

# CLEAN COAL TODAY

A NEWSLETTER ABOUT INNOVATIVE TECHNOLOGIES FOR COAL UTILIZATION

## NEWS BYTES

The U.S. Department of Energy (DOE) is hosting a series of scoping meetings for a **Programmatic Environmental Impact Statement (EIS) for implementation of the Carbon Sequestration Program**. The eight meetings are scheduled for May–June 2004, and will be held throughout the country. The preliminary schedule calls for completion of the draft EIS by Summer 2005, and issuance of the final EIS in Spring 2006. For more information, contact [heino.beckert@netl.doe.gov](mailto:heino.beckert@netl.doe.gov).

**The Pure Air on the Lake, L.P., Clean Coal Technology project**, has become the first CCT project to make a total repayment of over \$1 million. The “Advanced Flue Gas Desulfurization Demonstration Project” involved construction and

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## DOE-NETL CHAIR THIRD CARBON CAPTURE AND SEQUESTRATION CONFERENCE

Progress over the past several years in the developing technology of carbon capture and storage, as well as the continued need for government, private sector, and international cooperation in these areas, was a theme that resonated at the DOE-NETL Third Annual Carbon Capture and Sequestration Conference in Alexandria, Virginia. A spectrum of high-profile speakers from the U.S. and abroad addressed the range of issues facing carbon capture and control technology, including technology readiness, financial constraints, regulatory uncertainties, and an overriding need for public acceptance.

The three-day conference featured speakers from the Departments of Energy, Commerce, and State; industry; and the international sequestration/capture community. More than 400 people attended, including 80 representatives from 21 countries besides the U.S. In addition to plenary sessions each day, there were some 120 technical papers that focused on specific efforts in capture and separation; geological and terrestrial sequestration; measuring, monitoring and verification; and public outreach experiences. A number of talks related to the International CO<sub>2</sub> Capture Project (see page 3) and to progress achieved thus far under the Regional Sequestration Partnerships established last year.



*Acting ASFE, Mark Maddox, described sequestration projects*

Secretary of Energy Spencer Abraham addressed the audience on the first day of the conference, discussing the broad-scale, government sequestration effort, which not only operates domestically but also encourages international cooperation and projects through the international Carbon Sequestration Leadership Forum. The climate change effort at DOE, he said, involves not only fossil fuels but also hydrogen, nuclear, and renewables, as well as energy efficiency efforts. The Bush Administration’s 2002 Global Climate Change Initiative calls for an 18 percent reduction in carbon intensity of the U.S. economy by 2012. To achieve these goals without adverse economic consequences, “transformational” new technologies such as those highlighted over the three-day conference are required. DOE’s responsibility is the technology side of carbon capture and sequestration effort, while the Department of Commerce’s

*See “Conference” on page 2 ...*

*“Conference” continued...*

task is the science component. A science plan has been completed and a government-wide technology strategic plan is due out this year.

Detailing specific activities of the Office of Fossil Energy, Acting Assistant Secretary for Fossil Energy Mark Maddox cited the 80 sequestration projects supported by FE, and noted the increase in FE funding from \$9 million when President Bush took office to \$40 million today. He



also observed that long-term prominence of fossil fuels in energy production (coal use being predicted by EIA to increase 26 percent in 20 years) would depend on the success of cost-shared sequestration R&D. Presentations at the conference showed a determination on the part of government and industry to perfect these technologies deemed vital to our future.

NETL Director Rita Bajura summarized the main issues related to core R&D. She said that while separation and capture is very expensive, conference papers showed that the preliminary economics appeared promising for roughly 70 percent capture. The discussion also indicated that combined capture and sequestration costs could be brought down to the government's goal of less than 10 percent increase in the cost of electricity (for gasification), and less than 20 percent increase for

pulverized coal systems. Bajura noted that science has greatly increased our ability to estimate the CO<sub>2</sub> storage capacity of geological formations, seen as capable of accommodating the sheer volume of future CO<sub>2</sub> emissions. However, various speakers noted the need to develop specifications for use in finding safe, permanent geological storage locations. Such deposits occur naturally, and engineered sites have potential for the same effective containment. Health, safety, and environmental impacts are other concerns associated with sequestration. The regulatory/permit picture is yet unknown, but arguments are being made for a commodity rather than a waste classification. As a final point, Bajura said that measuring, monitoring, and verification must become successful at determining CO<sub>2</sub> pathways. Atmospheric detection systems, subsurface leak detection, mitigation tools and monitoring protocols are needed. Several speakers cited the monitoring component as the most vital for public acceptance of sequestration.

The financial side of CO<sub>2</sub> capture and sequestration also received emphasis at the conference. Developing countries such as China and India have vast coal resources, so the use of advanced technologies for greenhouse gas reduction must be encouraged. Barry Worthington, Executive Director, of the U.S. Energy Association suggested new financial instruments that can redirect flow of capital to advanced technologies in developing countries. Traditional utility investors, he said, are backing out due to financial pressures and are selling strained assets to owners who are not moving forward with tech-

nologies. Worthington recommended pursuing financing from non-utility corporations, insurance companies, and pension funds, and using new mechanisms such as innovative long-term bonds with delayed principal payout. He emphasized that increased government/private sector coordination is vital, as well as new models of trade assistance such as the Administration's proposed Clean Energy Technology Export Initiative.

Emissions credits were another financial instrument addressed at the conference. The Chicago Climate Exchange, Inc.'s experiment was described by Dr. Michael J. Walsh, Senior Vice President of the organization. This voluntary, multi-sector cap-and-trade program with project-based offsets involves 50 members, with total emissions of some 230 million metric tons (which Walsh says is comparable to total CO<sub>2</sub> emissions in the UK). Participants sign a four-year legally binding contract and thus far have succeeded in reducing emissions more than 1 percent below their 1998–2001 baseline. In another talk, James W. Voss, President of the Terra Verde Group, the principal in a number of International Carbon Credit Exchanges, said that 1–2 percent reductions are the maximum that can be expected of efforts lacking a clear imperative. The imperative, which would need both valuation and liquidity components, could come from the Kyoto agreement or some revised international mechanism, unilateral action from Congress, or a voluntary program with near-universal participation. The U.S., he said, is disadvantaged by a regulatory system that can change the value of carbon credits, what Voss called a “sovereign risk” issue. Thus, long term contracts cannot be negotiated and green

capital goes elsewhere. Voss noted that in the Chicago Climate Exchange, 1 metric ton of CO<sub>2</sub> trades at only \$1, while the value for Kyoto signatories, with a clear CO<sub>2</sub> reduction mandate, is \$4/metric ton.

The final day of the conference featured discussions from representatives of the seven Regional Partnerships. Recognizing that regional differences will likely require unique sequestration strategies, DOE established these Partnerships last year to develop infrastructure for wide-scale deployment, should it be required (see Fall/Winter 2003 *Clean Coal Today*). Scott Klara, NETL Program Manager, stressed that Phase II now being conceptualized by DOE will not be a technology development effort. Rather, it will implement the plans and protocol developed during Phase I, and per-

form proof-of-concept field tests for technology and infrastructure concepts. Klara anticipates that a competitive Phase II will be released in fiscal year 2005 with awards completed in early 2006. Phase II will be an open, competitive solicitation that will require completion of Phase I activities as a prerequisite for potential Phase II candidates.

Talks by the Partners brought out their particular regional perspectives. One in six Americans, for example, resides in the industrialized area comprising the Midwest Regional Carbon Sequestration Partnership. James J. Dooley said his organization wants not only to reduce global warming but to secure a future for their large industrial base. The Northern Rockies and Great Plains Regional Partnership (also known as “Big Sky”) has an immediate interest in

pursuing “ready-to-go” terrestrial sequestration options even though the storage potential is not so large as that for geological deposits. The group also has a strong interest in economic tools such as CO<sub>2</sub> trading. They are members of the Chicago Climate Exchange, the National Carbon Offset Coalition, and the Idaho-Montana Climate Trust. Speaking for the group, Susan M. Capalbo noted the need for public acceptance, and special attention to any water issues that appear.

In all, the conference confirmed that government, industry, regulators, and the environmental community are providing significant investment in a serious effort to accomplish carbon capture and sequestration. A number of projects already are producing important results.

## SEQUESTRATION CONFERENCE REPORTS ON INTERNATIONAL CO<sub>2</sub> CAPTURE PROJECT

The International CO<sub>2</sub> Capture Project is a consortium of eight major oil companies, the U.S. Department of Energy, the European Union, and Klimatek, the Norwegian Research Council. A number of sessions at the 3<sup>rd</sup> Annual Conference on Carbon Capture & Sequestration reported on important results of the project, which covers the entire sequestration “life cycle” of separation, capture, transport, and storage with monitoring, verification, and risk assessment. The primary objective is to achieve 50 percent reduction in costs for retrofit applications and a 75 percent reduction for new facilities. Reported results include:

- Preliminary economic analysis of a promising adsorption enhanced water-gas shift system that reduces the number of process steps required to make hydrogen for use in gas turbines. The CO<sub>2</sub> avoided-cost reduction is about 50 percent.
- Development of a hydrogen membrane-based reformer concept representing an advanced approach to co-production of hydrogen for use in gas turbines. The system would produce a stream of CO<sub>2</sub> amenable to sequestration, and has the potential to reduce the cost of CO<sub>2</sub> avoided by over 60 percent.
- Progress in oxy-firing technology with chemical looping in a fluidized-bed reactor that can significantly reduce NO<sub>x</sub> emissions. Chemical looping is a new combustion technology based on oxygen transfer from combustion air to the fuel. This process can produce a relatively pure stream of CO<sub>2</sub>.
- Advances in risk assessment data and methodologies, an important part of the measuring, monitoring, and verification (MMV) effort. A large database has been assembled that will allow geological storage risks to be quantified and compared to other sequestration/capture methods.
- Development of monitoring and remediation options for geological sequestration. The results indicate that depleted oil and gas fields generally are more secure than saline formations, due to trapping mechanisms in the rock.
- Development of Common Economic Model for technology comparison. This model has been used to compare selected CO<sub>2</sub> Capture Project (CCP)-evaluated technologies as applied to four real-world petroleum industry base cases.



## VIRTUAL REALITY TO IMPROVE NEW POWER PLANT DESIGNS, LOWER COSTS

When today's fossil-fueled power plants were first built, engineers and scientists performed lab-scale tests that generated large volumes of data, which subsequently were fed into bench-scale efforts. The resulting designs then became pilot-plants that were tested for an average of two to three years. Overall, the entire design and construction phase needed to build one coal-fired power plant took several years and cost millions of dollars.

Today, the U.S. Department of Energy's National Energy Technology Laboratory (NETL) 3-D Visualization Program is developing a simulation process that will improve the way power plants are designed. Historically, scaling up from pilot scale to commercial scale involved a leap of faith — full-scale demonstrations were not conducted due to the high cost — so many modifications had to be made after the commercial plant was constructed.

The 3-D Program was first assembled in 1999 when NETL researchers were joined by personnel from Iowa State University, West Virginia University, and the Pittsburgh Supercomputing Center. About 15 part-time employees from these organizations have been working on the program, which is scheduled to be completed this summer. The program will help power plant designers and technology vendors improve upon their designs, and identify and eliminate mistakes before the power plants are constructed. This capability could save hundreds of thousands of dollars in the power plant design process.

The 3-D Program consists of several components. The Leading Edge Visualization System Development Project (the visualization display system) is integral to both the Power Plant and Simulation Project (virtual power plants), and the Computational Fluid Dynamics Visualization Project. Combined, all three form a detailed undertaking that integrates software, hardware, models, and animation. The ability to analyze and visualize the power-generation system design with very accurate models is the key to predicting performance and obtaining the most appropriate design in a faster and more cost-effective manner. The most immediate goal of the 3-D program is cost control. If costly mistakes can be sidestepped, more efficient power plant designs will emerge. Using this process also helps to better manage the risks inherent in developing a novel design. By using a system that allows engineers to “see” a technology at its actual size and to simulate its behavior, researchers are encouraged to try more non-traditional concepts because both technical risks and costs are dramatically reduced.

### VISUALIZATION DISPLAY SYSTEMS

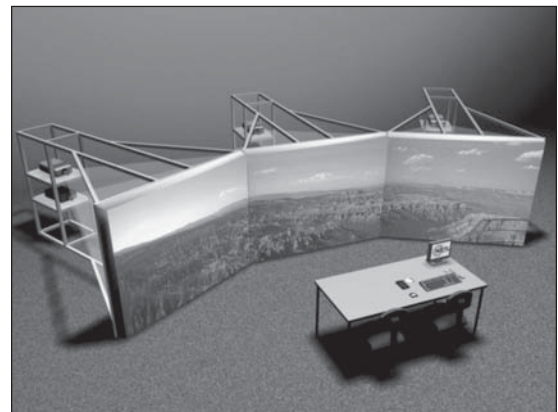
The visualization display system portion of the 3-D Program has been developing leading-edge hardware to carry visualization beyond images viewed on a computer desktop. Two types of display systems are being pursued. The first involves passive stereo technology to “immerse” the user into the virtual environment,

complete with walls six-feet high and eight-feet wide. The system employs polarizing filters and glasses like those used in 3-D cinemas and amusement parks. The viewer has the illusion of standing in a full-sized room or other area of a power plant, while in reality he is sitting in a chair. Work on this display is to be completed this summer.

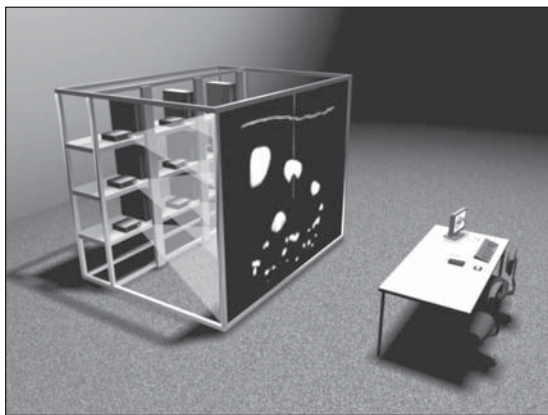
The second display, completed last year, uses tiles to create a very large, high-resolution display. Using nine computers clustered together, nine projectors are arranged in a tiled configuration and project an image onto a 6-ft by 8-ft sharp-resolution projection screen.

### VIRTUAL POWER PLANTS

Virtual power plants allow engineers and researchers to “walk” through a new power plant before it is constructed. To support such a display, computer-generated images of the entire plant are collected with a great level of detail — every floor, technology, and component as it is to be built. The 3-D program displays these images at full scale, and through simulation, allows an engineer to walk through a floor while the plant is operating.



*Passive stereo technology immerses viewer into a virtual environment*



*Tiled array of nine projected images provides a sharp-resolution view of simulations*

A specific device or technology — for example, a heat exchanger or hot gas cleanup system — can be selected, and viewers can see how that device operates in the plant. The resulting data permits engineers to make changes necessary to guarantee optimal performance. The visual representations are connected to a process simulator, allowing the virtual power plant to respond realistically to whatever changes an engineer or researcher makes within the virtual plant.

NETL virtual environments consist of three software applications: 3D Studio Max made by Discreet Inc., Virtools by Virtools Inc., and Aspen Plus from Aspen Technology Inc. The 3D Studio Max application creates virtual objects using primitive shapes and textures. The second, Virtools, allows users to navigate through a world of objects and can help define the sequence of objects in a display. Finally, Aspen Plus models the entire power plant process step by step, from combustion to cleanup. The user interacts with a virtual plant through a graphical user interface (GUI), which displays a high-level process flow diagram of the would-be power plant.

## COMPUTATIONAL FLOW DYNAMICS VISUALIZATION

To address the intense chemical reactions inherent in fossil power plant operations within the context of a simulated environment, NETL is developing software that will enhance visualization of transient computational flow dynamics (CFD). The lab now uses Fluent Inc.

and MFIX (Multiphase Flow with Interphase eXchanges) CFD simulation software. The new software program would translate CFD data into a format that can be viewed using open-source visualization software (see article in Clean Coal Today, Fall/Winter 2003).

Two open-source applications are being considered, both of which handle large amounts of data: Virtual Engineering (VE) Suite, developed by Iowa State, and ParaView, developed by Kitware. The VE Suite consists of applications that can visualize CFD and can change design parameters to enhance a technology's performance. For example, the diameter of a pipe can be enlarged to promote circulation and, in real time, a simulation can be observed of the way the larger pipe functions. ParaView, which is a multi-platform visualization application that supports computation models to process large sets of data, develops processing tools with an emphasis on distributed memory implementation.

These applications have produced extremely realistic simulations. Researchers, for example, are able to see bubbles rise in a column, and

watch as solids and liquids race through tubes. Even tiny unburned particles of coal trapped in gas can be seen traveling through pipes.

## TESTING ON BLACK LIQUOR GASIFIER

The information gathered through tests of the 3-D Program is being put to immediate use — a black liquor plant, built in Lynchburg, Virginia, is a joint effort between Georgia Pacific and NETL, and is now in shake-down.

Prior to construction of this plant, NETL researchers used the 3-D program on a black liquor gasifier. The ability to watch the inner workings of a black liquor gasifier through the virtual reality program provided a unique opportunity to simulate operation of gasifier injectors, and observe circulation patterns of gases and solids as they flow through the heat exchangers, which penetrate through the middle of the gasifier. This feature is not common to most gasifiers, and researchers were concerned that there would not be enough circulation. By viewing the operation through this simulation process, NETL engineers were able to interpret data; and as a result, may change operating parameters or find optimal operating conditions to give sufficient circulation.

The Lynchburg test also will help meet the goal of applying the 3-D program to coal-fired power plants, and ultimately to FutureGen plants.

## Two CCPI Projects Move Forward

This Spring, two important Clean Coal Power Initiative projects — the We Energies TOXECON™ and NeuCo Process Optimization projects — signed cooperative agreements with the U.S. Department of Energy (DOE) and are moving forward with testing. The two projects were among eight selected in January 2003 under Round I of the Clean Coal Power Initiative, and represent important new efforts in multi-pollution control, and power plant optimization for greater emissions control and plant efficiency/reliability.

### TOXECON™ IMPROVING REMOVAL PROCESS

The TOXECON™ process — an integrated system for removing up to 90 percent of mercury, as well as particulate matter, sulfur dioxide, and nitrogen oxides — will be tested at the We Energies Presque Isle coal-fired plant at Marquette, Michigan over a three-year operation period beginning in January 2006. The promising technology already has received the 2003 R&D 100 award. Under the cooperative agreement signed in April 2004, DOE is providing \$24.8 million toward project costs, with We Energies (Wisconsin Electric Power Company) providing \$28.1 million.

TOXECON™ is an EPRI-patented process resulting from years of research by DOE, EPRI, and nine other industrial partners. The process involves injecting sorbents into flue gas downstream of an electrostatic precipitator and upstream of a pulsed jet fabric filter (baghouse). Sorbents are activated carbon for 90 percent mercury control, and sodium- or lime-based injection to remove up to 70 percent of SO<sub>2</sub>, 30 percent of NO<sub>x</sub>, and HCl. Compared to the alternate practice of injecting carbon directly into the electrostatic precipitator (ESP), TOXECON™ requires less carbon and achieves higher mercury removal. The baghouse allows intimate contact between the carbon and mercury on the baghouse fabric.

The process targets elemental mercury emitted from plants burning subbituminous coals, such as that used at the Presque Isle plant. Unlike oxidized mercury, elemental mercury cannot be removed by wet scrubbers. Due to separate collection of fly ash from the ESP and spent activated carbon from the TOXECON™ device, fly ash from the process will not contain activated carbon. This facilitates ash use in coal utilization by-products, and thus decreases the amount of waste to be landfilled. The TOXECON™ process also permits injection of activated carbon in plants with hot-side ESPs, where temperatures are too high for mercury adsorption directly in the ESP. An additional benefit is a baghouse design with high air-to-cloth ratio, resulting in a smaller-sized, less costly unit.



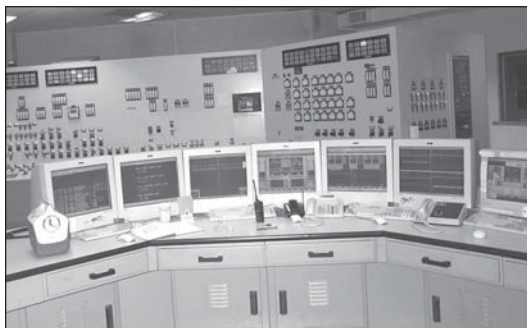
Ductwork at Presque Isle plant

TOXECON™ may prove to be the primary mercury control device for unscrubbed units that burn subbituminous coals employing cold-side ESPs, and for all systems employing hot-side ESP technology. DOE studies show that these markets account for 68 GW and 18 GW of power production, respectively. Successful demonstration of TOXECON™ technology could help utilities achieve compliance with future mercury regulations (see *Clean Coal Today*, Spring 2004). DOE's analysis, which assumes a certain level of market penetration, also shows that successful commercialization of TOXECON™ could reduce emissions by almost 2.8 million tons/year of SO<sub>2</sub>, over 409,000 tons/year of NO<sub>x</sub>, over 37,000 tons/year of primary particulate matter, and 14 tons/year of mercury.

### NEUCO SOFTWARE DEVELOPMENT

In March 2004, NeuCo, Inc. became the first CCPI project to sign a cooperative agreement with DOE. The company, a provider of optimization software for electric power producers, is developing the "Integrated Process Optimization System" based on a Process Link™ platform of neural networks, advanced algorithms, and "fuzzy" logic to maximize performance of coal-fired power plants. A four-year, \$19 million project (DOE's share is \$8.6 million) is taking place at Dynegy Midwest Generation's Baldwin Energy Complex in Baldwin, Illinois. The project involves two 600-MWe cyclone-fired units and one 600-MWe tangentially fired unit. This represents the first time five optimization software modules have been integrated into a computerized process network in coal-fired power plants. These modules include cyclone combustion, soot





*NeuCo software will be installed in control room at Dynegy Midwest Generation's Baldwin Energy Complex*

blowing, selective catalytic reduction (SCR) operation, overall unit thermal performance, and plant-wide financial performance optimization. Primary benefits include NO<sub>x</sub> reduction; heat rate, efficiency, and reliability improvements; extension of SCR catalyst life, and reduced ammonia consumption; as well as reductions in greenhouse gases, mercury, and particulates.

A combustion optimization module is to be released in the near term. Shortly thereafter, Dynegy plans to launch SCR optimization in implementing NO<sub>x</sub> emissions management during the upcoming ozone season. Other product modules, including the overall unit thermal performance and financial performance optimization, are scheduled for later release. Over the four-year project period, NeuCo plans to have two to three releases, or upgrades, of each product module.

Specific performance objectives at Baldwin include 5 percent NO<sub>x</sub> reduction, 1.5 percent improvement in heat rate and annual MWh output, a 1-year extension of SCR catalyst life, and a 15 percent reduction in ammonia consumption.

A DOE analysis indicates that successful commercialization of the Integrated Optimization Software

System could reduce NO<sub>x</sub> by some 13.4 thousand tons per year in the United States, with an additional 65 thousand ton reduction with sootblowing optimization. Power companies also would realize considerable savings from overall increased performance.

For more information on these and other CCPI projects, consult the CCPI Website at: [www.netl.doe.gov/coal/power/ccpi/index.html/](http://www.netl.doe.gov/coal/power/ccpi/index.html/).

*"News Bytes" continued...*

operation of a 528-MWe equivalent sulfur dioxide scrubber at Northern Indiana Public Service Company's Bailly Generating Station near Chesterton, Indiana. The project won awards from *Power* magazine and the National Society of Professional Engineers, and helped to modify both utility scrubber specifications and vendor guarantees for compliance with the Clean Air Act Amendments of 1990. Demonstration operations were conducted from 1992 to 1995.

On June 7, 2004, Secretary of Energy Spencer Abraham participated in a signing ceremony for the latest Clean Coal Power Initiative cooperative agreement — the **Western Greenbrier Co-Production Demonstration Project** — in Rainelle, West Virginia. The project offers a unique integration of technologies to convert coal waste "gob," as well as freshly mined coal, into electricity, steam, and structural bricks. The plant is intended as the anchor tenant at a new "Eco-Park." Watch for details in later issues of *Clean Coal Today*.

## UPCOMING EVENTS

**August 30 – September 2, 2004**

***The 5<sup>th</sup> "Mega" Symposium, Power Plant Air Pollutant Control Symposium***

**Sponsors:** EPRI, EPA, DOE, A&WMA

**Location:** Washington, DC

**Contact:** Thomas Feeley  
(412) 386-6134

[thomas.feeley@netl.doe.gov](mailto:thomas.feeley@netl.doe.gov)

**October 12 – 14, 2004**

***Western Fuels Symposium (formerly Low Rank Fuels)***

**Sponsors:** EERC, DOE NETL, EPRI

**Location:** Billings, Montana

**Contact:** Kimberly Yavorsky  
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*Comments are welcome and may be submitted to the Editor.*



## INTERNATIONAL INITIATIVES



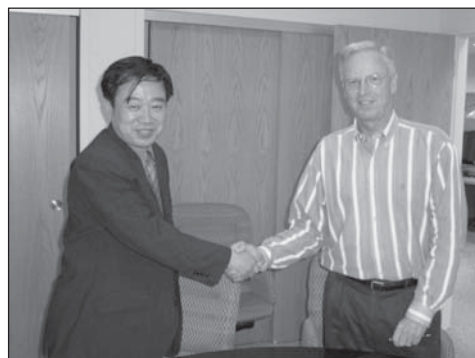
### CHINA SEEKS U.S. DE-NO<sub>x</sub> TECHNOLOGIES TO MEET NEW EMISSION REGULATIONS

At the beginning of 2004, the Chinese central government introduced new NO<sub>x</sub> control regulations for all existing and new coal-fired power plants. At the same time, provincial and municipal governments issued new local regulations, which are typically stricter than the national limits. These regulations are aimed at improving air quality, especially in urban areas on China's east coast, and involve emission fees/charges, emission limits, and penalties for exceeding the prescribed limits. At 450 mg/m<sup>3</sup>, the national-level NO<sub>x</sub> emissions limit specified by the new regulation for new plants firing high-volatile content coals can often be met by using low-NO<sub>x</sub> burners. However, the stricter limits imposed by local regulatory authorities (less than 200 mg/m<sup>3</sup> and, in some situations, less than 100 mg/m<sup>3</sup>) cannot be met by burner design and operation alone. Therefore, some form of secondary or post-combustion NO<sub>x</sub> control, referred to in China as De-NO<sub>x</sub>, will be required at some plants. Commercial De-NO<sub>x</sub> technologies include selective catalytic reduction (SCR), selective non-catalytic reduction (SNCR), and reburning.

A three-member senior delegation recently visited the United States to discuss De-NO<sub>x</sub> options in terms of capital and operating costs, performance, and reliability. China Power Investment Corporation (CPI), one of the generating companies created from the former State Power Corporation, plans to install De-NO<sub>x</sub> equipment at its new Kanshan Power Plant in Jiangsu Province. Kanshan, which is to be released for tendering at the end of May 2004, is to have two 600-MW ultrasupercritical pulverized coal units. Mr. Zheng Fangneng, Director, Division of Energy & Transportation, Department of High-Tech Development & Industrialization, Ministry of Science (MOST), headed the delegation, which included Mr. Li Zhenzhong, Deputy Director, National Power Plant Combustion Engineering Research Center (NPCC), and Mr. Liu Yi, Deputy Director, Kanshan Power Plant. NPCC is CPI's contractor on the Kanshan project for the De-NO<sub>x</sub> technology evaluation and selection.

This visit was coordinated under Annex IV: Energy & Environmental Control Technologies of the U.S.-China Fossil Energy Cooperation Protocol. Chinese representatives visited several leading U.S. De-NO<sub>x</sub> vendors, including Fuel Tech, Babcock & Wilcox, Foster Wheeler, and Alstom. The group also visited two power plants: Dominion Resources' Clover Power Station in Clover, Virginia, where Fuel Tech has installed SNCR, and Carolina Power and Light's Roxboro Station, where Foster Wheeler has installed SCR. Before leaving the United States, a Chinese representative also visited EPRI to get a more detailed perspective from the utility sector on the pros and cons of various De-NO<sub>x</sub> technology options.

As a follow-up, China plans to send a delegation of about 20–25 senior power plant managers to the United States this fall to learn more about U.S. De-NO<sub>x</sub> technology offerings and to visit power plants where the technology has been installed. Issues to be



*Li Zhenzhong (Deputy Director, NPCC) and Steve Argabright (president of Fuel Tech) shake hands after signing a Letter of Intention to jointly evaluate the technical and economic feasibility for the Kanshan plant*



considered include the potential for “bubbling” to yield lower overall control costs, the availability and cost of reagents (anhydrous and aqueous ammonia, and urea), and costs to license or import U.S. technologies. DOE is planning to work further with NPCC and MOST under Annex IV of the Protocol to assess various De-NO<sub>x</sub> technology options for Kanshan and other Chinese power plants.

## FE-EUROPEAN COMMISSION MEET TO DISCUSS CO<sub>2</sub> COOPERATION

The U.S. Department of Energy’s National Energy Technology Laboratory (NETL), and several key contributors to DOE’s Carbon Sequestration Program, met with the European Commission (EC) on May 7, 2004. This meeting followed the 3<sup>rd</sup> National Carbon Sequestration Conference in Alexandria, Virginia, and served as a forum to discuss common interests in carbon capture and sequestration research, and to explore potential cooperation. Scott Klara, NETL’s Carbon Sequestration Technology Manager, led the discussions on the U.S. side. This meeting followed an initial meeting last October in Brussels where the group discussed potential collaboration on carbon storage. After presentations by each side in the morning, the group spent the afternoon discussing collaboration opportunities. While further discussions are needed to define specific areas of cooperation, the group identified several areas of common interest, including: CO<sub>2</sub> capture using solvents and membranes; multiple pollutant sequestration of CO<sub>2</sub>, SO<sub>2</sub>, and NO<sub>x</sub>; matching CO<sub>2</sub> sources and sinks; and standard methodologies for estimating the costs of CO<sub>2</sub> capture, transport, and storage. Participants emphasized the need for coordination of ongoing and planned R&D; collaboration between leading R&D organizations on major projects of interest to both organizations, especially large demonstration projects; and mechanisms to share data and information from ongoing research projects.

## NETL HELPS INDIA WITH FLY ASH PROBLEM

India currently relies on coal for nearly 70 percent of its electricity generation, and forecasts indicate that coal will remain the backbone of the country’s power sector for many decades. Management of air quality and solid waste has become an important environmental and economic issue in India because some 90 million metric tons of ash are generated annually by its coal-fired thermal power stations. The largest generator, the National Thermal Power Corporation Ltd. (NTPC), is planning to add 10,000 MW in the near future to its existing capacity of over 20,000 MW, and is very interested in demonstrating the feasibility of ash haulback to mines, as an alternative to ash pond disposal. A well developed and executed ash haul-back project would not only fill in the pits created by open cast mining, but would properly reclaim the land, allowing suitable vegetation to grow. Trees and vegetation also could act as carbon sinks.

Under a Participating Agency Services Agreement with the India Mission of the U.S. Agency for International Development, the U.S. Department of Energy’s National Energy Technology Laboratory (NETL) is providing technical assistance on a broad range of projects in the coal and power generation sectors. To this end, an NETL-led team traveled to India in May 2004 to meet with Indian officials and review the results of a feasibility study, as well as hydrogeology and environmental impact assessments. The focus of this fly ash effort under consideration is a mined out area in the Gorbi Project of Northern Coal Fields Limited (NCL), located in Singrauli. It has been estimated that the potential for ash disposal in these quarries is about 50 million metric tons. The ash will be hauled by railcar from the Singrauli Super Thermal Power Station, which generates 2.5 million metric tons of ash annually, and is located 20 kilometers from the mine site.

## STATUS OF ACTIVE CCT DEMONSTRATION, PPII, AND CCPI PROJECTS

### CCT DEMONSTRATION STATUS

#### **JEA – ACFB Demonstration Project.**

The second demonstration test burn of 50 percent coal (Pitt #8)/50 percent petcoke was completed in the 300-MW JEA large-scale circulating fluidized-bed (CFB) combustion project. The 300-MW project at JEA's Northside Station, Unit 2, is the largest CFB combustor operating at commercial scale anywhere in the world. The first test burn began January 5, 2004, and was completed 11 days later. The second test burn ran from January 16–31, 2004. Both tests were conducted at 100 percent, 80 percent, 60 percent, and 40 percent of full load. Emissions were monitored at each load level and were well below permitted values. Four coal blends are being tested as part of the demonstration project. (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)

#### **Southern Company, Inc. – Demonstration of Advanced Combustion Techniques for a Wall-Fired Boiler.**

The purpose of the project was to evaluate the use of GNOCIS and other computerized process control software to further optimize operation of

Plant Hammond Unit 4. The project ended on April 30, 2003. The Final Report was issued. Post Project Assessment has been prepared. (Coosa, GA)

**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. A Final Report has been issued, and the Post Project Assessment is in review. (Polk County, FL)

#### **TIAX (formerly Arthur D. Little, Inc.) – Clean Coal Diesel Project.**

Sub-bituminous coal water slurry made from Alaskan Usibelli coal was successfully fired in the two-cylinder test diesel engine at Fairbanks Morse for over one hour on April 14, 2004. Both custom injectors functioned as designed without any problems, including during the switchover period from diesel fuel to coal slurry. (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. DOE received the draft in March 2004, and is finalizing the report. (Butte, MT)

### PPII STATUS

#### **Otter Tail Power Company – Demonstration of a Full-Scale Retrofit of the Advanced Hybrid Particulate Collector (AHPC) Technology.**

The project came on line in October 2002. Operations have shown very good particulate removal efficiency, but at the cost of higher system pressure drop. Perfor-

mance testing has shown that the average collection efficiency of the AHPC is 99.997 percent. The outlet dust loading is almost two 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 premature bag replacement, excessive bag pulsing and premature bag failure. The particulate collector remains on-line treating the full flow from the 450-megawatt power plant. The project team has been developing plans to make enhancements to the particulate control device that may extend the current demonstration period past October 2004, the original project completion date. (Big Stone City, SD)

#### **Sunflower Electric Power Corp. – Demonstration of a 360-MWe Integrated Combustion Optimization System.**

The combustion optimization sensors package consisting of the Burner Profiler, loss-on-ignition/furnace exit gas temperature (LOI/FEGT) sensors, and carbon monoxide sensors is operational. Data are being archived on the MKE computer and by EtaPRO, which also collects plant performance data. The low-NO<sub>x</sub> burner modifications and coal-balancing dampers have been installed. The coal-balancing dampers on Mill C are operating in automatic mode. System performance is being monitored and data are being archived in EtaPRO. 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. (Garden City, KS)

#### **Tampa Electric Company, Big Bend Power Station Tampa – Neural Network Sootblower Optimization Project.**

The Pegasus neural network intelligent soot blowing system has been

installed and is operating in closed loop mode (without operator supervision) at Tampa Electric's Big Bend Station. Preliminary reduction in NO<sub>x</sub> levels in the range of 10-20% and boiler efficiency improvements in the range of 0.5-1% have been observed. To incorporate and test opportunities for additional improvements in NO<sub>x</sub> levels, boiler efficiency improvements, and particulate emissions, updates to the Neural Network System have been implemented and are being tested. The tests are based on experience gained to date by adjusting soot-blowing sequencing and duty cycles, and employing finer soot-blower subgroupings. The project is in the "system optimization" phase. Following "system optimization," a period of "benefits demonstration" will be analyzed prior to wrapping up the demonstration project in March 2005. (Apollo Beach, FL)

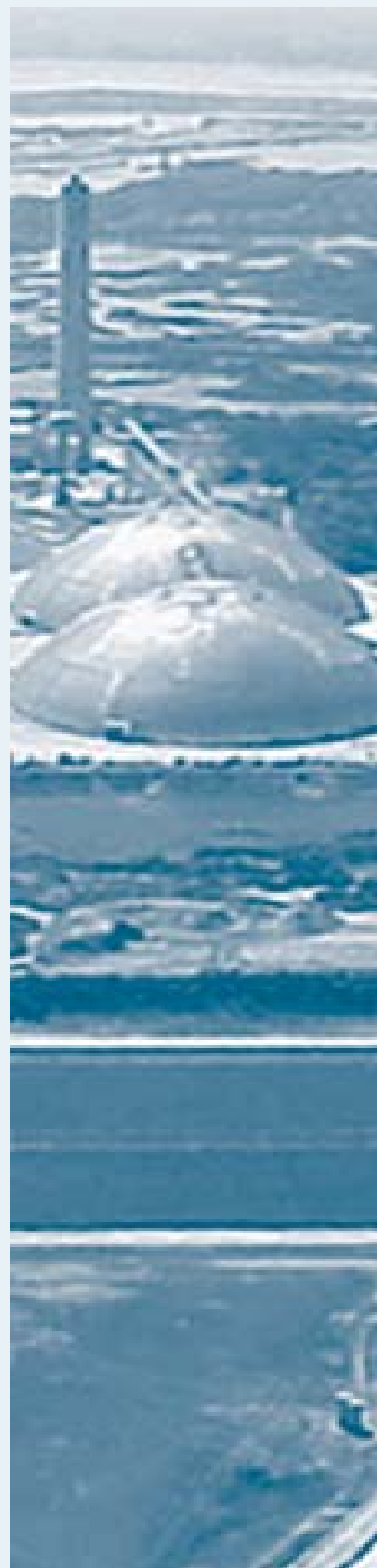
**Universal Aggregates, LLC** – *Commercial Demonstration of the Manufactured Aggregate Processing Technology Utilizing Spray Dryer Ash.* The Universal Aggregate PPII project, Commercial Demonstration of Manufactured Aggregate Processing Technology Utilizing Spray Dryer Ash, moved into Phase 3 operations on February 1, 2004. Numerous plant modifications have been made to date in an effort to refine the product and to improve the operation. The plant is expected to remain in test mode through the month of September. The project is scheduled to end in May 2005. (King George, VA)

## CCPI STATUS

**NeuCo, Inc.** – *Integrated Optimization Software.* This is the first project awarded under Round I of the Clean Coal Power Initiative (CCPI). NeuCo, Inc. of Boston, Massachusetts, a leading provider of optimization software for electric power producers, will design and demonstrate integrated on-

line optimization systems at Dynegy Midwest Generation's Baldwin Energy Complex located in Baldwin, Illinois. The optimization modules will address combustion, soot-blowing, selective catalytic reduction (SCR) operations, overall unit thermal performance, and plant-wide profit optimization at all three of the 600-MW coal-fired generating units. Two of these units are cyclone boilers with SCRs, while the third is a tangentially fired boiler. The benefits of this project will include reduced NO<sub>x</sub> emissions, increased fuel efficiency, and improved reliability. The increases in fuel efficiency (heat rate reduction) will also provide commensurate reductions in greenhouse gases, mercury, and particulates. (Baldwin, IL)

**We Energies** – *TOXECON™ Retrofit for Mercury and Multi-Pollutant Control.* This CCPI project was initiated in April 2004. We Energies will design, install, operate, and evaluate the TOXECON™ process as an integrated process to control mercury, particulate matter, sulfur dioxide, and nitrogen oxide emissions at their Presque Isle Plant located in Marquette, Michigan. TOXECON™ is a technology patented by the Electric Power Research Institute (EPRI) in which sorbents (including activated carbon) for mercury are injected into a pulse jet baghouse that is installed downstream of an existing electrostatic precipitator (ESP) particulate control device. This project addresses mercury control regulations recently proposed by EPA, as well as legislative proposals before the 108th Congress, including the President's Clear Skies Initiative, to control mercury emissions from our nation's coal-fired power plants. National Environmental Protection Act (NEPA) requirements were completed for this project prior to award, and engineering design work has been initiated. (Marquette, Michigan)





U.S. DEPARTMENT OF ENERGY

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