Innovative Water Management Techniques and Concepts for Coal-Fired Electric Utility Boilers," was issued in December 2002, with a closing date in February 2003. Multiple awards are expected by Fall 2003. The objective of the solicitation is to develop cost-effective approaches to better manage fresh water use and impacts on quality associated with coal-fired power plants. The solicitation will build upon NETL's current water analysis capabilities and competencies related to remote sensing, acid mine drainage treatment, water-credit trading, regulatory and policy analysis, of waters associated with oil and gas production. It will further complement ongoing research on the use of waste heat from the condensing cycle to reduce evaporative loss from closed-loop-cooling systems.

The solicitation is focused on nontraditional sources of process and cooling water, innovative cooling and water intake technologies, and advanced pollutant measurement and treatment technologies. All projects will be cost-shared, with a minimum private sector share of 20 percent of total project value.

The DOE-private sector R&D effort in advanced technologies and concepts to improve the management of water used by coal-based power systems will help to maintain coal's strategic role in the nation's energy mix while meeting the challenge of providing reliable, affordable, and environmentally sound energy for America well into the 21st century.

ILLINOIS GRANTS PERMIT TO DOE-FUNDED LEBS PROJECT

In December 2002, the State of Illinois issued a construction permit to Corn Belt Energy Corporation, an electric cooperative, for a 91-MW Low Emission Boiler System (LEBS) demonstration plant. This is the first construction permit for a coal plant issued by Illinois in 30 years, due to the slump in high-sulfur coal demand as a result of environmental requirements. The U.S. Department of Energy (DOE) Office of Fossil Energy is providing $33.5 million of a total estimated cost of $147 million for the LEBS demonstration. Other funding sources include the Illinois Department of Commerce and Community Affairs, and the Illinois Clean Coal Board. Corn Belt requires additional financing from the Rural Utilities Service in order to begin construction. Availability of DOE funds beyond the design phase are contingent on successful completion of the National Environmental Policy Act Environmental Impact Statement process now under way. The plant would be sited adjacent to the Turris Coal Mine in Logan County, Illinois. The LEBS technology makes use of an advanced U-fired low-NO_x combustion system that Riley Power Inc. (formerly Babcock Borsig Power) developed earlier in the LEBS program. The advanced low-NO_x firing system employs Riley's CCV® DAZ low-NO_x burners, combined with air and fuel staging.

ENERGY & ENVIRONMENTAL RESEARCH CENTER

Coal is the fuel of choice to produce electricity in the United States, accounting for 52 percent of the electricity produced in the year 2000. A plentiful domestic resource, coal's increased use could reduce U.S. dependence on foreign energy resources. However, effectively operating clean and efficient coal-based plants remains a challenge for the power industry, both in the United States and abroad.

As the world's leading research and development center for low-rank coals and, arguably, a leading center for all ranks of coal, the Energy & Environmental Research Center (EERC) is uniquely qualified to work with industry to meet that challenge. The EERC has been involved in research and development of clean coal technology for over 50 years. A self-supporting research, development, demonstration, and commercialization facility associated with the University of North Dakota, the EERC has developed partnerships with both private industry and government agencies, and lists clients from all 50 states and 47 countries.

The EERC is keenly focused on helping the energy industry meet demands of the world's ever-expanding population through responsible coal use. Key efforts include the development of pollution control technologies, new efficient and cost-effective coal-based generation technologies, and tools to optimize operation of conventional power systems.

DEVELOPING CONTROL TECHNOLOGIES

With mercury emission regulations on the horizon, the control of mercury from coal-fired boilers has become the most pressing issue U.S. utilities face today. Working in partnership with the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) in the late 1990s, the EERC was responsible for establishing and validating methods of sampling and analysis for mercury that are now accepted worldwide. The EERC, which is designated as the EPA Center for Air Toxic Metals, continues to be a leader in developing effective strategies for mercury control, like enhanced carbon-based sorbents and noncarbon sorbent materials.

Emissions of SO_3 are another pressing concern for utilities. While selective catalytic reduction (SCR) systems installed in numerous coal-fired boilers in this country have sharply reduced NO_x emissions from these facilities, an unintended consequence has been the formation of increasing amounts of SO_3 on the catalytic surface of the SCR systems. Working with its industrial partners, Marsulex Environmental and Alstom Air Preheater, Inc., the EERC has developed a mechanistic model that has allowed the team to configure and optimize the arrangement of the backend devices, eliminating 90 percent of the SO_3 in the flue gas stream. This solution currently is marketed by the alliance, with the EERC providing the modeling expertise and demonstration facilities used to verify and refine solutions to be installed in full-scale facilities.

Facilities also are increasingly under pressure to reduce fine-particle emissions from coal-fired boilers. The EERC, working with its partners W.L. Gore & Associates and DOE's National Energy Technology Laboratory (NETL), has developed an innovative new technology, the *Advanced Hybrid*™ filter, that combines the best features of fabric filtration and electrostatic precipitation. The EERC has patented this technology and licensed it exclusively to its partner, W.L. Gore & Associates. Two full-scale applications of the technology have been completed: one at a cement kiln in Italy and the other, a demonstration activity, at the Otter Tail Power Company's 450-MWe coal-fired boiler in South Dakota. The demonstration in South Dakota received partial funding under DOE's Power Plant Improvement Initiative. In both cases, the device successfully controlled over 99.99 percent of the particulates. This device is so efficient that the air leaving the stack near Milbank, South Dakota, is cleaner than the ambient air surrounding the plant with respect to fine particles.

ADVANCING GENERATION TECHNOLOGIES

For coal to remain the fuel of choice for power generation, more cost-effective and environmentally acceptable power systems must be commercialized. To accomplish this goal, the EERC has focused on understanding and matching fuel properties to system characteristics. This philosophy has been critical to EERC efforts to develop advanced coal-based power systems, including gasification technologies and an indirectly fired combined-cycle system.

The EERC has been working with DOE, the Southern Company, and Kellogg, Brown and Root on an advanced gasification system (transport reactor). This device offers a lower-capital-cost, high-throughput option that can significantly lower the cost of an integrated gas-

ification combined-cycle (IGCC) system for producing power. The EERC has employed a subscale development facility for this technology. Operating temperatures have been varied, from 1,500–2,000 °F (815–1,093 °C), and dry product gas higher heating values of 90 to 135 Btu/scf in air-blown mode and 212 to 267 Btu/scf in oxygen-blown mode have been measured. These results have been used by Southern Company to guide its work on the larger Wilsonville facility and its planning for a full-scale IGCC system that utilizes this technology.

The EERC, through a project with Xcel Energy and NETL, is exploring the option of using a range of lower grade fuels, including coals and biomass, in an innovative combined-cycle system. The system combines a typical steam cycle with an indirectly fired turbine cycle using very high-temperature but low-pressure air as the working fluid. The heart of this advanced system is a high-temperature advanced furnace (HITAF), originally developed with United Technologies Research Center (UTRC) under DOE funding, which uses heat exchangers that will ultimately produce high-temperature clean air to turn an aeroderivative turbine.

The EERC set a record for the highest-temperature clean air produced with a heat exchanger operated on a coal-fired furnace, 2,000 °F (1,094 °C), while firing an Illinois No. 6 bituminous coal. The overall system design is very similar to that of a typical pulverized coal-fired boiler system, except that ceramics and high-nickel (Ni) alloys are used to carry the very high-temperature air. This design makes it especially suitable as a boiler retrofit technology. In addition, calculations show that with the use of a gas-fired duct heater, efficiencies of 55 percent can be achieved, compared to 35 percent in today's coal-fired systems.

ENHANCING OPERATIONAL EFFECTIVENESS

In addition to new technology options, the EERC is developing exciting new tools to help the industry more effectively operate its existing fleet of coal-based power plants. Working with commercial partners, and with funding from EPRI and DOE, the EERC has developed, and is currently enhancing the *Guidelines for Solving Ash Deposition in Utility Boilers*. This three-volume series is intended to aid utilities in solving ash deposition problems such as slagging and fouling. One volume is geared to utility managers, another to boiler operators, and the third offers valuable resource information. The tool is based on lab-, pilot-, and full-scale data developed by the EERC over nearly 40 years of work on ash behavior during combustion.

The EERC has partnered with Alliant Energy in developing another tool, a computational fluid dynamics model of coal combustion. Today, it is possible to predict what will happen in a coal-fired boiler, based on the basic chemistry and physics of ash during combustion. This model will allow the operator to examine the impact of changing coal characteristics and boiler operating parameters on ash behavior. Still under development, it should be available commercially in the near future through Alliant Energy.

The EERC believes that effective use of coal is an important part of future energy production in the United States. With commercial partners, DOE, and others, the EERC is working hard to bring new technology options to the marketplace to meet the challenge of the cost-effective, environmentally acceptable use of coal today and well into the 21st century.

This guest article was submitted by Michael L. Jones, Thomas A. Erickson, and Gerald H. Groenewold, Energy & Environmental Research Center, P.O. Box 9018, Grand Forks, ND 58202-9018.

Aerial view of the EERC complex located in Grand Forks, North Dakota

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Comments are welcome and may be submitted to the Editor.

DOE EXPLORES EXTERNALITIES COSTS

On February 20–21, 2003, the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) sponsored a workshop on "Valuing Externalities." Approximately 40 stakeholders from a diverse group participated, including representatives from industries, National Laboratories, environmental organizations, academia, and other government agencies. The workshop included sessions on health effects of fine particulates; a survey of externality models — how they work, and how they differ; and steps in developing a mercury externality model.

This innovative workshop sought state-of-the art models and studies for valuation of power plant emissions reduction, especially as related to the complexities of placing a value on health benefits of future reductions in fine particulates and mercury. Studies on valuing externalities associated with electric power generation are used in energy planning and decisionmaking. Valuing externalities methodology ordinarily includes four steps: estimating the types and quantities of emissions of pollutants; predicting their chemical transformation, dispersion, and deposition; calculating the increased exposure to those pollutants; estimating the associated health and environmental risks; and expressing these risks in economic terms.

Participants included researchers and policy makers from private sector, academia, and government agencies. Shown at lecturn are: (top to bottom) Daniel E. Klein, Twenty-First Strategies, LLC; Gary Myers, Univ. of Rochester Medical Center; and John W. Goodrich-Mohoney, EPRI

The Energy Policy Act of 1992 states that energy decisions should include considerations of health and ecological impacts. DOE/NETL is interested in valuing externalities in order to prioritize environmental control technology RD&D as well as provide guidance to industry. In holding the workshop, NETL sought to understand outstanding issues regarding the benefits of particulate matter (PM) and mercury reduction. One expected outcome of the workshop was the identification of "next steps" to assist DOE in evaluating benefits of environmental control technologies through the development of better models, higher quality data, and more well-designed studies and analyses.

The first day of the workshop focused on health effects of fine particulates ($PM_{2.5}$). Because high-efficiency particulate removal devices exist at virtually all coal-based power plants, these plants emit less than 2 percent of all "primary" $PM_{2.5}$, (i.e., $PM_{2.5}$ released from its source as solid particles) in the U.S. However, much of the $PM_{2.5}$ measured at ambient monitoring sites actually consists of "secondary" $PM_{2.5}$, which is formed in the atmosphere through chemical reactions involving gases such as SO_2, NO_x, and organic vapors. Coal plants account for about two thirds of total SO_2 emissions and about 20 percent of total NO_x emissions nationwide; therefore, reductions in SO_2 and NO_x emissions from coal plants (as called for in the Clear Skies Act of 2003) are likely to have a greater impact on ambient $PM_{2.5}$ mass than reductions in primary $PM_{2.5}$ emissions.

Hundreds of studies have been done on the health impacts of $PM_{2.5}$, and epidemiological studies have found many different associations. However, the consensus is that the types of $PM_{2.5}$ that are most likely to harm people, and the biological mechanisms by which different types of $PM_{2.5}$ might harm human health, still remain mostly unknown. Unresolved issues include acidity, physical properties, organic and inorganic components, biological components, and co-pollutant interactions. Additionally, some gases (such as carbon monoxide) that are highly correlated with local vehicular $PM_{2.5}$ emissions, might be responsible for some of the harm that newer epidemiological studies attribute to vehicular $PM_{2.5}$. Panel sessions on these subjects concluded that more studies on PM exposure, mechanisms of epidemiology of any related illness, and premature deaths had to be conducted before any benefits from reduction of PM emissions from power plants can be determined.

Also discussed during the first day was the status of existing externality models. Three commercially available models were reviewed and discussed. One of the presentations examined utility externalities and some of the mortality impacts re-

lated to the higher cost of electricity. It was clearly indicated that effects of regulation-related energy costs on low-income populations need to be accounted for when assessing health effects. This session emphasized that externality analysis must consider offsetting the social costs of environmental policies.

The second day focused on requirements for developing a mercury externalities model. The latest data show that coal-based power systems emit nearly 48 tons of mercury annually, which is about 2 percent of all anthropogenic mercury emissions globally to air, and about 1 percent of total global mercury emissions to air. Elements required for developing a mercury externalities model were determined to be: quantifying Hg emissions; identifying Hg transportation/ transformation/deposition; locating food chain and human exposure paths; defining health outcomes/ecological damage; and assigning value to outcomes and alternatives.

An externality model will not be ready for use until information gaps are filled. A case in point was considered to be health effects of mercury in fish. For reasons not well substantiated, the highest levels of methylmercury tend to be in top-of-the-food-chain oceanic fish (shark, swordfish, and blue fin tuna). Participants noted that, though effects of methylmercury on pregnant women and newborns was currently a popular concern, only limited studies had been conducted.

Participants agreed that the next steps in developing a mercury externality model should include the following: documentation of health impacts of other pollutants, specifically selenium since selenium sequesters mercury; better quantification of the economic value of health impacts from coal combustion; better mass balance of atmospheric mercury loadings; establishment of a pathway or damage function to evaluate any impact; and establishment of biological mechanisms for different potential adverse effects from methylmercury in fish.

More information on the workshop, including copies of the presentations, can be found on the NETL Web site: http://www.netl.doe.gov/ under Events.

UPCOMING EVENTS

May 13–15, 2003
3rd Annual DOE/U.N. Hybrid Conference and Workshop
Sponsors: DOE, NETL, EERE
Location: Newport Beach, CA
Contact: Karen Lockhart
Phone: (412) 386-4763
E-Mail:
karen.lockhart@sa.netl.doe.gov

June 24–26, 2003
18th Low-Rank Fuels Symposium
Sponsors: DOE, NETL, EERC, EPRI
Location: Billings, Montana
Contact: Anne Fiala
Phone: (701) 777-3119

August 12–13, 2003
Mercury Control Technology R&D Program Review Meeting
Sponsor: DOE, NETL
Location: Pittsburgh, PA
Contact: Kimberly Yavorsky
Phone: (412) 386-6044
E-mail:
kimberly.yavorsky@netl.doe.gov

October 28, 2003
2003 Conference on Unburned Carbon on Utility Fly Ash
Sponsor: NETL
Location: Pittsburgh, PA
Contact: Kimberly Yavorsky
Phone: (412)386-6044
E-mail:
kimberly.yavorsky@netl.doe.gov

October 29–30, 2003
2003 Conference on Selective Catalytic Reduction and Non-Catalytic Reduction for NO_x Control
Sponsor: NETL
Location: Pittsburgh, PA
Contact: Kimberly Yavorsky
Phone: (412)386-6044
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November 17–19, 2003
Clean Coal and Power Conference and Second Joint U.S.-People's Republic of China Conference on Clean Energy
Co-Sponsor: DOE, CEED, NMA, EPRI, and CIBO
Location: Washington, DC
Contact: Kimberly Yavorsky
Phone: (412) 386-6044
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kimberly.yavorsky@netl.doe.gov

STATUS OF ACTIVE CCT DEMONSTRATION PROJECTS

ENVIRONMENTAL CONTROL DEVICES

Southern Company, Inc. – *Demonstration of Advanced Combustion Techniques for a Wall-Fired Boiler*. Phase 4 was extended until April 30, 2003 to evaluate the use of GNOCIS and other computerized process control software. The goal was to further optimize operation of Plant Hammond Unit 4 by controlling additional processes, including ESPs, sootblowers, and steam side equipment. (Coosa, GA)

ADVANCED ELECTRIC POWER GENERATION

City of Lakeland, Department of Water & Electric Utilities – *McIntosh Unit 4A PCFB Demonstration Project and McIntosh Unit 4B Topped PCFB Demonstration Project.* Lakeland Electric continues to evaluate its options to meet future power demand. During this internal review, Lakeland, Foster Wheeler, DOE, and others have been reviewing the system concept, siting, and financial issues in order to improve the project. (Lakeland, FL)

JEA – *ACFB Demonstration Project.* Construction of Unit 2 at the Northside Station has been completed in December 2001. The DOE demonstration planned for January 2003 was delayed while JEA made repairs/modifications to Unit 2. (Jacksonville, FL)

Kentucky Pioneer Energy, L.L.C. – *Kentucky Pioneer Energy Project.* The Environmental Record of Decision was published in the *Federal Register* on February 4, 2003, completing the NEPA process. Presentations to the PSC Siting Board were completed and a decision on issuing a Certificate is due. A groundbreaking ceremony for the fuel cell portion of the project (relocated to Wabash River) is scheduled for around May 26, 2003. (Trapp, KY and West Terre Haute, IN)

Sierra Pacific Power Co. – *Piñon Pine IGCC Power Project.* The project ended January 1, 2001. Sierra has submitted the Final Technical Report to DOE. Integrated operation of the gasifier, hot gas cleanup system, and gas turbine had not been achieved when the project ended. Because the state of Nevada repealed electric deregulation and placed a moratorium on the sale of power plants in the state, the pending sale of Sierra's Tracy Station (which includes the Piñon Pine plant) to WPS Power Development, Inc., was suspended. DOE's post-project assessment report was completed in December 2002. (Reno, NV)

Tampa Electric Co. – *Tampa Electric Integrated Gasification Combined-Cycle Project.* Tampa's Polk Power Station completed its operational period at the end of October 2001 with over four and one-half years of successful commercial operation. The Final Report was accepted by DOE, and copies were delivered to DOE on December 19, 2002. (Polk County, FL)

TIAX (formerly Arthur D. Little, Inc.) – *Development of Hybrid Advanced NO_x Control*. Clean Coal Diesel Project. Due to TIAX's reorganization, testing of the hardened engine parts has been delayed. Problems associated with oil leakage and the cooling system of the 18 cylinder diesel at University of Alaska, Fairbanks have been addressed and further checkout is necessary. DOE and TIAX are negotiating project changes. The current plan is to modify the Cooperative Agreement and rescope the current plan. The details of the changes to the test program will be available by mid-calendar year 2003. (Location, TBD)

COAL PROCESSING FOR CLEAN FUELS

Western SynCoal LLC (formerly Rosebud SynCoal® Partnership) – *Advanced Coal Conversion Process (ACCP) Demonstration.* DOE is negotiating with Westmoreland Mining LLC, owner of the Western SynCoal LLC, to complete the Final Report for the project. Current projections are that the report will be completed in June 2003. (Colstrip, MT)

Air Products Liquid Phase Conversion Company, L.P. – *Liquid Phase Methanol Process Demonstration Project.* On December 31, 2002, the Liquid Phase Methanol (LPMEOH™) Process Demonstration Facility completed a successful 69-month period of operation using coal-derived synthesis gas. Following the second successful in-situ activation of methanol synthesis catalyst completed in late June 2002, catalyst performance has exceeded all expectations. The overall catalyst deactivation rate during the final six months of operation was about 0.1 percent per day, which is significantly better than the baseline catalyst deactivation rate of 0.4 percent per day that was achieved at the LaPorte Alternative Fuels Development Unit using synthesis gas derived from natural gas. Over the entire operating period, the facility operated at an impressive on-stream availability of 97.5 percent, and produced nearly 104 million gallons of methanol, all of which was accepted by Eastman Chemical Company for use in downstream chemical processes. The facility is now being operated in a commercial mode by Eastman to help

satisfy its methanol feedstock requirements. Preparation of the Final Report is underway. (Kingsport, TN)

INDUSTRIAL APPLICATIONS

CPICOR Management Company, L.L.C. – *Clean Power From Integrated Coal/Ore Reduction (CPICOR).* Preparation of the Environmental Impact Statement for the CPICOR project has been placed on hold until further notice. The CPICOR Management Company (CMC) continues to work toward arranging the financing necessary to move the project into Budget Period 2. CMC also continues to work closely with the Australian developers of the HIsmelt Process and iron/steel engineering firms to establish a process and mechanical design database for this project. The Cooperative Agreement has been extended to August 30, 2003. Upon receipt and review of the Continuation Application to move into Budget Period 2, DOE will make a decision on the future of this project. (Vineyard, UT)

ThermoChem, Inc. – *Pulse Combustor Design Qualification Test.* The Final Report has been submitted and accepted by DOE, and the Cooperative Agreement is in the close-out process. The Post Project Assessment is in review and should be finalized in mid-2003. (Baltimore, MD)

PPII STATUS

Tampa Electric Company, Big Bend Power Station Tampa – *Network Sootblower Optimization Project.* Project came on line early 2003, and baseline testing is underway. First stage Neural Network operation is scheduled to begin summer 2003. *(Apollo Beach, FL)*

Universal Aggregates, LLC – *Commercial Demonstration of the Manufactured Aggregate Processing Technology Utilizing Spray Dryer Ash.* Universal Aggregates is a joint venture between CONSOL Energy, Inc. and SynAggs, Inc. The NEPA process has been completed for the site. The project has progressed through the design phase into construction. Ground was broken at the site on March 26, 2003. The facility is expected to be ready for shakedown in November 2003. (King George, VA)

Sunflower Electric Power Corp. – The Spring outage was initiated in mid-March 2003 and the installation of hardware commenced. The combustion optimization sensors package was installed and the sensors are operational. Data are being archived. During the outage, stiffeners were added to the probe guides to permit removal of the probes while they are hot. The mechanical and electrical installation of the coal flow measurement system is complete. The engineering design of the overfire air system is in progress and on schedule. Installation of the low-NO_x burner modifications and automated coal-balancing dampers was completed. Due to the extension of the coal nozzles, it was necessary to extend the ignitors and ignitor scanners further into the burners. Each of the coal mills was operated and the lines were checked for coal leaks and minor leaks were repaired. The boiler was started up on Tuesday, March 25, 2003. The coal flames appeared to be stable and the burner settings will be optimized in early April. (Garden City, KS)

Otter Tail Power Company – *Demonstration of a Full-Scale Retrofit of the Advanced Hybrid Particulate Collector (AHPC) Technology.* On October 25, 2002, the Advanced Hybrid™ Filter system came on line at the Otter Tail Company's 450-MWe Big Stone Plant to dispatch power. The first three months of operation have shown very good particulate removal efficiency, but at the cost of higher system pressure drop. Performance testing has shown that the average collection efficiency of the AHPC is 99.997 percent. The outlet dust loading is almost 2 orders of magnitude lower than the guarantee limit of 0.002 gr/acf. However, AHPC system pressure drop also has exceeded guarantee limits and has resulted in derating of the Big Stone Plant. The power plant was recently shut down to wash the boiler tubes and to make repairs and install additional instrumentation to improve performance of the AHPC. The Big Stone Plant was scheduled to return to operation in early March. (Big Stone City, SD)

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