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CLEAN COAL TODAY

A Newsletter About Innovative Technologies for Coal Utilization

News Bytes

On March 5, 2007, Jeffrey D. Jarrett resigned his post as Assistant Secretary for Fossil Energy to join the private sector. In December 2006, Thomas D. Shope was appointed as FE's Principal Deputy Assistant Secretary. Shope, an attorney, previously served as FE's Chief of Staff, and Chief of Staff at the Office of Surface Mining Reclamation and Enforcement. His other experience includes the Department of Interior Solicitor's Office, the Department of Labor's Office of Administration Law Judges, and the private sector. ◆

Carl O. Bauer, Director of the Office of Fossil Energy's National Energy Technology Laboratory, has been named Laboratory Director of the Year by the Federal Laboratory Consortium for Technology Transfer. The Consortium is a nationwide network of more than 700 major federal laboratories and centers, and their parent departments and agencies. ◆

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Inside This Issue

NETL Hosts Mercury Control Technology Conference

The National Energy Technology Laboratory (NETL) hosted nearly 300 attendees at its annual three-day Mercury Control Technology Conference held in December 2006. The event provided an audience of researchers, technology venders, electric utilities, and environmental regulators the latest information on mercury control technologies, environmental regulations, and coal utilization by-product (CUB) characterization and management. The Department of Energy (DOE) Office of Fossil Energy provided funding for the conference under its Innovations for Existing Plants (IEP) Program. Collaborative partnerships between DOE and its stakeholders were seen as key to progress in mercury controls and CUB (fly ash, bottom ash, boiler slag, and flue gas desulfurization by-products) utilization. The conference featured up-to-date descriptions of projects funded by NETL and cost-shared with a variety of stakeholders.

Overview Session

NETL Advisor, Michael Eastman, opened the Mercury Control Technology Conference overview session

The opening overview session set the stage for detailed technical presentations that followed. Michael Eastman, Senior Management and Technical Advisor to NETL's Strategic Center for Coal, placed mercury controls in the larger context of clean coal technology zero-emission efforts — chiefly the DOE FutureGen project that will feature integrated gasification combined-cycle technology for electricity, hydrogen fuels, and carbon sequestration. NETL's current mercury efforts were outlined by Thomas J. Feeley III, Technology Manager for the IEP Program. Since hazardous air pollutant stack testing began in 1993, the program has progressed through several phases of field testing of technologies, especially activated carbon injection (ACI). Technologies designed primarily for SO_2 and NO_X removal can also "co-remove" mercury with the other pollutants. Feeley noted that commercial utility orders for mercury sorbent injection developed and/or tested by NETL and its collaborators comprise more than 12 gigawatts of domestic coal-fired generating capacity. The NETL

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...*"NETL Mercury" continued*

program is developing technology for commercial demonstration of 70 percent mercury removal in 2007, and 90 percent removal by 2010, while also investigating advanced approaches to sequestering or removing mercury from CUBs. The program includes cost reduction targets 25–50 percent lower than the baseline cost of $60,000 per pound of mercury removed from flue gas. Both NETL's Feeley and George Offen of EPRI summarized progress made as well as challenges facing technology development. At the forefront is the successful demonstration at Presque Isle Station in Michigan, of the TOXECON™ mercury removal process, a collaborative effort of We Energies, DOE, and EPRI, using an EPRI-patented process. Challenges remain with respect to increased particulate loading from sorbent injection into the flue gas ductwork, acid gas and sulfur trioxide interference with ACI, capture of mercury in high-temperature conditions, and CUB impacts.

Regulatory drivers were outlined by Ravi Srivastava of EPA's Office of Air Quality Planning and Standards, who discussed provisions of the Clean Air Mercury Rule (CAMR), and the related Clean Air Interstate Rule, both issued in 2005. Together, the two rules create a multi-pollutant strategy to phase in significant reductions in emissions over the next decade. CAMR requires reduction of utility emissions of mercury from the current 48 tons per year to 38 tons/year in 2010, and 15 tons per year in 2018, a total reduction of 70 percent. A number of states intend to implement more stringent mercury regulations than those in the Federal CAMR.

On the international regulatory front, Lesley Sloss of the International Energy Agency noted that Best Available Technology requirements for other air pollutants in the European Union (EU) have caused mercury emissions for coal-fired power plants to decrease, even though those mercury emissions are not specifically regulated. There are, however, existing regulations on mercury emissions from waste incinerators and chlor-alkali plants; and on imports and exports of mercury-containing material such as batteries and light switches. Meanwhile, significant mercury research is under way in the EU. Rules for coal combustion may be implemented if existing rules fail to reduce mercury emissions to environmentally acceptable levels.

Technical panels reviewed advancements of major technologies. Overall, participants noted that emissions of inorganic mercury from power plants — both as air emissions and as by-product constituents — are affected by factors ranging from fuel rank (the type of coal and its chemical content), to the chemical form of mercury released when coal is burned. Other contributing factors include combustion conditions, flue gas characteristics, and air pollution controls designed primarily for non-mercury pollutants. Following are some highlights of the technical discussions.

Sorbent Injection

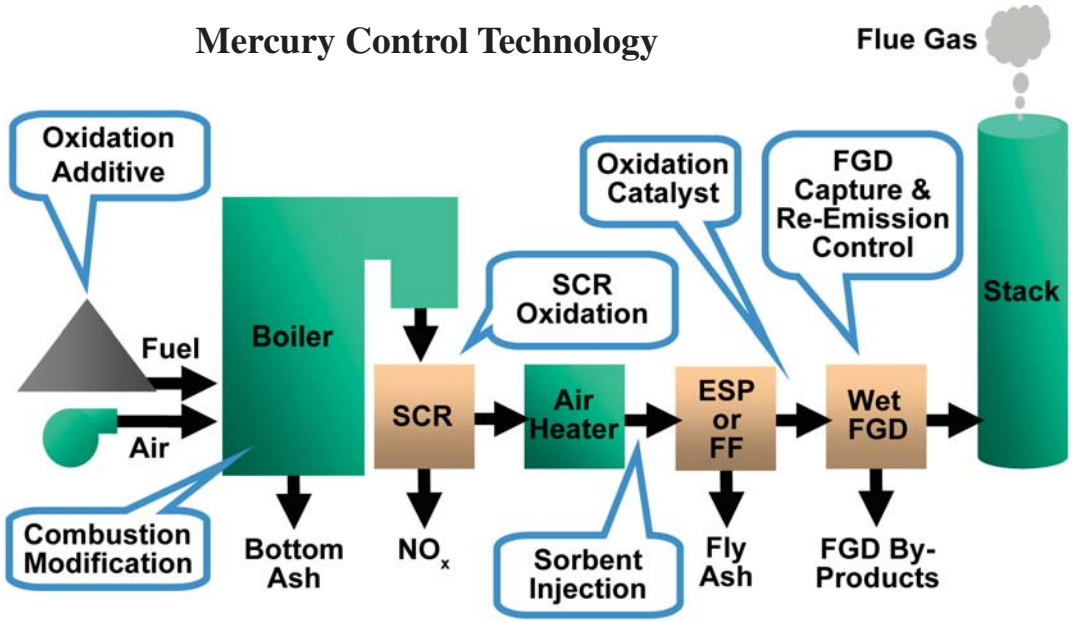
Sorbent injection, particularly activated carbon injection, is the most mature technology specifically for mercury control. Sorbent and the mercury it attracts are removed from flue gas along with boiler fly ash when the gas passes through a particulate removal device such as an electrostatic precipitator or fabric filter baghouse. NETL has been in the forefront with such innovations as its patented "Thief" process, now being commercialized. The process extracts partially combusted coal from the host boiler and re-injects it into the flue gas as a mercury sorbent.

Presenters emphasized the need for selecting the correct sorbent and injection point, in order to maximize the time the sorbent has to work (typically upstream of the particulate collection device), as well as effectively distributing the sorbent across the ductwork. We Energies and others are resolving associated issues such as smoldering of activated carbon in baghouse ash hoppers, and burning of fabric filter bags due to smoldering carbon in the ash hoppers below.

Research efforts have found that the use of sorbent injection upstream of existing particulate removal systems can result in removal of up to 90 percent of the mercury entering the particulate control device. Further R&D is needed to develop mercury sorbents with increased performance in high-temperature, high acid gas environments that significantly reduce the effectiveness of conventional sorbent injection.

Mercury Capture in SCR and FGD Systems

A number of speakers focused on oxidation of mercury in selective catalytic reduction (SCR) and wet flue gas desulfurization (FGD) systems. Oxidation additives can be applied to the coal, in the boiler, or in the flue gas path. The goal is to convert elemental mercury in flue gas to a water-soluble oxidized form that can be captured in a wet



FGD system. Catalytic oxidation of mercury can also occur in an SCR reactor used for NO_x control, or across a catalytic oxidation device installed immediately upstream of a wet FGD system.

Depending on site-specific conditions, a wet FGD system can remove up to 90 percent of the oxidized mercury entering the FGD system. However, mercury "re-emissions" (chemical reduction of oxidized mercury inside a wet FGD absorber and escape of elemental mercury back into the flue gas) can decrease mercury removal in the FGD system. The URS Group is studying the use of wet FGD additives to mitigate FGD re-emissions of elemental mercury.

As part of work at 10 bituminous coal-fired power plant sites, CONSOL Energy found that units equipped with an operating SCR and wet FGD experienced coal-to-stack mercury removal in the range of 65–97 percent. In the same group of 10 sites, four units with wet FGD but no SCR in operation had coal-to-stack mercury removal ranging from 53–87 percent. Although a wet FGD system can co-remove oxidized mercury, it is generally not cost-effective to install such a system solely for mercury control.

Novel work also is being conducted downstream of the FGD system. URS Group, NETL, and other project partners tested the MerCAP™ process to attract mercury to gold-coated plates in the flue gas ductwork. In one test, results ranged from 30–45 percent removal of incoming mercury over an extended period of time.

Mercury in CUBs

Mercury adhering to flyash and sorbent can end up in CUBs and CUB-containing manufactured products such as wallboard, concrete additives, and synthetic countertops. A number of presentations discussed the characterization and fate of mercury in CUBs. Both EPA and NETL are seeking greater understanding of mechanisms by which mercury could transfer from CUBs to the environment, and are working on new methods to test for CUB leaching to groundwater. Previous studies at NETL in which 14 plants were sampled found no apparent correlation between the total mercury content in flyash and the amount of mercury leached from flyash (see *Clean Coal Today*, Spring 2004).

USG Corporation sampled four wallboard plants and found that there was a wide range of thermal mercury released from FGD synthetic gypsum to the air (5 percent to 50 percent). Because the small sample may have skewed results, further investigation is needed.

One final area of discussion addressed issues posed by modeling and measuring. Ansys-Fluent, Inc., discussed the use of Computational Fluid Dynamics (CFD) modeling to represent site-specific conditions and to predict future performance of alternative mercury control technologies on boilers for individual generating units. Actual measuring of mercury concentrations at power plants is a continued challenge because technology is still developing, and a shortage exists of the skilled technicians needed to perform accurate analyses of very low mercury concentrations.

NETL has scheduled the next Mercury Control Technology Conference for December 11–13, 2007, in Pittsburgh, Pennsylvania. A related industry conference, Air Quality VI, is planned for September 2007 in Arlington, Virginia. ■

NEW CONSORTIUM FOR ULTRASUPERCRITICAL STEAM TURBINES

In order to complement work being conducted by the U.S. Department of Energy's National Energy Technology Laboratory (NETL) and a group of boiler vendors, NETL and its collaborators have formed a Turbine Consortium to promote advanced materials needed for ultrasupercritical (USC) steam turbines. The Consortium was started in the Fall of 2006, and participants/co-funders include DOE, the Ohio Coal Development Office (OCDO), Alstom Power, EPRI, General Electric, and Siemens under a prime contract with Energy Industries of Ohio (EIO). Researchers at NETL and Oak Ridge National Laboratory also are providing technical support.

R&D is needed on advanced materials for both boilers and turbines to allow use in ultrasupercritical conditions. Steam temperatures of 760 °C (1,400 °F) and pressures of 35 MPa (5,000 psi) were selected as target values in this project. To date, lack of materials with the necessary fabricability and resistance to creep, oxidation, corrosion, and fatigue, has limited the adoption of advanced USC steam plants.

The Consortium is evaluating erosion-resistant coatings to protect turbine components

The boiler group has already made significant progress, just completing the five-year Phase I effort testing properties of various materials at high temperatures and pressures. In Phase II, the boiler group is starting to evaluate materials that can be used in oxyfuel combustion. The new turbine work is focusing on materials for coatings and rotors.

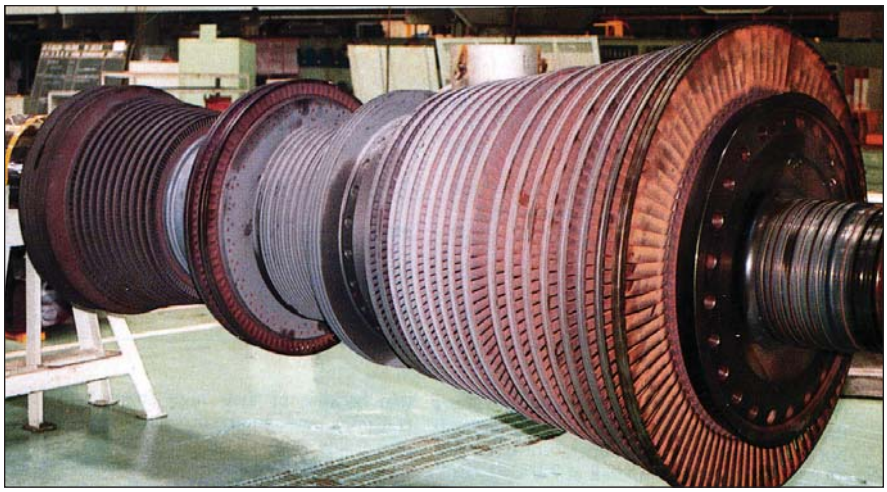
Erosion-resistant coatings being evaluated by the Consortium are intended to protect high-pressure turbine components from excessive steam oxidation and erosion from solid particles emanating from the boiler. Candidate substrate materials have been selected, and a test plan was prepared utilizing two steam oxidation test methods to expose specimens to atmospheric pressure steam. Initial coatings have been identified, and the base substrates to be used are two alloys — Udimet 720Li and Inconel 740. Preliminary test results show that, from a creep perspective (a measure of stress and time at which point materials start to deform), the standard aging treatment does not appear to significantly improve the properties compared to solution annealing without aging. Raising the solution temperature appears to increase the creep strength.

Rotors are one of the main focus areas of the Consortium. Areas of study include alloys and their mechanical properties such as tensile, creep, and fatigue properties. Development of a welded rotor for the proposed USC cycle will require joining a precipitation-hardened nickel alloy with a solution-hardened alloy. Haynes 263 and Inconel CCA 617 were identified as the best candidates for welding experiments that are designed to produce a welded joint between 2-inch thick sections of the selected materials.

In the design involving integral, non-welded rotor construction, a fabricated rotor consisting of conventional steel at the cooler sections (below 600 °C) and nickel-based superalloys at the higher temperature sections will be utilized. Based on a literature search, two alloys were selected for further evaluation of mechanical strength — Haynes 282, a new hybrid solution-precipitation strengthened alloy from Haynes International, and the high-strength gas turbine rotor alloy Udimet 720Li.

Based on an extensive literature survey, a spreadsheet of mechanical, physical, and thermo-physical properties has been created for 19 candidate rotor alloys. ThermoCalc software simulations (to simulate the heat transfer of candidate materials during cooling) were performed on all candidate alloys, and microstructural stability was assessed based on the phases found in the microstructure and the processing conditions. Heat transfer simulation of a large IP rotor ingot, under air cooling and fan cooling, was evaluated. The core cooling rate was found to be half that of the surface, and therefore the likelihood of cooling in air without cracking was confirmed.

Nimonic 105, Udimet 720Li, IN740, and Haynes 282 were selected for further evaluation of their mechanical properties and



Currently, large rotors are made from ferritic steels. The Consortium is evaluating use of a combination of ferritic steels and nickel-based alloys in these rotors to meet project goals.

microstructural stability. As the test temperature increases to 1,500 °F, the ultimate tensile strengths converge for Haynes 282 SA, Nimonic 105 AP (as processed), HT (age hardened for strength), and Udimet 720Li HT. However, at 1,400 °F, Udimet 720Li HT possesses the highest ultimate tensile strength (the highest load a material can sustain before fracture), with the Nimonic 105 alloys about mid-way between Udimet 720Li and Haynes 282. Researchers noted that Haynes 282 shows a small increase in strength in the range of 1,200–1,400 °F, despite expectations that strength would decline with increasing temperature.

The values for 0.2 percent yield strength (YS) — the stress point at which a material begins to permanently deform — converge for these three alloys at 1,500 °F; and at 1,400 °F the alloys rank in the same way as UTS. Again, Haynes 282 SA shows a bump in strength between 1,200–1,400 °F. The results of this study will provide a good indication of the relative tensile strength of these alloys for different processing conditions, to provide a basis for choosing among materials.

Creep testing also is under way for the candidate rotor alloys. For Udimet 720Li, testing is complete. Surprisingly, creep rupture failure occurred in less than 1,000 hours, despite the alloy's high YS. Udimet 720Li will be examined in more detail at lower stresses to determine if creep rupture behavior is comparable to that of Nimonic 105 and Haynes 282 alloys, both of which are still being tested. Creep times for those alloys are approaching 3,000 hours, and results are exceeding expectations given the much lower (0.2 percent) YS of those alloys.

The USC turbine materials development work, together with the USC boiler efforts, are expected to make significant contributions to FE efforts for the development of high efficiency, clean burning coal-fired power plants. ■

... "News Bytes" continued

American Electric Power, building on work with DOE, has announced the first commercial demonstration by a utility of carbon capture and geologic storage. The decision to begin CO_2 capture and storage at its Mountaineer Plant in West Virginia follows a three-phase, 10-year project with NETL. ◆

Secretary of Energy Samuel W. Bodman signed a Record of Decision in early April, clearing the way for construction of the 285-megawatt coal-fired advanced integrated gasification combined-cycle plant at Stanton Energy Center, near Orlando, Florida. The project was awarded under Round 2 of the Clean Coal Power Initiative, and will be co-owned by Southern Power Company, the Orlando Public Utilities Commission, and Kellogg, Brown, and Root. The plant is expected to be the cleanest of its type in the world. ◆

A Clean Coal Power Initiative project recently received the 2007 Engineering Excellence Award, conferred by the American Council of Engineering Companies of Minnesota. The award recognizes outstanding achievement by Great River Energy (GRE) and Barr Engineering who designed, constructed, and demonstrated a unique coal drying technology using waste heat to reduce moisture in lignite so more power can be produced from the same quantity of fuel. The 54-month demonstration is being conducted in cooperation with NETL at Coal Creek Station in Underwood, North Dakota. The award was presented to GRE and Barr Engineering officials January 26, 2007, in Minneapolis, Minnesota. ■

NETL MONITORS CO_2 STORAGE

A vital part of the Office of Fossil Energy's carbon sequestration program involves monitoring the integrity of long-term storage of carbon dioxide (CO_2) in geologic formations. To this end, NETL in-house researchers, working with private sector partners, researchers, and academia, are seeking to demonstrate advanced monitoring techniques to assess the capacity, stability, rate of leakage, and permanence of CO_2 storage in geologic formations. Ensuring the permanence of sequestered CO_2 involves site evaluation, background and post-injection monitoring, and laboratory research efforts coordinated with field activities. All of these efforts will contribute to commercialization of carbon sequestration technology, and its use in key projects such as FutureGen.

Ground-based CO_2 flux monitoring at the Frio project, near Houston, Texas

Various field tests have already taken place, and some are planned through the Carbon Sequestration Regional Partnerships. Such tests explore measuring, monitoring, and verification, while also testing sequestration methods in various geological formations (depleted oil and gas wells, brine formations, and deep, unmineable coal seams). Accurate monitoring not only establishes a baseline so that environmental impacts can be measured, but is requisite to regulatory approvals and ensuring public trust and support.

The long-term CO_2 storage capabilities of geological formations have not been well explored. NETL's monitoring program aims to apply a complementary suite of surface and near-surface monitoring techniques to detect short-term, rapid loss, and long-term intermittent slow leakage of CO_2 to the atmosphere, groundwater, or soil. These techniques include: adding monitoring perfluorocarbon (PFC) tracers to the injected CO_2, then detecting the presence of tracers in soil gas at parts-per-quadrillion levels; using natural tracers (e.g., radon and methane) already present in the soil-gas; applying shallow water aquifer chemistry monitoring to detect changes caused by reactions of infused CO_2 with clays and other soils; and determining the flux of CO_2 between the surface and atmosphere before and after CO_2 injection.

Tracer injection at Frio

Advanced geophysical site analysis tools are integral to monitoring methods. Ground-based measurements and remote sensing combine satellite-visible and infrared views with optical aerial photography to provide a complete characterization of the sites. Abandoned wells can be located using airborne and ground-based magnetometry. Magnetometers record changes in magnetism, indicating the presence of vertical steel wells. Methanometry (measuring atmospheric methane), coupled with radiometry (measuring radon), also can detect degradation of well-sealing cements — another potential for CO_2 leakage.

NETL's first successful monitoring effort took place in 2002, at the West Pearl Queen sequestration field test site (depleted oil wells in southeastern New Mexico). That effort was headed by Los Alamos and Sandia National Laboratories. PFC tracers, coupled with ground penetrating radar, found extremely low levels of leakage associated with thinning and faulting in the caliche layer that underlies the sandy soil. In 2004, NETL participated in another monitoring test at the Frio saline aquifer site near Houston, Texas, in a project sponsored by the Texas Bureau of Economic Geology and the University of Texas. Detection of natural tracers that come to the surface in locations where CO_2 might leak, was first tried at Frio. Natural tracers can identify areas that require more intense monitoring, or can be used to confirm results from other monitoring methods. Also tested at Frio were: shallow aquifer well monitoring, and CO_2 surface flux monitoring, as well as further testing of PFC tracers.

A project in Bozeman, Montana, experimented with shallow release of CO_2 — a deliberate and controlled release some 9 feet underground — in order to evaluate monitoring techniques. That effort, the Zero Emissions Research and Technology project, was directed by Montana State University and West Virginia University, with sponsorship by NETL. The experiment used many of NETL's surface monitoring techniques, finding excellent agreement between methods.

Remote sensing at the Salt Creek oilfield, near Midwest, Wyoming

NETL will also test its suite of monitoring technologies at the Southwest Regional Partnership enhanced coalbed methane sequestration field test, in the San Juan Basin, New Mexico. A geophysical site survey of the Basin has been completed, and CO_2 injection is to begin later this year. NETL also is building a geomechanical model, which will be used to help plan and interpret information from a surface tiltmeter survey, ultimately aiding in the monitoring of CO_2 migration throughout the coal seam. For soil monitoring, strategically placed pipes will measure tracers at 37 locations.

Monitoring techniques developed to date have shown versatility in applications over a range of climatic conditions and geological settings. Surface and near-surface monitoring have been successfully applied in the semi-arid soil conditions of southeast New Mexico, and at the heavily forested, swampy site near Houston, Texas. Both airborne and ground-based magnetometry have proven effective at locating even deeply buried abandoned wells at enhanced oil recovery sites.

The ultimate goal of NETL's sequestration monitoring effort is to provide the basis for monitoring long- and short-term leakage at commercial sequestration sites. Current efforts have focused on developing these techniques in cooperation with Phase II projects of the Regional Sequestration Partnerships. ■

UPCOMING EVENTS

May 7 – 10, 2007
Sixth Annual Conference on Carbon Capture & Sequestration
Sponsor: DOE/NETL
Location: Pittsburgh, PA
Contact: Kimberly Yavorsky
Phone: 412-386-6044
E-mail: Kimberly.yavorsky@netl.doe.gov
Web site: www.carbonsq.com

May 7 – 10, 2007
World of Coal Ash 2007 Conference
Sponsor: DOE/NETL
Location: Covington, Kentucky (Greater Cincinnati)
Contact: Bill Aljoe
Phone: 412-386-6569
E-mail: aljoe@netl.doe.gov
Web site: www.worldofcoalash.org

June 10 – 15, 2007
32nd Technical Conference on Coal Utilization & Fuel Systems
Sponsors: U.S. DOE, ASME & Coal Technology Association, with NETL
Location: Clearwater, FL
Contact: Barbara Sakkestad
Phone: 301-294-6080
E-mail: BarbaraSak@aol.com
Web site: www.coaltechnologies.com/conferences.html

2007 BUDGET EMPHASIZES CLEAN COAL

During his campaign for the Presidency, George W. Bush pledged to commit $2 billion over 10 years to advance clean coal technologies. The FY 2007 budget reflects this continuing commitment. The recently approved funding continues support for the development and demonstration of a balanced portfolio of key technologies in coal research aimed at near-zero emissions. This program is focused on the environmental sustainability of clean coal in a future carbon-constrained economy, while ensuring that coal remains a crucial part of the domestic energy mix.

The budget appropriates $100 million for the **Carbon Sequestration Program**, a 55 percent increase over FY 2006 appropriations. This will allow for expediting large-scale CO_2 injection field tests under the Carbon Sequestration Regional Partnerships, as well as other vital program activities.

The **Future Gen project** — to create the world's first near-zero emissions coal-based electric generation and hydrogen fuels plant — is fully funded at $54 million. $60.4 million is provided to allow for a third round of awards under the **Clean Coal Power Initiative**.

Other important program funding includes $63.4 million for **Fuel Cells**, $57 million for **Advanced IGCC**, $32.9 million for **Advanced Research**, $22.1 million for **Fuels**, $20 million for **Advanced Turbines**, and $16 million for **Innovations in Existing Plants**. ◆

INTERNATIONAL INITIATIVES

NETL HOSTS LATVIAN CLEAN ENERGY TECHNOLOGIES DELEGATION

Since 1991, when it reestablished independence following the breakup of the Soviet Union, the Republic of Latvia has made progress in transitioning its economy. The economy has been largely privatized, although the state still holds sizable stakes in a few large enterprises. Latvia's economy experienced average GDP growth of more than 7.0 percent over the past several years, and in 2005 reached 10.2 percent real GDP growth. Latvia has a population of 2.3 million, and it is dependent on imports for a substantial amount of its energy and raw materials. The country is particularly interested in widening its energy resource base, learning about waste utilization and energy efficiency, and engaging in sound energy policy planning.

On March 8–9, 2007, the Office of Fossil Energy (FE) National Energy Technology Laboratory (NETL) hosted a seven-member delegation from Latvia for a two-day briefing on the research, development and demonstration (RD&D) efforts of the Department of Energy (DOE) to develop cleaner energy technologies to meet growing demand, while at the same time addressing climate change. The Latvian "briefing" visit was coordinated by a team led by Arthur L. Baldwin, NETL Senior International Advisor. The visitors represented a number of Latvian organizations: Ministry of Economics, Department of Energy; Latvenergo, the state-owned energy supply group; Institute of Physical Energetics; Latvian Investment and Development Authority; and the Embassy of the Republic of Latvia to the United States.

Ranjani Siriwardane, NETL, briefs the Latvian delegation and NETL R&D personnel about regenerable desulfurization sorbent R&D

The delegation visited the NETL Pittsburgh and Morgantown campuses, touring in-house research facilities, learning about R&D projects on carbon capture and sequestration and related modeling and simulation activities, and touring power plant simulation facilities. NETL briefed the delegation on FE's overall Coal and Power Systems program, including the FutureGen Initiative. Carbon control R&D was another important topic, and NETL highlighted the Carbon Sequestration Regional Partnerships as well as international cooperation through the Carbon Sequestration Leadership Forum. Representatives of the National Institute of Occupational Safety and Health's Pittsburgh Research Laboratory also discussed their programs.

The Latvian delegation was particularly interested in commercially available combustion technologies capable of efficiently handling or co-firing waste materials, while providing steam for space heating. NETL arranged a visit to the Morgantown Generating Facility, a 68-megawatt, waste coal-fired, fluidized-bed combustion, cogeneration facility. Jointly owned by a partnership of Dominion Energy, The McNair Group, and Cogentrix, the facility provides electricity to Monongahela Power Company and steam to West Virginia University.

URUGUAY'S FIRST EXPOSURE TO CCTS

Late January is prime beach time for the people in Uruguay. The South American summer is in full swing, and thoughts of Punta del Este abound. It was the last week of a very cold January 2007, however, when five motivated energy officials from three Uruguayan entities arrived in Washington, DC, under the sponsorship of the World Bank for talks with U.S. coal experts and an introduction to clean coal technologies. In addition, the U.S. Department of Energy's National Energy Technology Laboratory arranged for the delegation to visit Springerville, a major new pulverized coal plant operated by Tucson Electric Power and Tri-State Generation and Transmission, in Show Low, Arizona.

From left to right: Tracy Shumway (Tucson Electric Power); Gerardo Triunfo (Ministry of Industry, Energy, and Mining of Uruguay); Maria Reidpath (NETL); Pablo Mosto (Ministry of Industry, Energy, and Mining of Uruguay); Alicia Nieto (National Environmental Agency of Uruguay); Leonardo Paulerci (UTE); Jeffrey Stevens (Tucson Electric Power); and Martin Bassagoda (UTE)

Uruguay is a nation of over 3 million people, and is approximately the size of Missouri. Its current installed capacity is 2,229 MW, of which 70 percent is hydroelectric power. Demand is growing and the state-owned utility, Usinas y Transmisiones Eléctricas (UTE), points to growth of 5.4 percent and 3.3 percent in demand during 2004 and 2005 respectively, as a trend that will likely continue in the next decade. A limiting factor in Uruguay's electric power generation is the lack of domestic energy resources. This has compelled UTE to rely on hydropower and imported fuel oil to supply the country's power plants. The natural gas supply, once abundant in neighboring Argentina and potentially available from Brazil, has recently suffered from economic and political pressures in the region, and is no longer an option for Uruguay. Despite the lack of domestic coal resources, Uruguay is looking at all potential energy sources, including coal.

The Uruguayan delegation included: Gerardo Triunfo, National Director, and Pablo Mosto, Senior Advisor of the Office for Energy and Nuclear Technology, Ministry of Industry, Energy, and Mining; Alicia Nieto, Manager, National Environmental Agency of Uruguay; and Leonardo Paulerci and Martin Bassagoda, Engineering Managers for UTE. The fact-finding mission objectives were to learn about coal-based power generation, technologies, and environmental impacts, to help Uruguay's energy planning and diversify its energy mix.

A welder works on emission control equipment at Springerville facility (Photo courtesy of ©Bechtel Corp.)

The Springerville facility has three 400-MW units. Unit 3, which was completed in 2006, is operated by Tri-State Generation and is the first major PC plant built in the United States in a decade. It is designed to fire Powder River Basin coal and uses low-NO_X burners and selective catalytic reduction for NO_X control, dry flue gas desulfurization for SO_2 control, and a pulse jet baghouse for particulate control. It features zero water discharge, and a wet mechanical-draft cooling tower. Fly and bottom ash are stored on-site in sealed landfill facilities.

The delegation was hosted by Jeffrey L. Stevens, Tri-State Generation Project Director. Uruguayan visitors were most interested in plant environmental controls and regulatory requirements. Plant cost and construction time, as well as logistics of coal delivery and handling, were also discussed. Participants noted the importance of locating plants near a port. Overall, the visit is an indicator that coal is making its way as an option for energy security, even for countries where no domestic coal exists. ■

Active CCT Demonstration, PPII, and CCPI Project Status

CCT Demonstration Status

Kentucky Pioneer Energy (KPE), LLC – *Kentucky Pioneer Energy Project*. The Cooperative Agreement has expired. The Draft Final Report is in progress. (Trapp, KY and West Terre Haute, IN)

TIAX, LLC (formerly Arthur D. Little, Inc.) – *Clean Coal Diesel Project.* The Final Report has been submitted and the Post Project Assessment is in progress. (Fairbanks, AK and Beloit, WI)

PPII Status

Otter Tail Power Company – *Demonstration of a Full-Scale Retrofit of the Advanced Hybrid Particulate Collector (AHPC) Technology.* The project has been completed. The Final Report has been submitted and approved. (Big Stone City, SD)

Universal Aggregates, LLC – *Commercial Demonstration of the Manufactured Aggregate Processing Technology Utilizing Spray Dryer Ash.* The Cooperative Agreement for this project ended on December 31, 2006. Universal Aggregates continues to make equipment modifications to improve throughput capacity and continuous run time of the plant. In January, 2007, the single-shaft pugmill was replaced with a twin-shaft unit. Although full-capacity operation has not yet been achieved, the plant has shipped finished product to its distributor and this material has been accepted and utilized by concrete block manufacturers. (King George, VA)

CONSOL Energy Inc. – *Greenidge Multi-Pollutant Control Project.* Construction of the integrated multi-pollutant control system at the coal-fired, AES Greenidge 107-MW Unit 4 in Dresden, NY, has been completed. Startup, commissioning, and guarantee testing are currently underway. This project includes a unique hybrid selective non-catalytic reduction (SNCR) and in-duct selective catalytic reduction (SCR) system for NO_X reduction; a circulating fluidized bed dry scrubber for SO_2, SO_3, and acid gas reduction; activated carbon injection for mercury control; and a baghouse for particulate control. This combination of technologies will demonstrate advanced emissions control at a lower cost than traditional retrofits at a plant of this size and age. (Dresden, NY)

CCPI Status

MEP-I LLC (Excelsior Energy Inc.) – *Mesaba Energy Project.* Excelsior's application for pre-construction permits continues through the state approval process. The application included requests for a large electric power generating plant site permit and routing permits for a high voltage transmission line and natural gas pipeline. Also included was Excelsior's request for air and water-related permits. The Draft Environmental Impact Statement (DEIS), prepared by DOE in cooperation with the Minnesota Department of Commerce, and intended to fulfill the requirements of both the Federal and State environmental review processes, is expected to be available in the near future. Its Notice of Availability will be posted in the Federal Register. The MPUC is also considering Excelsior's petition for approval of a 603-MWe power purchase agreement with Northern States Power, per the Minnesota Innovative Energy Project and Clean Energy Technology statutes. Excelsior is coordinating with the U.S. Army Corps of Engineers with regard to the wetlands permit process. The Project Definition and Development phase runs through April 2008. (Itasca & St. Louis Counties, MN)

NeuCo, Inc. – *Integrated Optimization Software.* The project at Dynegy's Baldwin Energy Complex has completed the planned efforts in Budget Period 1 within budget and on schedule. The Combustion Optimization module achieved the NO_X reduction goal of 5 percent along with improvements in cyclone stability. NeuCo has shown that its SCR Optimization module reduces ammonia consumption by 18 percent. NeuCo has installed the Sootblowing Optimization module on two separate units, with and without an intelligent sootblowing control system. This dual approach allows NeuCo to address a wide range of sootblowing issues. The latest release of CombustionOpt, SCR-Opt, and PerformanceOpt provide a variety of enhancements that were designed to make each of the Optimizers less of a "black box". All three optimizers now support advanced functionality for real-time analytics. (Baldwin, IL)

University of Kentucky Research Foundation – *Advanced Multi-Product Coal Utilization By-Product Processing Plant.* University of Kentucky's Center for Applied Energy Research (CAER) continues to evaluate the ultra fine ash product samples obtained during the pilot scale field tests at the 2,200-MW Ghent Generating Station. CAER is also determining private industry interest for participating in the detailed design and demonstration phase of the project. (Ghent, Carroll County, KY)

We Energies – *TOXECON™ Retrofit for Mercury and Multi-Pollutant Control.* This project is currently in the operations phase. In the period from December 2, 2006, to January 19, 2007, the project logged 48 consecutive days that achieved 90 percent or greater reduction in mercury emissions. Mercury emission reductions were achieved using two carbons supplied by Norit Americas, the standard Darco Hg and the brominated Darco Hg-LH, at four different injection rates. Total boiler load ranged from 165 MWe to 250 MWe, and temperature varied

in the range 325 °F to 345 °F, with brief periods near 285 °F during low load operations. We Energies also is addressing balance of plant issues and performing parametric and optimization testing. The problem of hot glowing embers previously found in the baghouse hoppers was alleviated by reducing the temperature set point for the hopper heaters and by emptying the hoppers more frequently. A permanent rubber curtain was installed at the ash unloader silo to prevent fugitive dust emissions during ash handling operations. Optimization testing to determine the effect of bag cleaning cycles on mercury emission control is ongoing. Trona injection testing for multi-pollutant control is scheduled for July 2007. The TOXECON™ project has continued to successfully demonstrate, under full-scale power plant conditions, reliable mercury continuous emissions monitoring (CEM). (Marquette, MI)

Western Greenbrier Co-Generation, LLC – *Western Greenbrier Co-Production (WGC) Demonstration Project.* The preliminary process design is completed. WGC continues to work to finalize key project areas including the plant engineering/procurement/construction, and operations and maintenance contracts. Arrangements for sale of power to support a public tax-exempt bond sale to fund the project are in progress. The West Virginia Air Quality Board approved the WGC Air Permit in March 2007. Public comments on the Draft Environmental Impact Statement (EIS) have been received and are being addressed. A National Environmental Policy Act (NEPA) Record of Decision (ROD) is expected in Summer 2007. (Rainelle, WV)

Great River Energy (GRE) – *Lignite Fuel Enhancement.* In Budget Period 2, GRE continues to design a full-scale dryer system. GRE is constructing two full-scale dryers, which can supply 50 percent of the coal needed for a 546-MW unit. Since March 2006, GRE has operated the first coal dryer, and processed nearly 300,000 tons of lignite coal. Lignite moisture content was reduced from about 38 percent to 29.5 percent, and the partially dried coal was supplied to the 546-MW Unit 2 at the Coal Creek Station. GRE engineers have observed that by virtue of its design, the drying unit segregates a mercury-rich fraction of the feed coal. Designers forecast that at full scale, this design feature would facilitate pre-combustion removal of 15 to 20 percent of the mercury in the feed, considerably reducing the downstream mercury capture load. The dryer technology has already been shown to reduce sulfur dioxide and nitrogen oxide emissions. (Underwood, ND)

Pegasus Technologies – *Mercury Specie and Multi-Pollutant Control.* The cooperative agreement was signed in April 2006. Sensors and other neural-network data acquisition features are being installed. Pegasus has submitted a request for a 5-month no-cost extension of budget period 1 extending it from May to October 2007. The project is to demonstrate non-intrusive advanced sensors and neural network-based optimization and control technologies for enhanced mercury and multi-pollutant control on an 890-MW tangentially fired boiler at the project host site in Jewett, Texas. The Pegasus technology provides plant operators the ability to assess detailed plant operating parameters that affect mercury capture efficiency as well as overall heat rate, and particulate removal and flue gas desulfurization efficiencies. The technology, once demonstrated, should have broad application to existing coal fired boilers and improve quality of saleable by-products such as fly ash. Performance testing will begin in October 2008. (Jewett, TX)

Southern Company Services, Inc. – *Demonstration of a 285-MW Coal-Based Transport Gasifier.* The NEPA Record of Decision was signed and the front end engineering design has been completed. (Orlando, FL) ■

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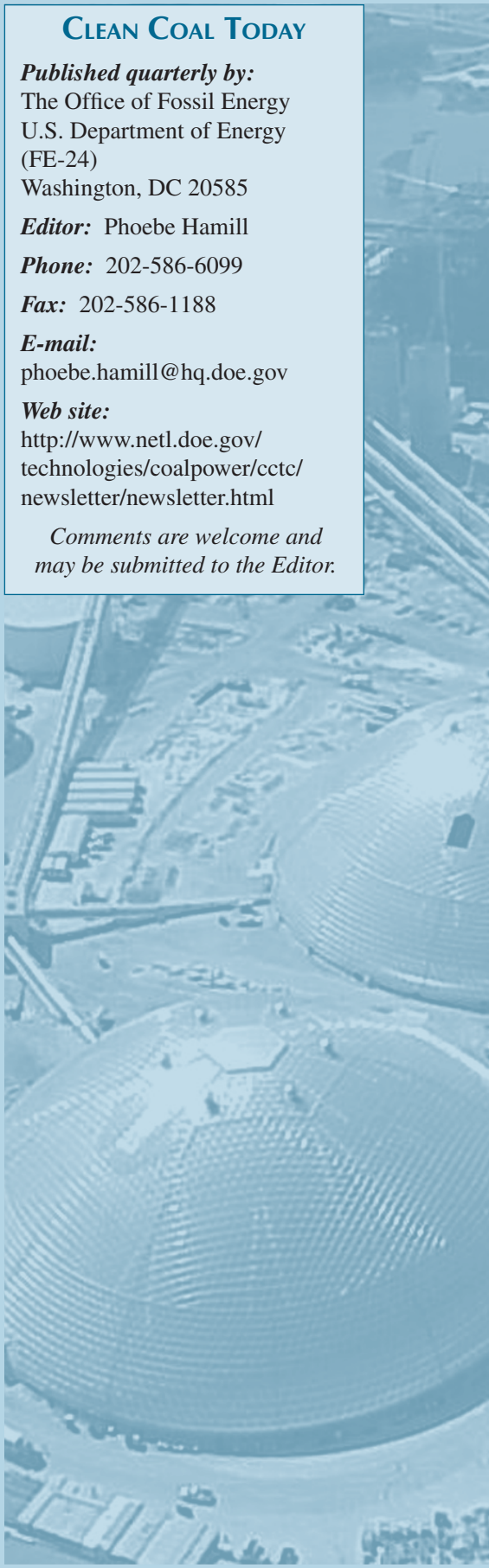

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