



A Report from EPRI's Generation Sector

October/November, 2009

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### DEAR EPRI GENERATION MEMBERS

As Bryan Hannegan wrote in the last newsletter, he has taken on an expanded role in coordinating our renewable efforts across EPRI, in addition to continuing his role as VP for the Environment Sector. I'd like to personally thank Bryan for all his efforts with the Generation Sector over the last two years. I know that he enjoyed this role and the organization has made significant strides forward due to his leadership. The good news is that he will still be working closely with us to ensure that the efforts in the areas of environment and renewable energy stay aligned and coordinated within EPRI.

While there are many challenges facing our industry today, I am impressed with the progress being made to solve them and the teamwork with EPRI. I am very pleased to be a part of this team and appreciate the opportunity to work with you on these challenges. Thank you for your continued support of EPRI and also of our team during this transition.

Sincerely,

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**CoalFleet for Tomorrow® – Future Coal Generation Options (Program 66)*****Global CCS Institute strategic analysis report on global status of carbon capture and storage (CCS) research and development (R&D).***

*Report summarizes notable R&D on CCS.*

In September, EPRI completed a report assessing the existing CCS R&D networks around the world as part of a strategic analysis project for the Global CCS Institute evaluating the global status of CCS. The report identifies organizations performing notable R&D in the area of CCS, summarizes the work with which they are involved, and identifies gaps in the current global R&D effort to deploy CCS technologies. The EPRI assessment supports the idea that the development of many CCS technologies must be accelerated if global commercial-scale deployment of CCS is to commence by the end of the next decade.

The EPRI report is one of four “foundation” reports prepared under the strategic analysis project executed by a WorleyParsons-led consortium that includes Schlumberger, Baker & McKenzie, and EPRI. The other three foundation reports cover: 1) a comprehensive survey of all CCS projects being undertaken globally; 2) a detailed analysis of the capture, transport, and storage costs for power plants and a select range of industrial applications; and 3) a detailed assessment of the status of policies supporting CCS development globally. All of the foundation reports were used to develop a synthesis report that includes a gaps and challenges assessment, risk analysis, and mitigation strategies as well as recommendations to the Global CCS Institute to help accelerate deployment of CCS technologies.

The foundation and synthesis reports are publicly available and can be downloaded from the Global CCS Institute website at [http://www.globalccsinstitute.com/general\\_information/reports\\_papers\\_documents.html](http://www.globalccsinstitute.com/general_information/reports_papers_documents.html).

For more information, contact Jose Marasigan ([jmarasigan@epri.com](mailto:jmarasigan@epri.com), 650-855-8739).

***Pilot oxy-combustion plant successfully demonstrated.***

*Test conducted at Clean Environment Development Facility.*

The success of a test program at a 30-MW oxy-combustion pulverized-coal pilot plant represents a significant step forward in the United States for the development of this CO<sub>2</sub> capture and storage (CCS) option. The test was conducted by Babcock & Wilcox (B&W) at the Clean Environment Development Facility (CEDF) in Alliance, Ohio. To ensure that the test program supported the utility industry expectation for commercial oxy-coal power plants, B&W and its industrial partner, Air Liquide, formed a utility advisory group, consisting of EPRI and 10 utilities. The test program and its results are described in an EPRI report entitled *Summary of Test Results from Babcock & Wilcox's 30-MW<sub>th</sub> Oxy-Coal Pilot Plant* (EPRI document #1017508).

The next step in advancing oxy-combustion technology is to develop a demonstration project. B&W already has announced that it intends to build a commercial-scale (100-MW net) oxy-combustion demonstration plant for Black Hills Corporation at a greenfield site in Campbell County, Wyoming. The plant is expected to be in service by 2015.

For more information, contact John Wheeldon ([jowheeld@epri.com](mailto:jowheeld@epri.com), 205-670-5857).

***Version 6 of Guidelines for Advanced Pulverized Coal Power Plants published.***

*New edition includes updates on CO<sub>2</sub> capture and oxy-combustion technologies.*

This report (1017511) was released in September. Changes/additions for Version 6 include: revision and expansion of the Design for Availability subsection, update of the CO<sub>2</sub> Capture subsection, update of the oxy-combustion subsection, and additional material on steam turbines and coal drying. Version 7 is scheduled to be released in June 2010. For more information, contact David Thimsen ([dthimsen@epri.com](mailto:dthimsen@epri.com), 651-766-8826).

***Integrated Gasification Combined Cycle (IGCC) Design Considerations for Carbon Dioxide (CO<sub>2</sub>) Capture published.***

*Two desk reference summaries of data also available.*

EPRI published this 1,200-page-report (1015690) containing detailed design, performance, and cost information on various IGCC plant designs. In an effort to make the results of that study more accessible, EPRI also published two 80-page desk references that summarize the cost, performance, and environmental data. These latter reports, both entitled *2009 Integrated Gasification Combined Cycle Engineering Economic Evaluation*, are available with summarized data in English units (1019367) and SI units (1019368). Aside from the difference in units, the reports are identical.

For more information, contact Ron Schoff ([rschoff@epri.com](mailto:rschoff@epri.com), 704-595-2554).

***Fall Gasification Users Association (GUA) meeting attendees tour Rentech Product Demonstration Unit.***

High attendance at the fall 2009 GUA meeting, held Oct. 7 in Colorado Springs, shows international interest in gasification remains strong. Three guests and 31 members representing 22 companies from eight countries heard an operations update from members currently operating five different IGCC plants, with a summary of availability statistics for each plant. Other members and guests also presented gasification projects in development in Alberta, Canada, Australia, Korea, and Japan.

The following day, several participants visited Rentech's Product Demonstration Unit in Commerce City, CO. Rentech has developed its own Fischer-Tropsch technology and is using the existing facility to produce clean-burning middle distillates such as diesel and jet fuel, as well as naphtha and specialty products. The primary goal of this test facility is to generate data for scaling up to a larger plant size. Plans for expansion at the facility include the addition of a ClearFuels biomass gasifier in 2010, where the planned feedstocks include wood chips and bagasse.

For more information, contact Jose Marasigan ([jmarasigan@epri.com](mailto:jmarasigan@epri.com), 650-855-8739).

***EPRI staff brings back new insights on status of oxy-fuel R&D.***

In early September, EPRI's David Thimsen and David Broske travelled to Cottbus, Germany to participate in the First Oxyfuel Combustion Conference put on by IEA. More than 275 participants from around the world spent four days reporting on the latest in oxy-combustion research, development, and demonstration.

While in Europe, Thimsen also made a number of visits to field sites including Doosan Babcock's 40-MWth oxy-PC Clean Combustion Test Facility in Renfrew, Scotland; Vattenfall's 30-MWth Oxy-PC pilot plant in Schwartze Pumpe, Germany; Vattenfall's Jänschwalde power station north of Cottbus, where a 250-MWe Oxy-PC boiler has been proposed; and the world's largest circulating-fluidized-bed (CFB) power plant (460 MWe) and the first supercritical CFB at PKE's Łagisza power station northeast of Katowice, Poland.

For more information, contact Thimsen ([dthimsen@epri.com](mailto:dthimsen@epri.com), 651-766-8826).

***Workshop on petcoke boilers held in Brazil.***

During the second week of August, CoalFleet for Tomorrow senior program managers John Wheeldon and David Thimsen and an EPRI consultant traveled to Rio de Janeiro and conducted a workshop on down-fired petcoke boilers for Petrobras' engineering staff at the Petrobras University. Petrobras is the largest energy producer in South America, including the manufacture and distribution of oil and gas, hydrogenation, and combined cycle plants.

For more information on the workshop, contact Thimsen ([dthimsen@epri.com](mailto:dthimsen@epri.com), 651-766-8826).

## **CO<sub>2</sub> Capture & Storage (Program 165)**

### ***1.7-MWe chilled ammonia pilot plant testing ends.***

*Most objectives achieved, and pilot plant provided important design data for next-generation and scaled-up designs.*

During the last two months of scheduled testing on this research pilot located at We Energies' Pleasant Prairie Power Plant, Alstom began to evaluate operation in a mode that fostered the precipitation of solids in the CO<sub>2</sub>-rich solvent stream, because these could be regenerated with less energy. However, continuing equipment problems prevented operation at desired conditions, and repairs would have required that the test program be extended beyond the hard shutdown date of Oct. 31. Therefore, Alstom shut down the pilot operation in mid-October.

For more information, contact Richard Rhudy ([rrhudy@epri.com](mailto:rrhudy@epri.com), 650-855-2421).

### ***Legal Rights and Liabilities of Underground CO<sub>2</sub> Storage published.***

*Report describes current legal landscape for entities injecting CO<sub>2</sub> for enhanced oil recovery (EOR) and options being considered for large-quantity CO<sub>2</sub> storage.*

Although CO<sub>2</sub> use for EOR is well established, the potential quantities that may need to be stored are more than fifty-fold greater than the amount used for EOR, and there is no obligation to demonstrate underground permanence of the injected CO<sub>2</sub>; therefore, the legal and liability issues are different.

This report (1017647) summarizes the legal framework under which CO<sub>2</sub> injection for EOR operates, as a background for understanding the possibilities being considered for CO<sub>2</sub> storage by both the federal and a number of state governments. The report includes a detailed description of the different nuances of injection rules defined by the states and Indian territories that have primacy for issuing permits compared to those that do not and instead operate under EPA's jurisdiction.

For more information, contact Brice Freeman ([bfreeman@epri.com](mailto:bfreeman@epri.com), 650-855-1050).

### ***EPRI supporting several post-combustion CO<sub>2</sub> capture proposals to DOE-NETL.***

*Highly leveraged way for industry to accelerate development of lower-cost/energy penalty post-combustion CO<sub>2</sub> capture processes, while also keeping EPRI's members better informed of cutting-edge technology.*

EPRI is providing letters of support to a number of CO<sub>2</sub> capture process developers who are submitting proposals to DOE-NETL (Department of Energy—National Energy Technology Laboratory) in response to its latest Funding Opportunity Announcement. EPRI agrees to provide these letters after a preliminary due diligence evaluation of the merits of the technology, and has identified several processes that show promise of being more than modest incremental improvements.

The DOE-NETL program, budgeted at \$55M, will provide up to \$3M/award for bench-scale work to improve novel technologies and demonstrate their readiness to be scaled-up, and up to \$15M/award for pilot-scale projects (≥ 0.5 MW equivalent flue gas flow) operating on a slip-stream of flue gas. The solicitation covers absorption, adsorption (slipstream tests only), and membrane separation.

For more information, contact Brice Freeman ([bfreeman@epri.com](mailto:bfreeman@epri.com), 650-855-1050).

### ***EPRI's CO<sub>2</sub> capture staff participates in several key meetings on CCS R&D.***

*Participation allows EPRI to help guide national R&D strategy on CO<sub>2</sub> capture and update/expand knowledge of R&D progress to share with members.*

- **DOE-NETL (National Energy Technology Laboratory) Carbon Capture 2020 Workshop** – Approximately 60 attendees attended the two-day event organized by DOE-NETL to solicit input on its future R&D plans. The workshop consisted of presentations on NETL's current research and breakout sessions in technology-specific areas — membranes, adsorption, absorption, etc. The objective of the breakouts was to provide input to DOE on research directions. In general, the participants agreed that additional capture chemistries, along with an expanded focus on modeling, would be fruitful. The agenda and presentations can be viewed at: <http://www.netl.doe.gov/publications/proceedings/09/cc2020/>.

- **ARPA-E Carbon Capture Workshop** – The Advanced Research Projects Agency – Energy (ARPA-E) is a new DOE agency charged to develop transformative, high-risk energy technologies. It is modeled after DARPA, an agency in the Department of Defense responsible for development of high-risk, high-reward technologies, primarily, but not exclusively, for use by the military. ARPA-E hosted a workshop Oct. 29 in Pittsburgh, where it sought help defining which CO<sub>2</sub> capture areas should be its focus, especially for future solicitations. Summaries and results from the workshop can be viewed at: <http://arpa-e.energy.gov/workshops/CC-Workshop.pdf>. Like the NETL workshop, the ARPA-E workshop was designed to provide open-ended feedback on membranes, adsorption, absorption, etc. The ARPA-E workshop also covered areas such as air capture, CO<sub>2</sub>-to-fuels, CO<sub>2</sub> conversion, etc., that generally are going to be more challenging and risky. ARPA-E expects to take results from this workshop as input for its upcoming solicitations, one in each of the first two quarters in 2010. ARPA-E recently issued 37 awards from its first solicitation, of which five were on CO<sub>2</sub> capture. See <http://arpa-e.energy.gov/projects/cc.html#Energy>.
- **MIT's 10th Carbon Sequestration Initiative Forum** – The theme for this year's conference was "Scaling-up CCS: Megatonnes to Gigatonnes." Presentation highlights included an early review of results from a third survey of public opinion on CCS. The survey team found that significantly more people are aware of CCS this year, but the public's interest in having the United States take a more active role to reduce CO<sub>2</sub> emissions waned, despite no change in willingness to pay for mitigation. Other presentations and discussions centered on the quality and quantity of structural traps within known injection formations, which some said is lower than earlier assessments indicated. This finding may drive injection primarily into "open" systems, and this is likely to mean that CO<sub>2</sub> injection managers will have to include a longer period of post-injection monitoring in their permits than initially envisioned.
- **Stanford University's Global Climate and Energy Project (GCEP)** – The 5th Energy Research Symposium highlighted work by GCEP, a 10-year, \$225 million research program managed by Stanford University and funded by a few large companies. One notable Stanford presentation described a strategy for increasing methane extraction from shales, thereby indirectly opening up a new, potentially large storage capacity for CO<sub>2</sub>. The concept relies on improved horizontal drilling and hydro-fracturing techniques to promote micro-seismic events that fracture shale structures, creating the permeable networks necessary for gas extraction. This concept, which opens up the opportunity for enhanced gas recovery (EGR) by CO<sub>2</sub> injection and the consequent storage of the injected CO<sub>2</sub> in the shale formation, is just beginning to be explored. Although laboratory studies have found that at least some shales can adsorb substantially more CO<sub>2</sub> than the gas (methane) that it replaces, many fundamental questions still remain. However, the potential for sizable gas production at reasonable prices and the large capacity of these formations for CO<sub>2</sub> after gas withdrawal suggest that more exploration and extraction will occur in shale formations. If successful, this concept will lead to new opportunities for CO<sub>2</sub> storage through EGR.

Details of these meetings are being published in a Program 165 newsletter (E230506). For more information on the DOE-NETL and ARPA-E meetings, contact Abhoyjit Bhowan ([abhown@epri.com](mailto:abhown@epri.com), 650-855-2383). For the MIT and Stanford meetings, contact Brice Freeman ([bfreeman@epri.com](mailto:bfreeman@epri.com), 650-855-1050).

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## OPERATIONS AND MAINTENANCE

### **I&C and Automation for Improved Plant Operations (Program 68)**

#### ***Fleet-Wide Monitoring Interest Group tours Entergy Center.***

EPRI's Fleet-Wide Monitoring Interest Group Meeting held Oct. 13 – 15 in The Woodlands, Texas was a huge success, attracting 85 participants. The meeting opened with two keynote speeches: "What has Fleetwide Monitoring Done for Entergy Fossil?" by Etienne Senac, Vice President of Operations for Entergy Fossil, and "Innovation" by Clinton Carter, Manager of Power Optimization Center for Luminant.

Members of the group toured the Entergy Performance Monitoring and Diagnostics Center, participated in a reception/vendor fair, chose from two parallel tracks of presentations, and discussed relevant topics in a roundtable format.

For more information, contact Aaron Hussey ([ahussey@epri.com](mailto:ahussey@epri.com), 704-595-2509).

## **Maintenance Management & Technology (Program 69)**

### ***Webcast held on electric motor maintenance strategies.***

In its second maintenance-focused webcast of the year, Program 69 teamed with CPS Energy as co-sponsors of a virtual roundtable discussion regarding electric motor maintenance strategies. Topics included the structure of various maintenance programs, roles and responsibilities of personnel, online/offline testing guidelines, qualification of off-site repair shops, and advantages/disadvantages of various Predictive Maintenance (PdM) and Non-destructive Examination (NDE) technologies. The previous webcast, co-sponsored by Hawaiian Electric Company (HECO), focused on critical spares management strategies.

For more information on either webcast, contact Brian Hollingshaus ([bhollingshaus@epri.com](mailto:bhollingshaus@epri.com), 704-595-2579).

## **Operations Management and Technology (Program 108)**

### ***Supplemental alarm management project shows promise.***

*Unit alarms reduced, documentation continues.*

The supplemental alarm management project under way at Gerald Gentleman Station is proceeding with good results. By resolving some of the “bad actor” alarms, the project has reduced unit alarms to fewer than 150 per day. The documentation and rationalization of all alarms continue and are about 50% complete. The plant staff feels comfortable that it will be able to complete the remainder of the alarms without EPRI support. Not only is this effort improving current operational performance, but it will support a DCS replacement scheduled for next year.

The field demonstration of high-performance human machine interface (HPHMI) graphics on the Gerald Gentleman Simulator has been completed, and the draft report of results written. Positive results were obtained using the HPHMI graphics. More demonstrations of these concepts could result in broader industry applications that have the potential to create significant improvement in operator performance.

For more information, contact Wayne Crawford ([wcrawford@epri.com](mailto:wcrawford@epri.com), 704-595-2727).

### ***Meetings with Abnormal Situation Management Consortium focus on collaboration.***

EPRI’s Wayne Crawford met with the Abnormal Situation Management (ASM) Consortium, and the consortium director met with Program 108 Advisors to seek better understanding of the work being done by the two organizations, and consider ways in which collaboration could be arranged between the two entities. Follow-up discussions are scheduled to explore a mutually successful working relationship. Both groups are addressing plant operations issues and have worked in some of the same areas in the recent past.

For more information, contact Crawford ([wcrawford@epri.com](mailto:wcrawford@epri.com), 704-595-2727).

## **MAJOR COMPONENT RELIABILITY**

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### ***Canadian regional workshop gives 10 companies in-depth look at EPRI’s MCR research.***

A two-day overview on current and past research from Program 63 (Boiler Life and Availability Improvement), Program 64 (Boiler and Turbine Steam and Cycle Chemistry), Program 65 (Steam Turbines, Generators and Balance-of-Plant), and Program 87 (Fossil Materials and Repair) was hosted by Ontario Power Generation in Toronto Sept. 29-30. The workshop brought together more than 70 participants from 10 organizations, including included power plant operators, chemists, engineers, and OEM staff.

The workshop covered the full spectrum of Major Component Reliability (MCR) programs, which provide data on critical material degradation mechanisms, conduct materials and chemistry-related R&D for advanced generation technologies, and quantify the benefits of chemistry improvements for fossil generating units. The collective MCR programs develop a technical basis and strategy to balance risks and costs of the largest, most costly equipment within the fossil power plant, and focus on integrating proven technologies into total solutions. There was particular interest among attendees about managing the impacts of increased cycling operation, as well as information about lay-up and preservation of fossil power units.

For more information, contact Alan Grunsky ([agrunsky@epri.com](mailto:agrunsky@epri.com), 704-595-2556).

## **Boiler Life and Availability Improvement (Program 63)**

### ***Protocol for conducting field trials of ceramic coatings on waterwall tubes.***

*Guidance provided on locations of test panels, instrumentation, and procedures.*

An EPRI report, *Benefit of Waterwall Tube Ceramic Coatings on Prevention of Slagging and Circumferential Cracking* (1018989), describes a protocol for conducting field trials of ceramic coatings for waterwall tubes. The protocol includes guidance on choosing locations for test panels, the choice of diagnostic instrumentation, procedures for collecting and analyzing data, and using the results to quantify the benefits of coatings.

Ceramic coatings might ameliorate or even prevent furnace wall slagging in certain regions of the wall and for specific boiler designs, coal types, and burner and combustion air delivery systems. However, detailed, quantitative measurements are needed in order to determine the effectiveness of ceramic coatings in preventing or ameliorating lower and upper furnace zone slagging and to understand the design and operating characteristics that benefit the most from ceramic coatings. Operators and personnel of coal-fired power plants can use this information to conduct field trials to determine the benefits of ceramic coatings in preventing slagging and circumferential cracking in specific circumstances.

For more information, contact Kent Coleman ([kcoleman@epri.com](mailto:kcoleman@epri.com), 704-595-2082) or Bill Carson ([bcarson@epri.com](mailto:bcarson@epri.com), 704-595-2204).

## **Fossil Materials and Repair (Program 87)**

### ***Issues with cyclic operation of power plants lead to ASTM standard.***

*Test standard developed for creep-fatigue testing.*

For some years, EPRI has taken a proactive approach to issues arising from cyclic operation of power plants, and in 2006, EPRI established an international experts group on creep-fatigue interaction. Under EPRI leadership, this group drafted a road map covering all relevant aspects of cycling plants, including materials for components, testing and characterization, analyses and assessment, data banks, and in-service component assessment. The creep-fatigue interaction project was initiated as a Technology Innovation (TI) project and moved to Program 87 in 2009.

It was noted that there was no testing standard for reliable data determination for design and assessment of in-service components. ASTM was approached to set up a sub-group in ASTM E08. In May 2008, a sub-group was formed, led by Bilal Dogan of EPRI and Ashok Saxena of the University of Arkansas. Within 18 months, the sub-group had produced a draft ASTM Test Standard for Creep-Fatigue Testing, which was balloted three times and finally endorsed by ASTM as Standard E2714-09 in November 2009. The new standard was announced at the ASTM meeting in Atlanta on November 9-11, 2009 and recognized as the ASTM standard produced in the shortest time.

Dogan is also leading international round robin testing on materials P91, P92, and Alloy 617, which will be carried out following the new standard and will provide information on bias to be included in the new test standard for crack formation. The EPRI-led group is also working on another ASTM Test Standard on Creep-Fatigue Crack Growth, which will be balloted in December 2009.

For more information, contact Bilal Dogan ([bdogan@epri.com](mailto:bdogan@epri.com), 704-595 2650).

### ***Webcast discusses exfoliation of oxide scales in boiler tubes.***

More than 25 organizations attended an Oct. 13 two-hour webcast on exfoliation of oxide scales from the steam-touched surfaces of superheater and reheater tubes. This phenomenon results in short-term overheating boiler tube failures (BTF) and solid particle erosion of the inlet stages of the steam turbine and valve surfaces. A number of recent BTFs have been attributed to exfoliation of steam-grown oxides in newly installed stainless steel superheaters.

The webcast discussed the results of a recent industry survey conducted by EPRI to gain a better understanding of the breadth and scope of the issue of exfoliation. Some of the key findings included 50% of the failures occurred in less than two years of component operation; stainless steels had a majority of the failures; and there is no clear trend with operation conditions, including failures in both supercritical and subcritical boilers.

Also discussed was EPRI's development of a 'first-of-a-kind' model to predict and control steam-side oxidation and exfoliation. The model, which incorporates the current state-of-knowledge of oxide growth and exfoliation, has gone through testing, and a number of baseline cases were conducted for prototypical superheaters in subcritical and supercritical boilers. The results will be made available in an upcoming technical update, entitled *Development of an Integrated Model to Predict and Control Oxide Scale Exfoliation* (1017625).

Finally, the webcast reviewed recent field failures that were metallurgically examined and evaluated against the model. For both the 347H and 304H failures examined, the model predicted the strain energy in the oxides was sufficient to cause exfoliation during the timeframe observed in the field.

For more information, contact John Shingledecker ([jshingledecker@epri.com](mailto:jshingledecker@epri.com), 704-595-2120).

## ENVIRONMENTAL CONTROLS

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### **Combustion Performance and NOx Control (Program 71)**

#### ***Tunable diode laser to be demonstrated for combustion optimization.***

*System may offer performance improvement and emission reduction.*

A demonstration of the ZoloBoss tunable diode laser (TDL)-based combustion optimization system was initiated with EON at the utility's Cane Run Station. This demonstration will be of high value to the EPRI membership in assessing performance improvement and emission reduction using TDL measurements in a combustion optimization feedback control loop.

For more information, contact Rick Himes ([rhimes@epri.com](mailto:rhimes@epri.com), 949-766-8470).

#### ***Corrosion predictor tool enhanced to include higher temperatures.***

*Tool provides first-order estimate of impact of wastage.*

A recent EPRI study investigated the impact of sulfur- and chloride-derived corrosion on waterwall tubes at higher temperatures than previously studied. The results were incorporated in EPRI's simplified corrosion predictor (SCP), which provides a first-order estimate of the impact of wastage for a particular coal. The study and its findings are described in the EPRI report *Program on Technology Innovation: Influence of Coal Properties on Fireside Wastage (Enhancement and Application of Predictive Tools)* (1016163).

The SCP tool uses a thermo-chemical equilibrium software program to calculate the composition of flue gases, including major corrosive species (H<sub>2</sub>S, HCl) and tube deposits (alkyl chlorides, FeS) under furnace conditions. Future improvements to the SCP tool may address continued validation of predictive models, improved coal blending assumptions, integration of the SCP with other predictive tools, and expansion of the SCP to include prediction of circumferential cracking as a function of fuel impacts.

For more information, contact Jose Sanchez ([josanche@epri.com](mailto:josanche@epri.com), 650-855-2580).

#### ***Webcast held on circumferential cracking demonstration project.***

A funders webcast was conducted on Oct. for the participating organizations of the PPL Brunner Island circumferential cracking demonstration project. Participants included PPL, Southern Company, TVA, APS, First Energy, Tarong, RRI, and CS Energy. Project results included the impacts of sootblowing, low-NOx operation, load following, maximum load, and other key parameters affecting boiler tube absolute and differential temperatures, both of which are prime factors in accelerated circumferential cracking occurrences.

For more information, contact Tony Facchiano ([afacchia@epri.com](mailto:afacchia@epri.com), 650-855-2494).

## **Post-Combustion NO<sub>x</sub> Control (Program 73)**

### ***SCR 101 primer/refresher brings big turnout.***

The first “SCR 101” webcasts were held in two 90-minute segments on Sept. 22 and 24. Designed for Program 73 member organization staff members relatively new to SCR technology or desiring a refresher course on the basics of SCR operations and issues, the webcast was very well attended with approximately 80 participants.

For more information, contact Dave Broske ([dbroske@epri.com](mailto:dbroske@epri.com), 704-595-2741).

## **Integrated Environmental Controls (Hg, SO<sub>2</sub>, NO<sub>x</sub> and Particulate) (Program 75)**

### ***Trace species leaching from mercury control process ash very low.***

*Amounts attributable to use of activated carbon for mercury control probably negligible, but needs to be confirmed via additional tests.*

Sorbent injection is a widely tested technology for mercury removal from the flue gas of coal-fired power plants. Recently, some people have raised concerns as to whether the presence of sorbent in fly ash alters the leachability of trace toxic species (As, Se, Hg, Cd, Cr, Pb, and Ni) from the ash. In this joint Program 75/Program 78 project, EPRI conducted a preliminary literature search to gather ash leachate data from various full-scale mercury control test programs.

The data obtained to date show small increases in leaching for all trace species except cadmium from ash samples collected during mercury control, but only two samples had a species (selenium) that exceeded its TCLP (toxicity characteristic leaching procedure) limits. Because the trace species leached are of such low concentrations, the amounts due to implementation of mercury controls may not be significant. More ash-leaching data—with a variety of coal types, plant configurations, and sorbent types—are needed to understand whether these increases are real and significant. A technical update (1018543) will be issued in December 2009.

For more information, contact Ramsay Chang ([rchang@epri.com](mailto:rchang@epri.com), 650-855-2535).

## **Particulate & Opacity Control (Program 76)**

### ***Utility baghouse survey obtains performance and operations data on recent installations.***

*Collection efficiencies, cleaning frequencies, and pressure drops were promising.*

EPRI completed a survey of nine recently installed pulse-jet baghouses on electricity generation boilers. The units had been in service for a relatively short period of time (1 to 3 years). Baghouses were selected that would represent a broad cross-section of the industry, covering baghouse configuration, vendor, coal type, and other key parameters. In general, baghouse performance has been excellent at most of the sites, although some early problems with bag-cleaning effectiveness were encountered.

Problems included malfunctioning pulsing systems, defective cages, low ash loading, and fine ash distribution (especially in TOXECON™ applications). The air-to-cloth ratios for the baghouses included in this survey ranged from 4.0 to 5.5 ft/min for the TOXECON™ applications, and 3.4 to 4.0 ft/min for the full ash burden baghouses. Information was also obtained on baghouse pressure drop and cleaning frequencies for both TOXECON™ and full-ash burden baghouses. Stack opacities were generally <5%. Long-term bag life is uncertain because most of the units have been in operation for < 3 years. A technical update report (1017570) will be issued in December 2009.

For more information, contact Ramsay Chang ([rchang@epri.com](mailto:rchang@epri.com), 650-855-2535).

## **Continuous Emissions Monitoring (Program 77)**

### ***Sorbent traps for mercury measurements unaffected by SO<sub>3</sub> in flue gas.***

*Laboratory tests using simulated flue gas with 20 ppm SO<sub>3</sub> on three widely used sorbent trap materials showed no effect on mercury absorption or desorption.*

Observed interference by SO<sub>3</sub> in full-scale tests of activated carbon injection raised concern that it would also interfere with carbon used by Method 30B (sorbent trap method) for determining mercury (Hg) compliance. Two separate tests were conducted with commercially available sorbents widely used in Method 30B. The first investigated any interference that could occur in adsorbing the Hg onto the sorbent tube. The results showed good absorption performance, with no breakthrough to the second bed and no Hg detected in a set of final impingers added specifically for this evaluation.

A similar test was conducted to determine if SO<sub>3</sub> could cause desorption of the Hg from the final spike bed that is required by Method 30B. Breakthrough and spike desorption are two key quality control requirements of the method, and failure of either one causes a "loss of data" according to EPA procedures. These tests showed no noticeable desorption of the collected mercury upon exposure to gas containing SO<sub>3</sub>.

For more information, contact Chuck Dene ([cdene@epri.com](mailto:cdene@epri.com), 650-855-2425).

## **Coal Combustion Product Use (Program 78)**

### ***Study finds mercury inhalation from CCPs not a public risk.***

*Mercury exposure estimated for indoor and outdoor scenarios.*

Results of a recent EPRI study indicate that coal combustion products (CCPs) used in common indoor and outdoor settings are unlikely to result in mercury exposures that pose a health concern. The study evaluated the potential health risks associated with inhalation of mercury from building products, such as concrete and wallboard, as well as outdoor construction and disposal applications. The results are published in a report entitled *Evaluation of Potential Human Health Inhalation Risks from Mercury in Building and Construction Materials Containing Coal Combustion Products* (1019016).

To estimate mercury exposure for each indoor and outdoor scenario, the researchers selected modeling parameters and individual exposure factors intended to represent high-end exposure, as well as inputs intended to reflect more typical conditions. In accordance with U.S. EPA guidance, modeled mercury air concentrations were used to calculate potential inhalation risks from beneficial uses of CCPs. Following U.S. EPA guidance, an exposure is not expected to pose a health risk if the hazard quotient is less than or equal to 1. Results of the risk assessment demonstrated that potential mercury exposures under all scenarios pose negligible risk; all calculated hazard quotients were at least two orders of magnitude below 1.

For more information contact Ken Ladwig ([keladwig@epri.com](mailto:keladwig@epri.com), 262-754-2744).

### ***EPRI briefs federal agencies and Capitol Hill staff on coal combustion product (CCP) research.***

*Briefings provided to inform EPA rulemaking on hazard designation of CCPs.*

On Oct. 15, EPA submitted its draft proposal for new regulations to manage CCPs to the Office of Management & Budget (OMB) for interagency review. Although the proposal is not yet public, it is believed to designate CCPs destined for disposal as hazardous waste, and exempt certain encapsulated uses such as fly ash in concrete and FGD gypsum in wallboard. It is also believed that the proposal includes provisions for phase-out of wet management practices. EPRI has completed a series of studies aimed at providing technical information to help inform this rulemaking. The selection of these studies was guided by an industry advisory group, which chose projects that compared the characteristics of CCPs (constituents, leaching, risk, etc.) to other materials not designated as hazardous, quantified the environmental benefits that would be lost if CCPs were no longer used for beneficial purposes, and assessed the impact on grid reliability if CCPs had to be handled as hazardous, thereby forcing power companies to shut down certain plants.

Beginning Oct. 16, John Novak and Ken Ladwig held briefings for key stakeholders in Washington, DC, regarding EPRI's recent research on CCPs. Briefings were provided to OMB, the Department of Energy (DOE), and EPA, as well as minority and majority staff for the Senate Environment and Public Works Committee and the House Energy and Commerce Committee. The briefings were well received, with staff asking many questions and asking for follow-on information.

For more information contact Ken Ladwig ([keladwig@epri.com](mailto:keladwig@epri.com), 262-754-2744).

## COMBUSTION TURBINES

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### Combustion Turbine and Combined Cycle O&M (Program 79)

*Project focuses on gas turbine catalyst remaining life.*

*Goal to avoid forced outages due to catalyst replacement.*

Many combined-cycle power plants constructed during the 'gas turbine boom years' of 1999 to 2002 are fast approaching the end of selective catalytic reduction (SCR) and carbon monoxide (CO) catalyst life. There are two important reasons to monitor catalyst life. First, the catalyst does not age linearly. Near the end of catalyst life, ammonia slip and CO increase exponentially as the catalysts deactivate. Second, there is a 6-to-12-month lead time on catalyst replacement.

EPRI has structured a collaborative project focusing on gas turbine SCR and CO catalyst systems. The goal of the project is to provide the participants with a standardized basis to track SCR and CO catalyst performance and remaining life to avoid an unexpected forced outage due to catalyst replacement. The project includes:

- **Catalyst Testing:** The catalysts will be tested annually, semi-annually, or bi-annually depending on the site operating schedules. A report will be prepared of estimated catalyst remaining life based on laboratory catalyst activity testing.
- **Catalyst Inspection and Tuning Guidelines:** Catalyst inspection and ammonia grid tuning guidelines will be developed.
- **Catalyst Cleaning and Rejuvenation Guidelines:** Methods for catalyst cleaning and rejuvenation will be assessed and guidelines developed.
- **Catalyst Procurement Guidelines:** New and retrofit, SCR and CO catalyst procurement guidelines will be developed.

For more information, contact Lenny Angello ([langello@epri.com](mailto:langello@epri.com), 650-855-7939).

### Heat Recovery Steam Generator Dependability (Program 88)

*Optimizing HRSG startup and shutdown.*

*Report provides seven-step roadmap approach to developing procedures.*

A recent EPRI report describes a method for developing or ensuring startup and shutdown procedures for heat recovery steam generators (HRSGs) that minimize damage to pressure parts from transiently high thermal-mechanical stresses. The report, *Optimization of Heat Recovery Steam Generator Startup and Shutdown in F-Class Units: Avoidance of Cracking in Thick-Section Pressure Parts* (1015464), provides a quantitative seven-step roadmap approach to developing operating procedures for coordinated unit startup and shutdown from various initial temperature and pressure conditions.

If used effectively, the methods presented in this report will generate startup and shutdown procedures that comply with the operation requirements and limits specified by combustion turbine and steam turbine manufacturers while simultaneously limiting thermal fatigue damage accumulation rates in critical HRSG pressure parts. The report also includes case studies that demonstrate how existing startup and shutdown procedures can be analyzed to quantify the thermal-mechanical damage that they impose on critical HRSG pressure parts.

For more information, contact Bill Carson ([bcarson@epri.com](mailto:bcarson@epri.com), 704-595-2204).

## **Renewable Generation (Program 84)**

### ***EPRI, Tri-State G&T, and NV Energy to demonstrate solar thermal hybrid power plants.***

*Demonstration projects follow first-of-its-kind feasibility study.*

EPRI has announced two new Industry Technology Demonstration projects to explore potential for adding solar energy to fossil-fueled power plants in order to offset fuel requirements while reducing emissions. Both projects involve adding steam generated by a solar thermal field to a conventional fossil fuel-powered steam cycle to help generate electricity, creating a solar “hybrid” plant. Tri-State Generation and Transmission Association, Inc., will host one demonstration at its coal-fired 245-megawatt (MW) Escalante Generating Station in Prewitt, NM. NV Energy will host the other demonstration at its natural gas-powered 1,102-MW Chuck Lenzie Generating Station near Las Vegas.

Solar thermal hybrid applications have the potential to be an important, low-cost option for adding solar power to the generation fleet, allowing utilities to meet renewable energy regulatory targets, reduce plant emissions, and lower fuel costs. The hybrid system will inject solar-generated steam into the steam cycle of the fossil plants, resulting in fewer emissions and a lower reliance on fossil fuels. This approach solves the intermittency challenge of integrating solar power onto the grid without compromising the reliability of supply.

Announcement of the demonstration projects follows completion earlier this year of a first-of-its-kind feasibility study to comprehensively evaluate several solar technologies and integration options for a broad array of fossil technologies across a range of locations. Project participants included Tri-State G&T, NV Energy, Dynegy, Inc., Progress Energy, Salt River Project, and Southern Company. The study consisted of a broad conceptual design analysis and two detailed plant case studies—one for NV Energy and one for Dynegy.

The results were published in a conceptual design report and two detailed case study reports. The reports are: *Solar Augmented Steam Cycles for Natural Gas Plants: Conceptual Design Study* (1018645), *Solar Augmented Steam Cycles for Natural Gas Plants: Griffith Energy Facility Development Guideline Manual* (1018646), *Solar Augmented Steam Cycles for Natural Gas Plants: Chuck Lenzie Generating Station Development Guideline Manual* (1018647). The three reports are also available together as EPRI report 1019289.

For more information, contact Cara Libby ([clibby@epri.com](mailto:clibby@epri.com), 650-855-2382).

### ***Low-cost condition-monitoring systems for wind turbines to be evaluated.***

*Study assesses oil-particle-counting system.*

A recent EPRI report describes the deployment and field assessment of a relatively low-cost condition-monitoring system for wind turbines. The results, published in *Field Assessment of Wind Turbine Condition Monitoring Technology, Phase 1: Lubricating Oil Condition Monitoring* (1019567), describe the benefits, limitations, and lessons learned associated with installation and data collection from an oil-particle-counting system for evaluating the condition of wind turbine gearboxes.

Previous EPRI work has made a strong case for deploying lower-cost condition-monitoring systems on today’s megawatt-scale wind turbines to reduce and eliminate costly unplanned outages due to gearbox, generator, and other major component failures. The present work is the first phase of a multiphase research project to assess the performance of such systems under real operating conditions. Researchers collected and examined one year of data from three Vestas V47 wind turbines at the Tennessee Valley Authority’s Buffalo Mountain wind energy project. The condition-monitoring system in this study is pertinent to oil-wear-particle-counting systems used in the main gearboxes of wind turbines. Other studies will focus on other aspects of wind turbine condition monitoring.

For more information, contact Luis Cerezo ([lcerezo@epri.com](mailto:lcerezo@epri.com), 704-595-2190).

## **Understanding Power and Fuel Markets and Generation Response (Program 67)**

### ***Report explores outlook for U.S. natural gas market.***

*Market has gone from under-supply to excess supply in one year.*

A major new EPRI report analyzes the factors shaping the U.S. natural gas market over the next five years. The report, *Power Industry Development Paths and Natural Gas Market Risks: Cycles of Markets, Drilling, and Demand* (1017516), notes the almost unprecedented transition in the U.S. gas industry in a little over a year from a tightly balanced market to one with excess supply.

The report examines the recent history and intermediate-term outlook for the three components of the U.S. supply portfolio: namely, domestic production, liquefied natural gas (LNG) imports, and Canadian imports. Also, included in the report are an assessment of the intermediate-term outlook for natural gas demand, and an analysis of the intermediate-term outlook for the supply and demand balance for the U.S. natural gas industry.

For more information, contact Jeremy Platt ([jplatt@epri.com](mailto:jplatt@epri.com), 650-855-2179).

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## **OUTREACH ACTIVITIES**

### **Legislative**

#### ***Coal Utilization Research Council (CURC).***

On Oct. 15, John Novak, EPRI Executive Director, Federal and Industry Activities, Environment and Generation, gave a presentation at the CURC General Membership Meeting covering the 2009 update to Prism/MERGE, EPRI CO<sub>2</sub> capture and storage (CCS) activities, and the analysis of incentives for CO<sub>2</sub> capture and storage.

#### ***Coal Utilization Research Council (CURC) General Membership Meeting.***

On Oct. 15, EPRI Senior Project Manager Ron Schoff and Novak participated in the CURC General Membership meeting held on Capitol Hill. John Novak gave a slide presentation to provide an update on EPRI CCS activities.

#### ***U.S. Department of Energy (DOE) Office of Fossil Energy.***

On Oct. 16, EPRI staff met with Vic Der, Principal Deputy Assistant Secretary, Office of Fossil Energy. Novak attended the meeting and EPRI's Stu Dalton, Jeff Phillips, George Offen and Jack Parkes participated by phone. The purpose of the meeting was to provide an update on the EPRI Industry Technology Demonstration projects, to discuss the status of DOE CCS activities, and to explore areas of future collaboration.

#### ***White House Office of Management and Budget (OMB).***

On Oct. 16, Ken Ladwig, EPRI Senior Research Manager, and Novak met with staff from the Office of Management & Budget (OMB) Office of Information and Regulatory Affairs, the White House Council on Environmental Quality, and EPA on coal combustion products (CCPs). Ladwig presented slides describing recent EPRI research on sustainable management of CCPs. The meeting took place under Executive Order 12866 which governs meetings with the OMB when a proposed regulation is under interagency review (EPA submitted proposed regulations for coal combustion products to OMB on Oct. 16.) Under Executive Order 12866 meetings with OMB are posted in the OMB calendar, the lead agency (EPA) is invited, and any materials, such as slides, provided during the meeting will be posted on the OMB website.

### ***Global CCS Institute(GCCSI).***

On Oct.19, Novak participated in a GCCSI workshop on CCS capture-ready in Washington, DC.

### ***Atlantic Council of the United States.***

On Oct. 26, Novak participated in an Atlantic Council workshop, “Perspectives on a Realistic United States Electric Power Generation Portfolio: 2010 to 2050.” He gave a presentation on the 2009 update of Prism/MERGE.

### ***U.S. Chamber of Commerce.***

On Nov. 13, EPRI VP of Environment and Renewables Bryan Hannegan gave a presentation on CO<sub>2</sub> capture retrofits to the chamber’s Emerging Technologies Committee.

## **Technology Transfer**

Several EPRI members have shared their successes in applying EPRI research results in recently published Success Stories. To read any of the stories below, visit [www.epri.com](http://www.epri.com) and search for the document number shown. If you have an application success and want to share that with your colleagues, please contact Susan Rodgers ([srodgers@epri.com](mailto:srodgers@epri.com), 704-595-2572).

### ***Southern Company Evaluates Novel, Cost-Effective Mercury Control Technologies (1020183).***

Southern Company is seeking cost-effective technologies capable of achieving high mercury removal levels in the different plant configurations and for the different coals used in its system. Southern Company and EPRI have conducted joint demonstrations of three alternate mercury control methods that show promise for addressing these issues. These demonstrations results provide Southern Company, an Atlanta-based regional energy company with more than 42,000 megawatts of generating capacity, with cost-effective options for mercury control.

### ***We Energies Evaluates Mercury Control in Plant Demonstration (1019599).***

We Energies, like other operators of coal-fired power plants in the U.S., is seeking the most cost-effective mercury control options for its power plants. The test program at Presque Isle demonstrated TOXECON’s capability to capture 90+% of the mercury in the flue gas over the long term. This demonstration, along with tests at other sites, presents the first-full-scale, long-term demonstration of mercury-specific control technology for the utility industry.

### ***PNM Sponsors Feasibility Study of Solar Central Power (1019620).***

Located in an area with a world-class solar resource, PNM sought to explore the potential for development of a solar project. All solar technologies were of interest, including solar thermal technologies, such as central receiver and parabolic trough, as well as photovoltaic technologies such as crystalline and thin-film. PNM conducted a feasibility study that develops detailed information on potential sites, technology options, economic factors, regulatory considerations, and environmental impacts. In this case, EPRI was engaged with PNM as the lead sponsor to conduct a study that would evaluate the potential for a 50- to 500-MW concentrated solar plant to be built in New Mexico.

### ***NV Energy Evaluates Application of Solar-Augmented Steam Cycles for Natural Gas Plants (1020281).***

Utilities with fossil-fueled power plants need to find ways to offset fuel costs, reduce plant emissions, anticipate and address regulatory pressures, meet state renewable portfolio standards, develop a diverse generation portfolio, and demonstrate corporate leadership in environmental stewardship. One attractive option for addressing these challenges could be solar-augmented steam cycles for natural gas plants. To better understand the potential of solar augmentation in its system, NV Energy hosted a plant case study as part of an EPRI collaborative project that evaluated the technical and economic viability of solar augmentation options for several steam cycle plant designs.

## In The News

EPRI and its members made headlines in a number of media outlets in October and November, including:

### October.

**Oct. 1** – Art Altman of the Generation Planning (Program 178) staff was interviewed by Stella Farrington, editor of *Energy Risk* magazine, about his risk management research. The result was a subsequent interview with one of the magazine's writers for a December issue article and a request for an article from EPRI's Generation News Service for the January 2010 issue.

**Oct. 7** – A *Bloomberg* article on natural gas cited EPRI research that found electricity plants coming on line in 2015, wind energy would cost almost one-third more than coal and about 14 percent more than natural gas.

**Oct. 7** – *Solar Industry News* ran an article about EPRI VP Bryan Hannegan's expanded role in renewable energy effort focusing on improving the cost and performance of current and emerging renewable generation technologies.

**Oct. 8** – EPRI, Alstom and We Energies held a press conference on the promising results of the Pleasant Prairie chilled ammonia carbon capture pilot project. Senior Vice President Hank Courtright represented EPRI as he, We Energies CEO Gale Klappa and Alstom U.S. President Pierre Gauthier presented at two press conferences – one for a touring group from the Society of Environmental Journalists, and another for national, regional and local media. The result of the press conferences, a joint Alstom-EPRI report, and a press release was more than two dozen stories in media including Reuters, *Reliable Plant Magazine*, *Interactive Investor*, *Triangle Business Journal*, *the Sun-Herald*, *Earth Times*, *E&E News*, *Power Magazine*, *the Milwaukee Journal-Sentinel*, *Milwaukee Business Journal*, *Energy Daily*, Wisconsin Public Radio, and Greentech Media. Courtright also was interviewed about the project on CleanSkies TV.

**Oct. 12** – EPRI's involvement with the We Energies chilled-ammonia carbon capture project and AEP's Mountaineer capture and storage demo was mentioned in an article in the *Huffington Post* about the future of coal as an electricity generation fuel in the United States.

### November.

**Nov. 2** – CoalFleet Manager Jeff Phillips was quoted extensively in a lengthy *Climate Change Business Journal* article about climate change legislation and EPRI's CCS research.

**Nov. 3** – An article in *InTech* magazine, co-authored by EPRI Project Manager Aaron Hussey, highlighted EPRI's research on low-cost wireless sensors test performance and battery life.

**Nov. 6** – Senior VP Hank Courtright was quoted and EPRI's work cited in *Scientific American* on the AEP's Mountaineer carbon capture and storage project in New Haven, WV, and the lessons derived from the carbon capture project at Wisconsin Energy's Pleasant Prairie plant.

**Nov. 10** – The *Financial Times* published a report that EPRI was involved in a partnership under the auspices of E.ON UK to validate carbon capture and storage technology at a proposed 1,600-megawatt Kingsnorth supercritical coal plant.

**Nov. 13** – EPRI Project Manager Cara Libby was interviewed by ClimateWire for a story on the water demands of solar thermal systems.

**Nov. 13** – Libby was quoted in an article in *CSP Today* about why utilities are interested in concentrated solar power but are not yet willing to spend money to build CSP facilities.

**Nov. 13** – *The New York Times* ran an article that compared the cost of solar with that of coal; the reported cited studies by EPRI that found solar thermal technologies are far more expensive than coal, and photovoltaic rooftop solar panels, in turn, produce more expensive electricity than solar thermal.

**Nov. 18** – EPRI VP Bryan Hannegan is quoted about demand for natural gas for power generation in an article in *Energy & Environment*.

**Nov. 18** – Hannegan was quoted in the *National Journal* about the use of natural gas to augment the intermittency of wind generation, saying that the long-term prospects for gas as a backup fuel is contingent on policy decisions.

For more information, contact Jeff Brehm ([jbrehm@epri.com](mailto:jbrehm@epri.com), 704-595-2021).

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