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CLEAN COAL TODAY

A NEWSLETTER ABOUT INNOVATIVE TECHNOLOGIES FOR COAL UTILIZATION

NEWS BYTES

In October 2004, the U.S. Department of Energy announced a second round of **project selections under the Clean Coal Power Initiative** (CCPI). The goal of the $2 billion, 10-year program is to develop and demonstrate a new generation of power plant technologies. Under this round, four projects were selected. **Peabody Mustang Clean Coal Project**, sponsored by Peabody Energy and its partners, will be located in Milan, NM. The project will develop an innovative and cost-competitive multi-pollutant "Airborne Process" scrubber, regeneration, and fertilizer production system. **Southern Company Services** will construct a 285-MW (net) coal-based

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SEQUESTRATION LEADERSHIP FORUM MEETS IN AUSTRALIA

The Carbon Sequestration Leadership Forum (CSLF) held its second Ministerial-level meeting in Melbourne, Australia in mid-September 2004. The inaugural Ministerial meeting had been held in Tysons Corner, Virginia in June 2003, and the Policy and Technical groups met in Rome, Italy in January 2004. The CSLF, a Ministerial-level international forum, was launched by the U.S. Department of Energy (DOE) and the U.S. State Department in February 2003, and seeks to make carbon capture and storage commercially competitive and environmentally safe through international collaborative efforts in data gathering, R&D, and joint projects. A total of 16 countries and the European Commission have signed the CSLF charter. South Africa, Germany, and France are the newest members.

Ian Macfarlane, Minister of Industry, Tourism and Resources, represented Australia at the Melbourne meeting

Two senior Australian officials spoke of their country's position as a significant energy producer and exporter, with geology amenable to sequestration. Ian Macfarlane, Australia's Minister of Industry, Tourism and Resources, acted as host Minister for the Melbourne forum, while Senator Ian Campbell, Minister for Environment and Heritage, made opening remarks. Macfarlane noted the priority placed on identifying and developing sites for safe, long-term CO_2 storage, and the necessity for a consistent regulatory approach across the six Australian states and two provinces. Campbell elaborated on Australia's role as the world's fourth largest coal producer (for export and domestic use). Australia is committed to limiting its CO_2 emissions to 108 percent of 1990 levels between now and 2020, while energy demand is expected to increase 50 percent. Thus, a suite of policy options is required, Campbell said, that will encourage renewables, efficiency, low-emission technologies, and sequestration. Moreover, he noted that Australia needs policies that do not drive investment offshore, and that encourage innovation and investment by the private sector.

The U.S. Minister to the conference was DOE Deputy Secretary Kyle E. McSlarrow, acting for Secretary of Energy Spencer Abraham. Principal

See "CSLF" on page 2...

"CSLF" continued...

Deputy Assistant Secretary for Fossil Energy, Mark Maddox, is Chair of the CSLF Policy Group. Speaking at the plenary session, Maddox stressed that technology development can provide an answer to the linked concerns of world economic development and carbon dioxide emissions. Multinational cooperation through the CSLF also can provide a usable template for legislative, regulatory, and financial incentives for capture and storage. Maddox noted the pivotal role of stakeholders, as well as the complementary role of DOE's FutureGen project that is to employ integrated gasification combined-cycle (IGCC), a core technology for carbon capture.

The Melbourne meeting delivered on some of the key tasks identified in the CSLF charter, and resulted in the signing of a ministerial communiqué. Ten sequestration projects were officially endorsed (see CSLF Web site, www.cslforum.org). The projects cover most applications of energy use and various phases of CO_2 capture and storage. Forum approval shows these to be serious projects meeting established stringent criteria, and should increase their overall visibility and public acceptance. All project sponsors must be willing to share non-proprietary information, and the projects undertaken must result in data that would allow sponsors of subsequent projects to make improved estimates of technical performance, and technology costs and benefits.

The Ministers at Melbourne also approved a Roadmap, developed by the Technical Group, outlining a variety of alternative capture/sequestration pathways that a country could adopt depending on its circumstances. The pathway that a country chooses

will depend on its current and planned electricity generating method and fuel, and its specific geography for transporting and storing CO_2. The Roadmap is to be a "living" document that may change as countries write their own roadmaps. CSLF Roadmap themes are in three key areas: lowering costs; identifying/securing reservoirs, and developing monitoring and verification technology, all according to an established timetable. The Roadmap is intended to provide a common understanding of technology stages and gaps. Four modules evaluate current status of CO_2 capture and storage technology; document ongoing activities; determine technology gaps; and outline possible routes for meeting future CO_2 capture, transmission, and storage needs for CSLF member countries.

The Ministers also reviewed and accepted a Task Force report on regulatory issues affecting carbon capture and storage. Australia hosted an international sequestration regulatory workshop in November 2003 in order to help develop the report. Case studies explore the four stages of project life: capture, storage, injection, and post-injection. While some regulatory parallels could be found for the first three stages, there remain definite gaps in monitoring and verification standards for the post-injection stage. In order to facilitate dialogue with stakeholders, the Ministers also agreed to establish a Stakeholder Engagement Register on the CSLF Web site. Since the CSLF is composed of government representatives, stakeholders are not official members but participate as observers, give presentations, and hold their own meetings. The Policy and Technical Groups are involved in a continuing effort to explore the best means of stakeholder interaction and public outreach.

The next meeting of the CSLF Policy and Technical groups is scheduled for Berlin, Germany in September 2005. As per the Charter, the Ministers will not meet again until 2006. Next steps involve acting on further capture/sequestration project nominations made at the Melbourne meeting, and closing gaps in the Roadmap. The European Commission will be heading a task force investigating the capture/transport gaps on a country-specific basis. Canada will spearhead an effort to do the same for CO_2 monitoring. Australia will be in charge of a group reviewing standards for capacity measurement at potential storage sites. Other new work includes a Canadian-led effort to consider further CSLF activities in public awareness outreach, and a task force led by India to study financial incentives. The Melbourne Minister's communiqué and related reports can be found on the CSLF Web site. The Web site is maintained by the DOE Office of Fossil Energy, which acts as Secretariat to the CSLF.

JAPAN'S CLEAN COAL CYCLE (C3) INITIATIVE

The Ministry of Economy, Trade and Industry (METI) launched a study group — the "Clean Coal Cycle (C3) Study Group" — on Japan's new coal policy for the next couple of decades to reposition coal in a mid- to long-term energy policy. In June 2004, the study group issued the interim report "Japan's New Coal Policy Toward 2030: C3 Initiative Toward Establishment of the Clean Coal Cycle." The driving force behind the new coal policy is concern about carbon dioxide (CO_2) emissions and global warming, which have focused international attention on fossil fuels, particularly coal. In addition, the new policy seeks to address international coal supply and trade to improve price stability, which is considered necessary to underpin the diversification needed to meet energy security objectives.

The Japanese government views coal as an essential and strategic element of its long-term energy supply security. The in-depth coal policy review that led to the C3 Initiative, the action program for the new coal policy, was stimulated by this strategic perspective and the increasing difficulties surrounding coal use due to global climate concerns. The objectives, directions, and action plans that the C3 study identified are viewed as essential if coal is to be effectively utilized in an economically reasonable and environmentally friendly manner over the medium to long term. While this initiative is firmly rooted in Japan's own energy supply needs and environmental perspectives, the goals and directions of the new policy are set in the Asian regional context, necessary from the points of view of both the international coal market and the global warming issue.

The overall thrusts identified for the new Japanese coal policy are to greatly reduce CO_2 emissions and other environmental impacts of coal use; diversify energy sources, allowing coal to leverage other fossil fuels as a contribution to increased energy supply security; and secure a stable supply of coal in both the short and longer term. To achieve these objectives, the coal policy outlines five basic directions. High efficiency use of coal will be promoted. This policy element could include taking advantage of the Kyoto Clean Development Mechanism. Environmentally harmful by-products would be reduced, or beneficial uses found. New coal utilization possibilities would be cultivated via RD&D projects. The expansion of supply potential is another important direction. Infrastructure improvement is necessary and could be fostered by financial incentives. Procurement of coal would also be made more efficient in order to maintain and strengthen coal's stable, low-cost advantage. Establishment of a liquid coal trading market is being considered.

Japan also sees itself in a regional and global leadership role with regard to the development and application of advanced, environmentally friendly coal technologies that the report projects will increase the compatibility of environmental protection and economics in the use of coal. Technologies mentioned in the report include various established clean coal technologies, as well as carbon capture and sequestration. Action plans are aimed at the realization of a society with high-efficiency energy utilization in the short- and mid-term time frame, and zero-emissions in the mid- to long term. Japan sees the dissemination of innovative CCTs into Asian countries as contributing to the resolution of global warming issues, as well as enhancement of the country's industrial competitiveness.

A detailed analysis of the goals and directions for investigation resulted in a number of action plans for implementing the new coal policy. Details of the action plans, as well as the full report, can be found at http://www.meti.go.jp/english/report/index.html/. For additional information, about the Initiative, contact okouchi-hiroshi@meti.go.jp, or azuma-tetsuya@meti.go.jp.

This guest article was submitted by Hiroshi Okouchi, Manager of Stable Coal Supply, and Tetsuya Azuma, Planning Manager, Agency of Natural Resources and Energy, Japan Ministry of Economy, Trade and Industry.

UPCOMING EVENTS

January 27–28, 2005
Solid State Energy Conversion Alliance Core Technology Peer Review Workshop
Location: Tampa, Florida
Contact: Karen Lockhart
(412) 386-4763

January 25–28, 2005
Asia-Pacific Economic Cooperation Clean Fossil Energy Technology and Policy Seminar
Location: Cebu City, Philippines
Contact: Scott Smouse
(412) 386-5725

April 11–15, 2005
World of Coal Ash
Organizers: ACAA International, NETL, OSM, UK CAER
Location: Lexington, KY
Contact: Lynn Brickett
(412) 386-6574

NETL EXPLORES MERCURY MEASURING TECHNIQUES

Experts active in the fields of measuring and controlling mercury emissions from coal-fired power plants agree that existing measuring techniques do not readily produce verifiable emissions data. Such was the consensus at a recent workshop sponsored by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) and Electric Power Research Institute (EPRI) on measuring mercury in coal-fired power generation systems. The workshop allowed open discussion among participants from industry, academia, and research institutions, on ways to improve measurement quality in order to conform to draft specifications issued by EPA as part of plans to regulate power plant mercury (see *Clean Coal Today*, Spring 2004). Mercury controls are likely to take place in the 2007-08 timeframe and no existing measurement or monitoring techniques are exact enough to meet strict criteria set forth in the draft rule (EPA's Performance Specification 12A [PS-12A], Specifications and Test Procedures for Total Vapor-phase Mercury Continuous Monitoring Systems in Stationary Sources). Manpower requirements and attendant high costs, as well as sensitivity to operator error, were also noted as problems with today's systems. In all, the deficiencies underscore the need for novel measuring techniques being researched by NETL and its partners.

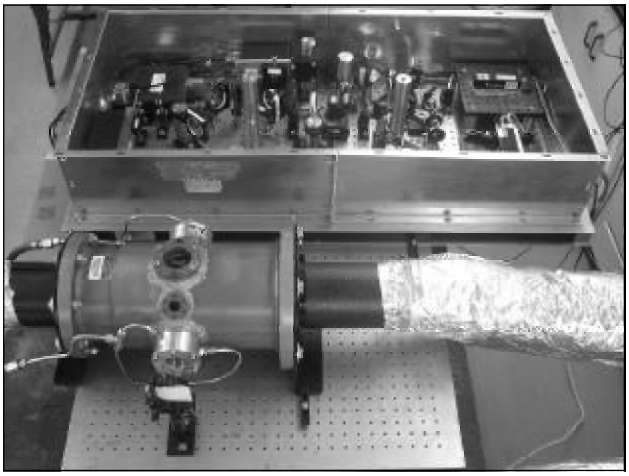
Capturing, measuring, and sampling mercury in coal fired power plants is challenging because of the low part-per-billion concentrations normally present in the exhaust stream and the dynamic conditions of a power system. Mercury in high-temperature flue gas is also reactive and can change forms between elemental and oxidized states. Current technology is only capable of measuring mercury in its elemental form. This requires pre-treatment to convert the oxidized forms of mercury to elemental mercury. To ensure accurate measurements, SO_2 and particulates also must be removed.

The Ontario Hydro Method is the predominant technique for measuring the total amount of gas phase mercury in the exhaust streams of coal-fired power generation systems. Ontario Hydro makes use of a series of chemical impinger solutions to trap the mercury in the liquid from the gas phase. The collection of mercury in these solutions is made manually by trained personnel, with samples sent to a laboratory. This renders the technique too time consuming and expensive to be used on a regular basis. Workshop participants also noted that a lack of uniform QA/QC procedures can make results inconsistent.

Automated on line analytical systems are commercially available for measuring mercury from incinerators, and these systems have been adapted for coal-fired utilities. However, these systems also use chemical solutions to trap the mercury and thus are time consuming and high maintenance. New Continuous Emission Monitoring (CEM) and semi-CEM approaches are being tested that do not require use of a chemical solution.

NEW LASER TECHNIQUES

In an effort to develop more viable techniques, NETL's Advanced Research Program is supporting concurrent efforts that use laser light in innovative ways. Lasers are being used to measure trace levels of mercury without the need for extensive pre-treatment of the gas prior to analysis. One system, the Cavity Ringdown Spectrometer, introduces light into a mirrored cavity where it reflects off the mirrors several times, allowing the light to absorb relative to the concentration of mercury in the stream. Use of mirrors greatly multiplies the total path length of the light. This system has superior detection capability — 1.5 parts per billion of gas phase mercury in the presence of 1,000 ppm sulfur dioxide. Special signal processing eliminates the need to remove constituents from the flue gas that adversely affect measurement accuracy. The laboratory demonstration of the technology has been



Prototype laser detection system developed by Purdue University that combines lasers with different wavelengths to measure pollutant gases

successfully completed, and the Spectrometer will be tested in the field to assess commercial viability.

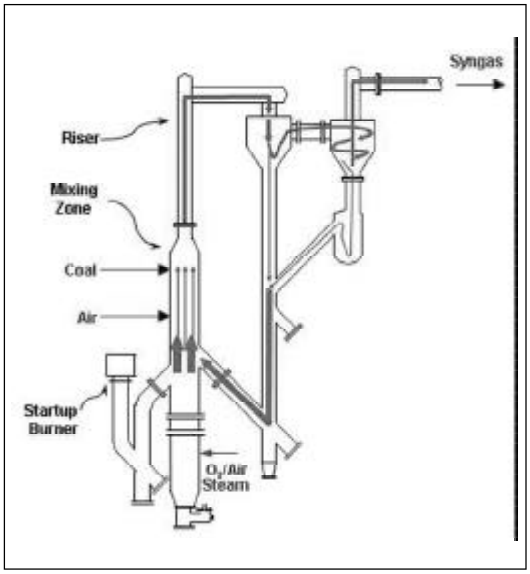
In another effort, NETL is teaming with Sandia National Laboratory's Combustion Research Facility to investigate the feasibility of using laser light to measure an oxidized form of mercury (mercuric chloride, $HgCl_2$). Sandia's fundamental examination has focused on using laser light to fragment and fluoresce the mercury molecules. The feasibility of this technique has been demonstrated in the laboratory with a detection limit of 1 ppb. This ongoing work is one of the first demonstrations of the direct detection and measurement of mercuric chloride, an important step in the goal of a practical online measurement system for total mercury. Sandia is also using a novel fiber-based laser system to transfer the light, which could serve as an efficient and practical application in full-scale CEM installations.

NETL recently tasked Purdue University with a project to develop an alternative light source using diode type lasers and sum frequency mixing of light to generate the specific wavelength needed for the detection of mercury. Purdue will test this light source to measure the concentration of elemental mercury in a flowing gas stream. If successful, this approach will not require any sampling of mercury or treatment of the flue gas. Purdue also will study the feasibility of using laser-induced breakdown spectroscopy to measure all forms of mercury including mercury bound to particulate. Such a technique could provide the first direct measurement of total mercury in a single step.

DEVELOPMENT OF TRANSPORT REACTOR GASIFICATION AT THE PSDF

The Power Systems Development Facility (PSDF), located near Wilsonville, Alabama, is a large pilot plant (2–3 tons/hour coal feed rate) designed to carry out research and development (R&D) on advanced power systems and components at a size sufficient to support commercial scaleup. R&D at the PSDF is conducted under U.S. Department of Energy (DOE)/National Energy Technology Laboratory partnerships with energy industry participants. Southern Company Services (SCS) operates the PSDF, and together with DOE engages power system developers and contributors, which currently include the Electric Power Research Institute (EPRI), Kellogg Brown and Root, Inc. (KBR), Peabody Energy, Siemens-Westinghouse Power Corporation (SWPC), and the Lignite Energy Council.

The purpose of the PSDF is to gain operating experience with new process configurations and critical components for advanced power generating and synthesis gas-producing systems to provide data for scale-up to first-commercial, zero-emission clean energy systems. The PSDF started operations in 1996 and initially focused on testing and developing Particulate Control Devices (PCDs) to remove particulate matter (PM) from gas streams at high temperature and pressure under both pressurized fluidized-bed combustion and integrated gasification combined-cycle (IGCC) conditions. The work also resulted in the development of the KBR Transport reactor, as a combustor and as a gasifier.



Schematic of Transport Gasifier reactor

Work at the PSDF has paid off. The KBR Transport Gasifier and a number of balance-of-plant (BOP) components tested at the PSDF are technologies chosen for a project selected under the second round of the Clean Coal Power Initiative (CCPI). The CCPI project will demonstrate a 285-MW (net) IGCC unit applying a KBR Transport Gasifier in an air-blown mode. BOP equipment includes a Siemens-Westinghouse PCD. The goals for the 285-MW demonstration are to achieve a heat rate of 8,400 Btu per kilowatt-hour, which equates to 40.6 percent efficiency on a higher heating value (HHV) basis. Future units based on the 285-MW demonstration unit design are projected to be 600-MW class units running at efficiencies of 41.5 percent HHV.

See "PSDF" on page 6...

...PSDF continued

TRANSPORT GASIFIER AND PCD FEATURES

The KBR Transport Gasifier is based on the company's catalytic cracker technology, which has been used for decades in petroleum refineries. The reactor operates at considerably higher circulation rates, velocities, and riser densities than a conventional circulating fluidized bed, resulting in higher throughput, better mixing, and higher mass and heat transfer rates. The KBR gasifier has undergone more than 6,000 hours of testing since 1999.

The reactor consists of two sections; a short, larger-diameter mixing zone and a longer, smaller-diameter riser (see schematic on page 5). In the gasifier configuration, air and steam are introduced at the bottom of the mixing zone, operating at up to 285 psig and 1,800 °F, to raise heat by burning the carbon in the recirculated char. The coal and sorbent are fed to the top of the mixing zone to separate the coal from the oxidant and avoid burning the volatile material produced when the coal is heated. All of the solids and gases are carried from the mixing zone into the riser where devolatilization and carbon-steam gasification reactions occur. Some of the sulfur released from the coal is captured as calcium sulfide by the calcium in the coal or added calcium-based sorbent. The majority of the unreacted char and sorbent-derived material leaving the riser is captured by a disengager and cyclone assembly and recycled back to the mixing zone through a standpipe and a non-mechanical "J-valve." This increases the effective solids residence time, which improves carbon conversion and sorbent utilization. The product gas and fine char that are not captured in the cyclone are cooled to 700-800 °F in a heat exchanger before entering a candle-filter PCD developed by SWPC, which removes any remaining PM from the gas.

The SWPC PCD has a tangential side inlet and a single cluster holding candle-configured filters in two plenums containing up to 91 candle filters, which are backpulsed separately (see photo). Each filter is equipped with a safeguard device to block PM flow in case of a filter failure. The filter holder and safeguard have been improved to routinely achieve outlet PM levels below the detectable limit of 0.1 ppmw. The captured PM, combined with the solids removed at the base of the standpipe, can be conveyed to an atmospheric fluidized-bed sulfator where any carbon in the char is burned off and calcium sulfide is converted to calcium sulfate before disposal in a landfill.

Candles from the inside of the Siemens-Westinghouse candle filter vessel

RESEARCH PROGRESS

Over the past several years, the PSDF has been conducting important testing to improve transport gasifier performance and versatility using both the traditional air-blown operation, and oxygen-blown operation. The PSDF also has been engaged in fuel cell testing toward DOE's goal of 60 percent efficient IGCC under oxygen-blown conditions.

Oxygen-Blown Operation. The KBR gasifier has been operated in an oxygen-blown mode to produce a clean syngas that can be used with processes being developed to meet DOE's zero emissions goal. The objective is to develop coal-based technology that is competitive with natural gas in cost and emissions. To do so required a new lower mixing zone spool piece to accommodate a smaller volume of oxidant (oxygen instead of air), and introduction of more steam to avoid creating hot spots in the mixing zone and riser. Oxygen-blown tests demonstrated a smooth transition from air to oxygen, and produced synthesis gas with a heating value of 180 Btu/scf on a lower heating value (LHV) basis compared to 115 Btu/scf (LHV) under air-blown conditions. Carbon conversions were somewhat lower, 90 percent compared to over 95 percent with air, but the pressure was limited by the oxygen supply equipment to about 130 pounds per square inch gage (psig). In July 2004, 4-day testing with oxygen, at pressures up to 205 psig, was successful. The results suggest that pressures up to 230 psig could be attained, which would allow significantly higher coal feed rates.

Coal Moisture Content. Testing was conducted to evaluate KBR gasifier tolerance to moisture con-

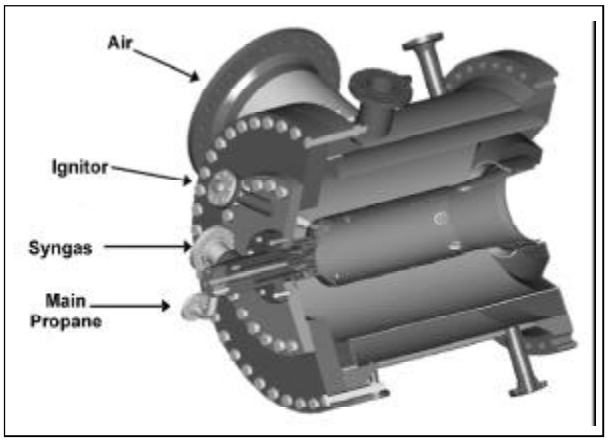
tent, which can be quite high in the low-rank coals considered to be a market target for the gasifier. Test runs with coals having moisture contents up to 45 percent showed that the feed systems could tolerate 20–22 percent moisture without plugging. The wet coal problem was overcome by raising the pulverizer mill temperature about 10 °F above the dew point so that no condensation occurs. The oxygen content of the gas used to sweep the mill and convey the coal was kept below 13 percent to avoid fires and dust explosions. Routine steady operation with wet and low-rank coals is a significant accomplishment.

Lignite Testing. Lignites were tested in the KBR gasifier as well. Tests showed an apparent sensitivity to high-sodium content lignites as evidenced by deposits in the cyclone loop seal. This initially required lowering operating temperature, and negatively affected carbon conversion efficiency. But the problem was traced to sodium fusion with sand used in gasifier startup, which could be dealt with through modified operating procedures.

Solid Oxide Fuel Cell Testing. SCS developed a synthesis gas cleanup train to remove tars, sulfur and chlorine compounds, trace elements, and residual PM. Previous work had shown that ammonia up to 5,000 ppmv, hydrogen chloride below 1 ppmv, and hydrogen sulfide below 0.1 ppmv were not detrimental to fuel cell operation. The cleanup system at the PSDF was placed after the PCD, which removes most heavy metal vapors and dust particles. Zinc oxide was used in two vessels in series, the first operating at 600 °F to remove sulfur compounds to less than 1 ppmv, followed by a 400 °F stage to achieve an equilibrium concentration of about 0.1 ppmv. A commercial chloride guard material, containing 90 percent aluminum oxide and 10 percent sodium aluminate at 550 °F, was placed downstream to remove HCl to less than 1 ppmv. A cold gas cleanup system was designed as a backup and operated in series behind the hot gas cleanup system. The 1-kW SOFC incorporated two 15-cell stacks in series, operated at 1,380 °F, and applied internal synthesis gas reforming. The fuel cell produced 620 W at 21 volts and operated successfully for 62 hours.

Piloted Synthesis Gas Burner (PSB). SWPC developed a PSB for use with the 4-MW Rolls-Royce/Allison 501-KM gas turbine at the PSDF in order to combust synthesis gas with heating values as low as 60 Btu/scf. These low heating values are encountered because the test unit dilutes synthesis gas by using nitrogen in lieu of synthesis gas for solids conveying and purging. But the PSB **has potential for NO_x** control applications where turbines must sustain flame stability while combusting very lean air/fuel mixtures. The PSB is a long, large diameter burner that is started on propane and then switched to synthesis gas with a pilot flame of propane to increase the heating value of the fuel gas if needed. A double wall, separated by a narrow gap with impingement cooling holes in the outer wall, and gas effusion holes in the inner wall, is used to provide combustor liner cooling (see Figure below). PSB tests included operation on propane for 10 hours, integration with the Transport Gasifier, and operation on synthesis gas for six hours.

Economic Studies. PSDF participants completed economic studies on both a single air-blown Transport Gasifier in an IGCC application with a PCD, and an F-class turbine and two air-blown Transport Gasifiers in an IGCC application with PCDs and two F-class turbines. Results showed that construction of a single train plant would cost an estimated $1,290 per kilowatt, and that a two-train plant would cost an estimated $1,040 per kilowatt. Additional studies to be published next year will examine oxygen blown operation versus air blown operation, synthesis gas cleanup versus stack gas cleanup, and CO_2 removal options.



Siemens-Westinghouse piloted syngas burner

In over a decade of operation, the PSDF has helped move new gasification technology toward commercialization. Future test plans will concentrate on supporting air-blown gasification for low-cost power generation, and oxygen-blown gasification to achieve the goals of DOE's zero emissions power generation and hydrogen production.

AUSTRALIAN COAL: A SUSTAINABLE FUTURE

Clean coal is now firmly on the agenda of energy policy in Australia following the establishment of the COAL21 program to reduce and ultimately eliminate greenhouse gas emissions from coal-fueled power generation. Launched in March 2004, the COAL21 *"Plan of Action for Australia"* has involved a unique partnership between government (at the federal and state level), the coal and power industries, private and public research communities, and the coal industry union.

Coal is the dominant fuel for Australian power generation and the largest contributor to Australia's greenhouse gas emissions. It is also the country's major export — Australia being the largest exporter of coal in the world. Coal's contribution to the efficiency and productivity of the domestic economy and export earnings has been recognised in the Australian government's recent energy policy, which provides strong support for RD&D in clean coal technologies.

COAL21 was developed as input to policy making and as a valuable contribution to the national discussion of energy and greenhouse gas reduction. COAL21 has bipartisan support in Australia, despite reservations from some parties and environmental groups. The Australian coal industry, through the Australian Coal Association's sustainable development program, has been a leading driver of the COAL21 agenda.

COAL21 identifies a range of actions for reducing or eliminating greenhouse gas emissions from the use of coal in Australia's electric power generation. The action plan complements efforts to increase the uptake of renewables and rein in rapidly growing energy demand through measures to increase end-use efficiency. Technologies proposed include the capture of carbon dioxide (CO_2) emissions from power stations and permanent storage in underground geological structures, a pathway to achieving near-zero emissions from coal. Other priority technologies identified in the Plan include those that increase the efficiency of coal use, and coal gasification that may allow coal to provide large amounts of hydrogen gas for a future "hydrogen economy." The Plan outlines actions that should be pursued in Australia to accelerate the development of each of the technologies. These actions are divided into two broad phases: an RD&D phase to around 2015, and a subsequent deployment phase.

There are opportunities for reducing emissions from all stages of the coal chain including production, utilisation, and waste disposal. More than 95 percent of emissions occur at the point of combustion at power stations; thus, the Plan recognizes that these emissions represent the best opportunity for large-scale abatement action.

There have been a number of recent moves within Australia consistent with COAL21 toward the development of "near-zero-emission" coal-fueled power generation, and which represent a significant development in the forward agenda of the COAL21 Plan of Action for Australia. They include developments in use of oxy-fuel for retrofitting existing power stations, integrated gasification combined-cycle (IGCC), and carbon dioxide capture and storage technology.

Projects announced recently include:

- Investigation of oxy-fuel technology for a first-of-a-kind demonstration retrofitted powerplant in Queensland, including the capture and geological storage of the CO_2;
- A project by Stanwell Corporation (also in Queensland) involving IGCC and capture and storage;
- A feasibility study for a 500-megawatt brown coal fueled advanced gasification power station in the Latrobe valley of Victoria;
- A CO_2 injection demonstration project; and
- Purchase by Anglo American Coal of the controlling interest in a coal-to-liquids project in Victoria involving IGCC and geological sequestration.

The Australian initiatives are in line with a growing international consensus that clean coal and carbon sequestration technologies are needed as an integral component of the global response to climate change. Australia also is a strong contributor to the international effort through organisations such as the Carbon Sequestration Leadership Forum (CSLF).

For more information, see the Web site at: www.coal21.com.au/.

This guest article submitted by Mark O'Neill, Executive Director of the Australian Coal Association.

FORECASTING THERMOELECTRIC FRESHWATER NEEDS

The requirement for a sustainable supply of clean freshwater to meet future needs is critical to both the United States and the world. As our population increases and economic development continues, energy demand also will grow. Energy and water are inextricably linked, further challenging our ability to meet increasing demands for both. Electricity production requires a reliable, abundant, and predictable source of water. In terms of total U.S. water use, the thermoelectric generating industry is second only to agriculture as the largest domestic user of freshwater according to the most recent U.S. Geological Survey (USGS) data — accounting for 39 percent of all freshwater withdrawals in the United States.

The U.S. Department of Energy's (DOE) Energy Information Agency (EIA) 2004 Annual Energy Outlook's reference case forecasts significant increases in new thermoelectric generating capacity, along with the retirement of some existing capacity, through 2025. DOE's National Energy Technology Laboratory (DOE/NETL) completed an analysis of the freshwater required to meet thermoelectric generating capacity projections (fossil and nuclear) in terms of both withdrawal and consumption. For the study, it was assumed that future generating facilities will employ a re-circulating cooling system (*i.e.*, wet cooling towers), while all retired facilities are once-through cooling plants. This assumption follows current trends in choice of cooling systems, driven primarily by state and federal regulatory requirements. While the analysis focused on freshwater, approximately 30 percent of water withdrawn for power plant cooling comes from saline sources. The table below provides a comparison of changes in freshwater withdrawal and consumption by thermoelectric power plants for each of the six cases described below.

Changes in Daily Freshwater Withdrawal and Consumption by Thermoelectric Power Plants 1995–2025

	1995	2025	Delta, 10 gpd	Delta, %
Freshwater Withdrawals — Billion gallons/day (gpd)				
Case 1	132.1	119.2	-12.9	-10%
Case 2	132.1	132.1	-9.0	-7%
Case 3	132.1	132.1	0.0	0%
Case 4	132.1	137.9	5.8	4%
Case 5	132.1	113.4	18.7	-14%
Case 6	132.1	136.8	4.7	4%
Maximum	132.1	137.9	5.8	4%
Minimum	132.1	13.4	-18.7	-14%
Freshwater Consumption — Billion gallons/day (gpd)				
Case 1	3.3	8.7	5.4	163%
Case 2	3.3	7.1	3.8	114%
Case 3	3.3	3.3	0.0	0%
Case 4	3.3	8.8	5.5	165%
Case 5	3.3	3.3	-0.1	-2%
Case 6	3.3	7.8	4.5	135%
Maximum	3.3	8.8	5.5	165%
Minimum	3.3	3.3	-0.1	-2%

- Case 1 – All additions and retirements occur at facilities using freshwater.
- Case 2 – Additions and retirements are proportional to current source withdrawals (70 percent freshwater/30 percent saline).
- Case 3 – All additions and retirements occur at facilities using saline water.
- Case 4 – Additions occur at freshwater facilities, while retirements occur at saline facilities.
- Case 5 – Additions occur at saline facilities, while retirements occur at freshwater facilities.
- Case 6 – All retired coal units listed in the report are assumed to be once-through cooling. These units are repowered rather than retired but the existing once-through cooling system continues to be used. New capacity additions listed are reduced by the repowered units.

The analysis estimated that by 2025, daily freshwater withdrawals required to meet the needs of U.S. thermoelectric power generation may decrease to 113 billion gallons/day (-14%) or increase to 138 billion gallons/day (+4%) compared to 1995 freshwater withdrawals depending upon the assumptions made about the source of cooling water and type of cooling technology employed for new and retired capacity.

Because a significant fraction of water withdrawn for use in a re-circulating cooling tower is lost

See "Freshwater" on page 10...

...Freshwater continued

through evaporation, changes in consumptive use of freshwater by thermoelectric generating sector was also estimated. The USGS estimates that, in 1995, freshwater consumption by U.S. thermoelectric power plants was approximately 2.5 percent of total withdrawals, or 3.3 billion gallons/day. The study projected that, by 2025, freshwater consumption could increase by as much as 165 percent in the case where all new plant additions use freshwater and all retirements occur at saline facilities (see Case 4).

Overall, the results of the analysis indicated that the amount of freshwater needed to meet forecasted increases in thermoelectric capacity over the next two decades will increase slightly or will decline to some degree in terms of withdrawals. In terms of consumption, several cases projected a large increase on a percentage basis as older once-through cooling plants are replaced by new re-circulating cooling plants. However, thermoelectric plants will likely continue to represent only a small fraction of total freshwater consumption in the United States in 2025.

While this analysis looked at freshwater requirements on a national basis, it is recognized that there are significant regional differences in projected electricity growth and freshwater demand, availability, and competing use sectors. As such, DOE-NETL has initiated a follow-on analysis.

The report is available at http://www.netl.doe.gov/coal/E&WR/index.html; then click on Ref. Shelf., Water-Energy Interface, and Other Publications.

ADVANCES IN CO_2 CAPTURE VIA OXYGEN-BASED COMBUSTION PROCESSES

The Office of Fossil Energy, as part of its carbon sequestration program, has been investigating several pathways to lowering capital costs and minimizing energy penalties incurred in capturing CO_2 from large point sources. Pre-combustion capture methods involve the removal of CO_2 from synthesis gas (syngas) produced in a gasifier, prior to combustion of the syngas. Post-combustion capture methods use sorbents or membranes to remove CO_2 from power plant flue gas. A third promising method, under investigation by NETL and its private sector partners, is oxygen-based combustion (oxycombustion). This method produces a high-concentration, sequestration-ready CO_2 stream and, unlike alternative pre- and post-combustion methods or the commercial monoethanolmine (MEA) post combustion removal method, does not require a costly CO_2 separation process. Oxycombustion is considered a near-term step in achieving 2012 program goal of CO_2 capture with less than 10 percent increase in the cost of electricity.

At NETL, cooperative agreements with Foster Wheeler, Alstom, and Air Liquide, are exploring the operations capabilities and technical issues of oxycombustion processes. Basic oxycombustion involves the combustion of coal or another fossil fuel with a mixture of pure oxygen and recycled flue gas. This eliminates the presence of N_2 in the flue gas, results in much higher CO_2 concentrations and greater combustion efficiency. For both pulverized coal (Foster Wheeler and Air Liquide) and circulating fluidized-bed (Alstom) oxycombustion, a key operational parameter is the recycle ratio of the flue gas. This is the ratio of the flue gas sent back to the combustor (preferably low) to the flue gas sent to sequestration. Recycling flue gas lowers oxygen concentration in feed to the boiler, effectively lowering higher flame temperatures associated with oxycombustion, and avoiding damage to boiler wall materials. High recycle ratios, however, have attendant high throughput or mass flow rates that negate gains in efficiency. But if the recycle ratio is optimized, the oxycombustion process will result in greater efficiency and lower throughput rates than possible using air-fired processes. The lower throughput and increased thermal efficiency makes possible smaller, less costly boiler equipment.

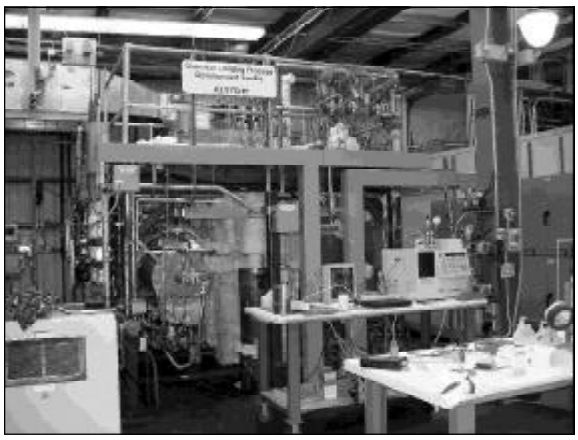
The major disadvantage of these oxycombustion processes is the requirement of oxygen production from cryogenic air separation units. However, the efficiency drop for oxycombustion (4–10 percent depending upon configuration) is less than that of the MEA process (16 percent), the commonly used carbon capture process. MEA efficiency drops result from the need to divert steam to regenerate the MEA solution.

To overcome the energy penalty of cryogenic air separation, two advanced oxycombustion pathways are being investigated. Through a cooperative agreement with Praxair, NETL is examining the development of the oxygen transport membrane (OTM) combustion process. This process involves the use of OTM membranes at high temperatures (1,500–2,000 °F) in the

combustion environment. Air flows through the inside of the membrane tubes while fuel is on the outside. The oxygen is driven through the membrane due to the chemical potential of the reaction on the fuel-membrane surface. This provides for a highly efficient means of simultaneous air separation and combustion without the need for cryogenic processes or high pressures (and also eliminates high compression costs). Currently, Praxair is constructing a multi-tube OTM combustion test apparatus that will enable determination of OTM reliability and optimal process configurations.

In another effort, NETL and Alstom are investigating chemical "looping" combustion and gasification processes to further increase power plant efficiency and decrease CO_2 separation costs. The process involves the use of a solid oxygen carrier that is "looped" between an oxidation and reduction reactor. In the oxidation reactor, the oxygen carrier is reacted with air to form an oxygenated carrier particle. The oxygen-depleted air is sent to the stack while the oxygenated carrier particles are sent to the reducer reactor. Here the fuel is either combusted or gasified by the oxygenated carrier particles, thereby returning the oxygen carrier to its reduced state. These particles are looped back to the oxidizer for further reaction. The product gas consists of mainly CO_2 in the combustion case or CO_2 and H_2 in the gasification case. For gasification, a second solid particle loop is utilized. A CO_2 absorption particle is looped between the reducer (where CO_2 absorption occurs) and a calciner (where the sorbent is regenerated) to create both a pure CO_2 stream and a medium Btu fuel gas.

Preliminary design studies have discovered that the OTM and looping processes could capture 99 percent of the CO_2 created at a cost near the program goal of $10 per ton of CO_2 avoided. This is accomplished with an investment cost comparable to that of air-fired systems. The major technical issues under investigation are the leakage of air between the reaction units along with difficulties in controlling the rate of solids circulation. Alstom recently has completed construction and preliminary testing on a chemical looping process development at their Power Plant Laboratories in Windsor, Connecticut. The company has successfully demonstrated the chemical looping chemistry using methane as the fuel along with various solids flow patterns. Future work on this project will focus on both the demonstration of coal combustion and sorbent regeneration.



Alstom's Chemical Looping Gasification Process Development Unit in Windsor, Connecticut

...News Bytes continued

IGCC plant near Orlando, Florida, and demonstrate air-blown gasification based on the transport gasifier (see PSDF on page 5). **The Mesaba Energy Project**, sponsored by Excelsior Energy, Inc., will demonstrate next generation ConocoPhillips E-Gas-based IGCC (531 MWe) at Hoyt Lakes, Minnesota. Lastly, the **Pegasus Technology Project**, sponsored by Pegasus Technologies, Inc., will demonstrate advanced multi-pollutant controls at an existing utility plant in Jewett, Texas. For more information, see the Fossil Energy Web site (http://www.fe.doe.gov/programs/powersystems/cleancoal/).

The University of Kentucky Research Foundation and its partners recently signed a cooperative agreement with DOE under CCPI Round 1. The $9-million cost-shared project will demonstrate advanced beneficiation processes to separate power plant ash materials into high-quality, marketable products.

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Comments are welcome and may be submitted to the Editor.

INTERNATIONAL INITIATIVES

NETL ASSISTS IN MEASURING CHINA'S MERCURY EMISSIONS

To address concerns over trans-Pacific transport of mercury emissions, the U.S. Department of Energy's National Energy Technology Laboratory (NETL) is involved in several important efforts to measure and characterize mercury emissions in China. China's economy is growing fast, and coal will play an important role. The Chinese government currently regulates SO_x, NO_x, dust, and black carbon emissions from electricity production. Little interest, however, is paid to mercury since that pollutant is not viewed as a pressing environmental and health concern.

In one activity, NETL is working with Argonne National Laboratory to expand the Regional Air Pollution Information and Simulation-Asia (RAINS-ASIA) project to include mercury emissions. Mercury will be added as a parameter to the existing model, which includes pollution data from a variety of sources such as residential stoves, utility and industrial boilers, and zinc mining and smelting. The model goes into considerable detail about fuel used per source and type of combustion. As part of the new effort, the coal transportation aspect of the model is being expanded to estimate mercury emissions as a function of the original mercury content of coal as mined and as burned. Mercury data being added is derived from Chinese research and literature, as well as from the USGS World Coal Quality Inventory (WOCQUI).

A second area involves thermal stack sampling and is being conducted as part of a memorandum of understanding with the Chinese Ministry of Science and Technology (MOST) under Protocol Annex IV. NETL is developing a stack sampling plan with Dr. Jinsong Zhou of Zhejiang University's Thermal Power Research Institute. Dr. Zhou recently visited NETL to discuss sampling methods, such as Ontario Hydro, and Continuous Emissions Monitoring (CEM) techniques. Six coal-fired electricity plants in the Shanghai area have been identified as potential candidates for mercury sampling. After MOST's approval of a sampling method, mercury and speciation data will be collected from the designated plants. Sampling is expected to begin in the spring of 2005.

These two efforts, one to build an in-depth theoretical understanding of the relationship between technology, fuel choices, and mercury emissions, and the second to obtain mercury emissions data from Chinese coal-fired electricity plants, contribute to a working group collaboration between NETL, the U.S. Environmental Protection Agency (EPA), and the U.S. Geological Survey (USGS). The EPA and USGS are pursuing both outreach and technical research with respect to mercury emissions in China. EPA's Research Triangle Park is developing an ambient monitoring program with Beijing University and the Rendi Institute to collect ambient mercury data in the Beijing and Shanghai regions. Emissions data from the Zhejiang University sampling effort will be compared to the Shanghai ambient monitoring data to lead to a better understanding of the contribution of coal-fired generation to ambient mercury levels. The EPA Office of International Affairs is working with the Chinese Environmental Protection Agency, and Global Village (a Chinese non-governmental organization) to increase awareness of mercury emissions as an environmental and health issue. In an effort to further develop its WOCQUI inventory, USGS is anticipating the founding of a research center in southern China to obtain data to evaluate the health effects of coal use.

JAPAN'S CLEAN COAL DAY

The U.S. Department of Energy (DOE) Office of Fossil Energy (FE) was invited to participate in Japan's 13th Annual Clean Coal Day held in Tokyo, Japan on September 2, 2004. The event is sponsored by the New Energy and Industrial Technology Development Organization (NEDO) and managed by the Center for Coal Utilization, Japan (CCUJ). It was followed by another day-long "Environmentally Friendly Coal Seminar," also sponsored by NEDO.

Over 250 participants from a variety of countries gathered at the event, of particular importance this year due to Japan's new energy policy that places more emphasis on coal. The Ministry of Economy, Trade and Education (METI), part of the Agency for Natural Resources and Energy, has developed a "New Coal Policy of Japan – Clean Coal Cycle (3C) Initiative." A keynote speech by METI's Dr. Shigeki Sakurai outlined the recommendations of the policy study such as optimizing efficiency, securing long-term supply contracts, and working to develop carbon sequestration systems integrated with IGCC and fuel cell technologies (see guest article, page 3). Japan relies heavily on oil, and considers itself vulnerable to Middle East supply disruptions. Coal is primarily imported from Australia and constitutes some 20 percent of primary energy supply.

FE's Jarad Daniels was invited to speak on the FutureGen Initiative, DOE's $1-billion, 10-year global partnership effort to develop the world's first zero-emissions power plant. The project would pioneer advanced hydrogen production from coal, emit virtually no air pollutants, and capture and permanently sequester CO_2 emissions. A 275-MW prototype plant is envisioned, to be cost-shared by DOE, an industrial consortium operating the plant, and international partners. The project would employ advanced gasification technology integrated with combined-cycle electricity generation, with a goal of 60 percent efficiency, double today's rate. It is estimated that the project would take 10 years to complete, and project results would be shared among participants and industry as a whole. Attendees at the Tokyo workshop were most interested in sequestration technologies and costs, gasifier design, and international cooperation. For details and current status, see http://www.fe.doe.gov/programs/powersystems/futuregen/index.html/.

Other speakers included Atsushi Tsutsumi of the University of Tokyo, who spoke on Energy Recuperation Technology, which recycles waste heat from gas turbines or fuel cells back into the gasifier for a more tightly coupled process. This could increase efficiency and facilitate CO_2 capture and sequestration. Dr. Chris Spero, Project Manager of Oxy-Firing Study Group, described the Japan-Australia oxy-fired pulverized coal power plant feasibility study now beginning. This is a key activity of Australia's COAL21 program (see guest article, page 8). David Goss, Executive Director of the American Coal Ash Association, and Hans-Joachim Feuerborn of the European Coal Combustion Products Association discussed the use of coal combustion by-products (CCP) in the United States and Europe. Some 35 percent of coal combustion products in the United States find beneficial uses, while in the European Union countries for which data was available, only 12 percent of total CCPs had to be temporarily stockpiled or landfilled. Both the United States and EU face uncertainties about the impact of regulatory requirements on fly ash quality and markets. Minori Fujii, a senior technical advisor at Takenaka Partners in Japan, discussed an electric power project in China that Takenaka is implementing under the Kyoto Protocol's Clean Development Mechanism (CDM), which allows transfer of credit for emissions reductions in developing countries.

ACTIVE CCT DEMONSTRATION, PPII, AND CCPI PROJECT STATUS

CCT DEMONSTRATION STATUS

JEA – *ACFB Demonstration Project*. The four planned demonstration phase test burns, which began January 13, 2004, were completed on August 12, 2004. Fuels and fuel blends tested during the period included 100% Pittsburgh #8, a 50/50 blend of Pittsburgh #8 and petcoke, 100% Illinois #6, and a 80/20 blend of petcoke and Pittsburgh #8. Test reports have been received for two tests with the others anticipated over the next several months. All tests were conducted at 100, 80, 60, and 40 percent of full load. Emissions were monitored at each load level and were well below permitted values. (Jacksonville, FL)

Kentucky Pioneer Energy (KPE), L.L.C. – *Kentucky Pioneer Energy Project.* FuelCell Energy (FCE) has requested a no-cost-to-DOE time extension in order to complete installation and demonstration testing of the fuel cell at the Wabash River site. FCE proposed test program revisions include an increase to 100 percent Kentucky coal in the amount of coal gasified during the six-month demonstration period. The KPE extension request will allow the development of additional project information permits and zoning timelines. (Trapp, KY and West Terre Haute, IN)

Tampa Electric Co. – *Tampa Electric Integrated Gasification Combined-Cycle Project.* Tampa's Polk Power Station completed demonstration operations at the end of October 2001 with over four-and-one-half years of successful commercial operation. The Post Project Assessment Report was published in August 2004. (Polk County, FL)

TIAX (formerly Arthur D. Little, Inc.) – *Clean Coal Diesel Project.* In July 2004, University of Alaska Fairbanks (UAF) decided to schedule the installation of a new transformer that would provide more flexibility as to when the diesel engine generator can be run at desired load points. Based on the schedule for these electrical interconnect upgrades, TIAX will conduct hard parts and selective catalytic reduction tests in mid 2005. TIAX is reviewing cost estimates for the design modifications to the baghouse at the Fairbanks Morse facility in Beloit, Wisconsin and will evaluate the options based on installation time and procedure. (Fairbanks, AK and Beloit, WI)

Western SynCoal LLC (formerly Rosebud SynCoal® Partnership) – *Advanced Coal Conversion Process (ACCP) Demonstration Project.* In January 2003, Westmoreland Power, Inc. transferred ownership of Western SynCoal LLC to ENPRO, of Butte, Montana. The Final Technical Report has been issued. (Butte, MT)

PPII STATUS

Otter Tail Power Company – *Demonstration of a Full-Scale Retrofit of the Advanced Hybrid Particulate Collector (AHPC) Technology*. The AHPC has been cleaning the full flow from the power plant since October 25, 2002. Otter Tail Power Company continues to operate the particulate control device and obtain superior particulate removal as evidenced by stack opacity in the 0 percent range. Demonstration testing has shown mixed results. Superior particulate removal has been accompanied by increasing operating costs due to increasing overall pressure drop or premature bag failure. Partial bag replacements have been occurring at 6-month intervals while bag life in the range of 5–7 years was expected. Otter Tail Power Company is in the design phase to modify the control device to increase its size in an attempt to control pressure drop/operating costs. (Big Stone City, SD)

Sunflower Electric Power Corp. – *Demonstration of a 360-MWe Integrated Combustion Optimization System*. The combustion optimization sensors package is operational. Data are being archived on the MKE computer and by EtaPRO, which also collects plant performance data. The low-NOx burner modifications and coal-balancing dampers have been installed. The coal-balancing dampers on Mill C are operating in automatic mode. The automated coal flow balancing system on Mill C is operational following resolution of a cable problem. Sunflower continues to evaluate the impacts of overfire air on furnace exit gas temperature. Despite slagging, the boiler continues to operate satisfactorily. (Garden City, KS)

Tampa Electric Company, Big Bend Power Station Tampa – *Neural Network Sootblower Optimization Project.* During 2004, the NN-ISB was successfully operated in closed loop mode without operator intervention. The project is now in the benefits demonstration phase. Test data to date has shown reduction in NO_x levels in the range of 10–20 percent and boiler efficiency improvements in the range of 0.5–1 percent. Successful application of this sootblowing system has developed significant technical information advancing neural network technology's acceptance within the electrical generating industry. (Apollo Beach, FL)

Universal Aggregates, LLC – *Commercial Demonstration of the Manufactured Aggregate Processing Technology Utilizing Spray Dryer Ash.* The project is in the operations phase. Universal Aggregates has been modifying the combination of material additives and equipment configurations to produce a consistent product from the spray dryer ash removed from the Birchwood Power Facility. The "green" material from the extruder is now being mixed with embedding material and fed to the curing vessel. This process is improving rapidly as the plant operators learn the best settings and adjustments based on the outcomes. The project is scheduled to be completed in May 2005. (King George, VA)

CCPI STATUS

NeuCo, Inc. – *Integrated Optimization Software*. The technical progress made in the first year of the four-year project is significant. Initial results of the combustion optimization showed stabilization of cyclone-fired combustor and SCR operations leading to enhanced slag control, and reduced stack NO_x emissions and ammonia slip at the host site of Baldwin Energy Complex, which has three 600-MW Powder River Basin coal-fired boilers. (Baldwin, IL)

University of Kentucky Research Foundation (UKRF) – *Advanced Multi-Product Coal Utilization By-Product Processing Plant*. The Cooperative Agreement was awarded in November 2004. The purpose of the project is to design, construct and operationally demonstrate a near-commercial scale advanced coal utilization by-product beneficiation plant that is capable of producing pozzolan for cement, aggregate, graded fill sand, recycled carbon fuel, and polymeric filler for plastics. The UKRF Center for Applied Energy Research (CAER) team includes commercialization partner CEMEX USA, one of the world's largest cement manufacturers, and Kentucky Utilities Company, a subsidiary of LG&E Energy Corporation. LG&E is hosting the project at their 2,000 MW Ghent Generating Station. The project period is from November 2004 to October 2008. National Environmental Policy Act requirements have been completed for this project. (Ghent, KY)

We Energies – *TOXECON™ Retrofit for Mercury and Multi-Pollutant Control*. The project was initiated in April 2004. National Environmental Policy Act requirements were completed for this project prior to award. The project is currently in the engineering design phase. An initial design review meeting was held, and the participant has submitted a Project Management Plan. Balance of plant engineering design is ongoing. Specifications for the baghouse design and other subsystems have been developed, and requests for bids have been issued for these items. (Marquette, MI)

Western Greenbrier Co-Generation, LLC – *Western Greenbrier Co-Production Demonstration Project.* A cooperative agreement between DOE and Western Greenbrier Co-Generation, LLC (WGC) was signed in April 2004. The WGC facility is designed around an ALSTOM atmospheric-pressure circulating fluidized-bed furnace/boiler designed to operate on waste coal (gob). The power plant is envisioned to be the anchor tenant of a planned "eco-park" in which 90 megawatts of power will be produced for sale on the national electric grid, ash byproducts will be produced, and steam and heat will be supplied to small industry in the neighboring industrial park. The project is now in Phase 1 – Project Definition. The project team is working to achieve conceptual design "freeze" in early 2005. It is expected that after the first 7–8 years of power plant operation, a large coal waste site will be eliminated thus removing a current source of acid mine drainage that is causing much expense and compromises the local environment. (Rainelle, WV)

Great River Energy – *Lignite Fuel Enhancement*. The Cooperative Agreement was awarded in July 2004. The project is schedued to continue until April 2008. In the project's first phase, a prototype module will be designed to dry about one-sixth of the coal fed to a 546-megawatt (MW) unit. Following successful demonstration of the prototype, GRE will design, construct, and perform full-scale, long-term operational testing on a complete set of dryer modules needed for full power operation of one 546-MW unit. (Underwood, ND)

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