

EXPERT GROUP ON CLEAN FOSSIL ENERGY (EGCFE) PROGRESS REPORT TO THE 49th MEETING OF THE APEC ENERGY WORKING GROUP (EWG 49)

A summary of administrative and project activities undertaken by the EGCFE since the EWG48th Meeting is provided by the EGCFE Chair, Mr. Scott Smouse (USA).

ADMINISTRATIVE

The EGCFE's web site <www.egcfe.ewg.apec.org> is maintained by USDOE's National Energy Technology Laboratory. A major review of the website is underway with the aim to revamp the site in early 2015.

EGCFE Secretariat

Ms. Toshiko Fujita of JCOAL-JAPAC is the EGCFE Secretariat.

Support Contractor

Technical support to the EGCFE Chair is provided by Dr. Ian Torrens (USA) through a USDOE site-support contract, for preparation of APEC project concept notes, full project proposals, project monitoring and completion reports, EGCFE progress reports to the EWG, development of technical programs for EGCFE seminars and workshops, and other ad hoc tasks related to EGCFE and EWG activities as required.

Planning Activities

EGCFE business meetings are typically held in conjunction with the annual Clean Fossil Energy Technology and Policy Seminar. The last meeting was held on 21 February 2012 in Gold Coast, Australia. However, owing to travel limitations by the U.S. EGCFE Chair, the annual EGCFE seminar and associated business meeting were not held in 2013 and 2014. A meeting had been scheduled in May 2013, which was postponed after cancellation of the annual EGCFE Technical and Policy Seminar owing to the U.S. government budget situation. The next business/planning meeting will be held in conjunction with the next annual Seminar, which is being planned for early 2015 in Malaysia.

Scott, please update the above ADMINISTRATIVE info. By the way, I notice that the EGCFE website list of publications and events is substantially out of date. Several of the project final reports mentioned below are not posted there for downloading.

PROJECT STATUS

(1) APEC Initiative for Deploying Advanced Clean Coal Technologies (CCT Deployment Initiative): Phase 1 (EWG 02/2013A)

With growing concern about the environmental impacts from rapidly expanding coal-fired power generation, including local and regional pollution and climate change, there is a strong need to ensure that new generating plants incorporate the best and most advanced clean coal technologies to maximize generating efficiency and to minimize environmental emissions.

This project builds on a multi-year Expert Group on Clean Fossil Energy (EGCFE) program aimed at both new and existing coal-fired power generation. The overall objective of the program is to accelerate the uptake of clean coal technologies (CCT) for new plants, particularly in developing APEC economies where coal use is on a rapid growth path; and to improve the performance of existing plants, including reduced emissions, through power plant upgrading and refurbishment and better environmental monitoring.

The specific objectives of the Fukui CCT Deployment Initiative were to:

- Assess plans for new coal-based energy facilities in several developing APEC economies,
- Identify and assess technical, economic and institutional challenges limiting near-term adoption of clean and efficient coal technologies in each economy, and
- Highlight government policies and incentives needed to support acceleration of CCT deployment in each economy, to disseminate best practices for application of CCTs to new and existing power plants, to recommend capacity building measures in this area in the selected economies, and to identify APEC efforts needed to promote CCT deployment.

- This project is the first phase of the Initiative. It assesses the status of cleaner coal technologies, related policies, and technical, economic, and institutional challenges slowing cleaner coal technologies deployment in two selected developing APEC economies. The project includes technology options for carbon dioxide management, including carbon capture, utilization and storage (CCUS), and issues related to early demonstration and adoption of these options.

The assessment included:

- CCT-related policies in each economy, including technical, economic and institutional challenges facing their deployment.
- Technology options for CCS including carbon capture, utilization and storage (CCUS), and issues related to early demonstration and adoption of these options.
- Dissemination of best practices for applying CCT technologies to new and existing power plants.

The chosen contractor, Aurecon, held a kick-off videoconference with the Institute of Energy Economics Japan (IEEJ) and the EGCFE chair in March 2014.

It was agreed that the developing APEC economies to be targeted would be Thailand and Indonesia. A meeting between Aurecon and IEEJ was held in Tokyo in June 2014 to finalize the content of a preliminary assessment report and discuss the program for the visits to the two target economies. The project team jointly decided on the clean coal technologies to be considered in the study, and the respective responsibilities of Aurecon and IEEJ were agreed. Visits to the target economies were scheduled for July 21-25.

The objective of the visits to Indonesia and Thailand was to carry out in-economy consultations and assessments by a team of experts, including engineers, technologists, policy and regulatory analysts, and financial advisors. The purpose of the consultations with various government and private organizations that are stakeholders and/or decision-makers in the energy sector was to gain insight into factors influencing the deployment of clean coal technologies in the target economies.

The main findings of the target economy visits were the following:

- Indonesia has a Roadmap to deploy clean coal technologies. According to its plan, from 2017 to 2025, ultrasupercritical (USC) technology will be applied for the larger power plants mainly in Java, and after 2025 IGCC technology will be applied for commercialized power plants. They are waiting for IGCC to have been successfully implemented by developed economies. Since there are many small islands with poor transmission networks, they consider deploying the comparatively higher efficiency plants, such as circulating fluidized bed (CFB) for the medium and small coal-fired power plants, as well as supercritical plants.
- Thailand does not have a Roadmap for cleaner coal technologies, but has a Power Development Plan (PDP 2010 Revision 3, currently being revised as PDP 2014) that considers energy diversification. It is anticipated that the use of coal will increase in the coming decades due to the goal of achieving energy security by reducing dependence on gas consumption, the uncertainty of successfully deploying new and renewable energy to the planned level, and concern over the public acceptance of nuclear power plants.

The project final report provides recommendations regarding how APEC could support the achievement of the objectives of the two target economies. Specifically for Indonesia:

- By helping in its effort to deploy more USC plants in order to improve the plant efficiency and reduce coal consumption at least until IGCC or CCS has become technically and commercially mature;
- By helping it with education programs on the latest generation of CCTs, including IGCC, through workshops and some training courses to consider the next generation of coal-based energy facilities;
- By supporting education programs on CCS technologies taking into account the local conditions;
- By promoting the assessment and deployment of hybrid coal / renewable technologies such as coal/biomass. The Indonesian economy has significant biomass that could be utilized to reduce the CO₂ footprint of both new and existing coal-fired plants.

The recommendations for supporting Thailand's efforts are:

- By providing advice and information to the Thai Government to deploy whatever CCT may be included in their new PDP 2014. Pulverised coal-fired USC technology will probably be applied to the new power plants planned in the Southern area, and IGCC may be applied for the second stage replacement of Mae Moh Power Plant, if commercially feasible.

- Because Thailand needs to cleanly and economically utilize their Mao Moh lignite reserves, they would benefit from deploying IGCC technology. APEC should support Thailand's efforts to educate their people about the latest technologies on IGCC through a workshop and training courses.
- By supporting education programs on CCS technologies taking into account the local conditions.
- By promoting the assessment and deployment of hybrid coal / renewable technologies such as coal/biomass and coal/solar thermal. Thailand has significant biomass and solar resources that may be utilized to reduce the CO₂ footprint of both new and existing coal-fired plants.

The project final report provides recommendations regarding how APEC could support the achievement of the objectives of the two target economies.

This project was intended to be the first step in the APEC CCT Deployment Initiative. It is likely that there could be support for a follow-up project or projects in the context of the Initiative. One approach could be to repeat the activity for another set of APEC target economies. Another project could be devised to provide advice and assistance to APEC developing economies in their efforts to measure aggregate CO₂ emissions per unit of GDP.

(2) APEC Expert Workshops on CCUS-EOR (EWG 15/2013A)

At present, in the absence of a price on carbon, the economics of CCS do not favor deployment unless a project receives some form of financial support. There are, however, situations where captured CO₂ can be sold and utilized, rendering the project economics more attractive. The most practicable example of carbon capture, utilization, and storage (CCUS) is for enhanced oil recovery (EOR), where CO₂ is used to stimulate the production of oil from reservoirs (CCUS-EOR) with declining production.

Based on available data, China, the world's largest emitter of CO₂, offers the greatest opportunity in the APEC region for CCUS-EOR. Committed to reduce its emission levels, China is exploring various CCS options and CCUS-EOR can become a key stepping stone towards the deployment of large-scale CCS in APEC. This APEC project aims to bring CCUS-EOR greater prominence internationally, with particular emphasis on near-term opportunities in China and other developing APEC economies.

The project was approved by APEC in January 2014. Five proposals were received in response to an RFP, and Development Technologies International was selected unanimously by a panel of EGCFE experts.

The first workshop was held in Beijing during September 2014, hosted by the Peoples University of China. It was a 2-day event with some 30-40 participants. It took the form of roundtable discussions on selected topics:

- CCUS-EOR Basics and Overview of the EOR Process
- Advanced CO₂-EOR Technologies
- EOR Economics and CCUS Investment Models
- Legal and Regulatory Aspects of CCUS-EOR
- GHG Compliance and CCUS-EOR / MRV Approaches
- CCUS-EOR Opportunities in China
- CO₂-EOR vs. Saline Storage/Monitoring.

The second workshop took place in the United States, hosted by Southern Company and Mississippi Power, with a visit to the Kemper County Energy Facility, which is a state-of-the-art 582 MW integrated gasification combined cycle (IGCC) plant with the capability to capture about 65% of the CO₂ generated. The facility will capture ~ 65 percent of its carbon dioxide (CO₂) or ~3 million metric tonnes per year for transport via a 60 mile pipeline to EOR operations.

The workshop took the form of roundtable discussions on selected topics, with a brief introduction of each topic. Holding the US workshop at one of the world's leading CCUS-EOR sites provided hands-on learning, enhanced knowledge exchange, and promoted the formation of relationships and enabling frameworks for further collaboration.

The U.S. Trade Development Agency (TDA) hosted a self-funded study tour after the second APEC workshop.

(3) CCS Capacity Building in Mexico (EWG17/2013A)

Recognizing that Mexico is the 7th largest emitter of CO₂ in the APEC region and that CCS technology holds the most promise to reduce these emissions, Mexico has started developing and implementing this technology. Two APEC workshops were held to start building CCS awareness and capacity (in 2007 and 2012). This project built on

the previous two workshops and on the network of contacts and resources established during these events, in coordination with related efforts by the World Bank and the Global CCS Institute.

The objectives of the project are:

- To organize three targeted workshops aimed at:
 - Undergraduate students in the earth sciences of universities not included in the 2012 APEC workshop;
 - Students and faculty linked to the National Association of Schools of Engineering; and
 - Geologists from industry, academia and other institutions involved in CO₂ storage capacity assessments.
- To develop technical protocols for the assessment of CO₂ storage capacity in deep saline formations. Storage assessment protocols and training should include reference to depleted petroleum reservoirs, enhanced petroleum recovery and deep saline formations given Mexico's geology and storage potential, as well as economic factors.

The training materials for the Mexican workshops should be widely applicable and can be transferred to other developing APEC economies.

The project was approved by APEC on 1 January 2014. The project RFP was posted on the APEC website in January 2014, with proposals due by February 28. Two proposals were received. The Global Carbon Capture and Storage (CCS) Institute was selected by a panel of EGCFE experts and the contract with APEC was finalized in June 2014.

The original timetable according to the RFP called for three workshops to be held from May - September 2014. The first workshop - an Advanced Storage Workshop involving 40 participants mainly from CFE, UNAM, IPN and PEMEX - was held in August 2014 in Mexico City. The second workshop, aimed at engineering teachers and students from IPN and UNAM, was held in October, also in Mexico City. There were 240 participants. The third workshop, CCUS Workshop for CO₂ Storage, was held in the University of Sonora in Hermosillo, Mexico, on 22-23 January 2015. It covered the basics of geologic storage, CO₂ storage capacity assessment, monitoring, measurement and assessment, EOR and storage case studies, CCS risk assessment, and various aspects of CCS in Mexico. There were over 200 participants.

(4) APEC Expert Workshop on Innovative Systemic Approaches to Enhancing Coal-Fired Power Generation Efficiency (EWG 19/2013A)

This 3-day workshop interfaced with the APEC/EGCFE Advanced CCT Deployment Initiative project (EWG 02 2013A) providing additional input and information of value to the final report of that project. The workshop shared proven results of various innovative technologies and best practices to enhance coal-power power generation efficiency, reducing coal consumption and CO₂ emissions, as well as ensuring a safer and more secure power grid in emergency supply disruptions. It included low-cost measures that are applicable to nearly every coal-fired power plant, to enhance power generation efficiency, reducing coal consumption and CO₂ emissions. This is of particular relevance to regions where the energy-mix is dominated by coal.

The project was approved by APEC in January 2014. An RFP was posted on the APEC website that same month. Three proposals were received from China Energy Research Society (CERS) & Beijing LAD Electric Power Technology Co., Ltd.; Forest Power & Energy Holdings, Inc.; and BBB Energy. The proposal from China Energy Research Society and Beijing LAD was recommended based on its overall approach to executing the planned tasks.

The workshop was scheduled for late March 26-28, 2015. The agenda included a visit to Shanghai Waigaoqiao Phase III (2 x 1000 MW) ultra-supercritical power station to showcase technologies and best practices to improve the performance of coal-power generation.

Workshop topics included:

- Information on state-of-the-art technology demonstrations and deployments aimed at lower-emission power generation through efficiency enhancement.
- Applicability and transferability of these technologies to existing and future coal-fired power plants in regions where the energy-mix is dominated by coal.
- Systemic and holistic approaches to enhance coal-fired power generation efficiency through innovations in optimizing operating procedures and residual thermal resource recycling.
- Input to the finalization of the EWG 02 2013A project on advanced CCT deployment.

(5) Coal-Based Power Generation and Conversion - Saving Water (EWG 08 2014A)

Most energy production and conversion methods need large amounts of water, and most methods of producing fresh water require energy. Policy-makers need to understand the links and trade-offs between water and energy, termed the nexus. This is a critical issue for China and the United States – the world's two largest producers and consumers of coal – and all economies relying on coal to meet their energy demands.

This project will collect and share information on:

- Developments to make coal-based power generation and conversion to synthetic natural gas and chemicals more efficient and less-water intensive;
- Recovery and reuse of water from coal-based energy production, including use of alternative sources of water and coproduction of water with carbon capture, utilization, and storage (CCUS);
- Policy and regulatory developments in APEC member economies related to the water-energy nexus for coal-based energy production.

The end product of this water-energy nexus project will be a report containing information on the latest developments to make coal-based energy systems, including power generation and production of SNG and chemicals, more efficient and less water-intensive. The report will set the scene by describing the nature and magnitude of the water-energy nexus, drawing from practical examples in regions where water is scarce, and highlighting the technical, economic and institutional issues faced by power generation in such regions. A number of case studies will describe how specific power generating plants in such arid regions manage their water needs. The report will synthesize information from these case studies and other recent sources, to summarize the latest developments for recovery and reuse of water from coal-based energy production, including use of alternative sources of water and coproduction of water with carbon capture, utilization and storage. Policy and regulatory developments related to the water-energy nexus will be highlighted.

The project's long-term intended impacts are to put developing APEC economies with rapidly growing use of coal for electricity generation and production of SNG and chemicals in position to deploy more efficient clean coal technologies as effectively and economically as possible, and to build professional capabilities and capacity for achieving this. Long-term sustainability is a key objective of the EWG forum. The results of the project are likely to identify more detailed work needed on specific aspects of clean coal technology deployment in developing APEC economies, including the availability and utilization of needed water resources, which could be the object of future APEC projects. The results are likely to identify more clearly the barriers to CCT deployment due to the water-energy nexus in the situations different APEC economies find themselves, and further APEC work may be necessary to resolve the issues and find the most efficient way forward.

This new EGCFE project proposal was accepted for funding in the second APEC round of 2014. An RFP was issued in March 2015, and six proposals from contractors were received in late-April. The selection process is expected to be completed in the near future.

(6) APEC Water-Energy Nexus Expert Workshop

Policymakers need to understand the links and trade-offs between water and energy, termed the nexus. An APEC project covering these issues, "*Water-Energy Nexus: Coal-Based Power Generation and Conversion - Saving Water*" (EWG 08 2014A) is now getting underway (see above). It aims to collect and share information on developments to make coal-based energy generation more efficient and less-water intensive, on recovery and reuse of water from coal-based energy production, and on policy and regulatory developments in APEC member economies related to the water-energy nexus for coal-based energy production. Understanding the water-energy nexus and proactively addressing potential energy system vulnerabilities stemming from water resource dependency is important for all nations reliant on coal to meet their energy and economic development needs.

The Expert Workshop proposed in this follow-up project will build on information generated and lessons learned in EWG 08 2014A. This project's contractor will be in close contact with the contractor undertaking the above project, as far as the scope and content of the Workshop is concerned. Coordination between the two projects will aid in identifying invited speakers who are not only knowledgeable in this field of activity, but also capable of identifying critical future directions of research and analyses needed within the APEC region on the water-energy nexus field of activities spanning from technology through policy to regulations.

The objectives of this Expert Workshop (in an economy to be selected) will be:

- To discuss and evaluate the priorities identified in EWG 08 2014A project findings, and to share up-to-date knowledge and experience.
- To discuss future work in this area and develop recommendations, including capacity building needed on technologies, on the economics of measures addressing water-energy nexus issues, and on needed policy/regulatory structures.

This new EGCFE project proposal was submitted to APEC in May for the first funding round of 2015. The deadline for submissions was June 1.

Scott, I have no information on the following two projects, which were included in the last EGCFE report to the EWG based on information you gave me about them at that time. As I recall they were Chinese projects.

(7) Comprehensive Integration and Optimization of Coal-Based Clean Power and Chemicals Multi-Generation (CBMG)

The CBMG project proposes a new technological way approach to clean and efficient utilization of coal resources. An integrated coal-based multi-generation system will co-generate electricity, provide heating and cooling for the local community, and produce calcium carbide, combined with CO₂ capture at the lowest cost and minimum environmental impact. The solid residues will be recycled and re-utilized. This system is designed to transform the present electric power or CHP co-generation model into an integrated multi-generation model with almost zero CO₂ emission to the environment.

The main objective of this project is to build a coal-based multi-generation system and to create related websites and a forum where CBMG issues can be discussed and shared. This will enable innovative experience and knowledge on power and chemical product multi-generation to be shared with other APEC economies to enhance the understanding of the CBMG concept. This will assist the development of similar projects in other economies that are suitable for their situation.

The project stemmed from a feasibility study launched by the Shanxi International Energy Group in 2009, and is overseen by Dr. Weiping Yan of the Power Engineering Department of North China Electric Power University.

(8) APEC Forum: Improving the Energy Efficiency of Coal-fired Power Plants & Reducing the Air Pollutants Discharge

This 1-day self-funded event will be held in Beijing, China, on December 4, 2014, will be organized by China Guodian Corporation with support from the National Energy Administration of China. The event will involve cooperation between the EGCFE and the EWG's Expert Group on Energy Efficiency and Conservation. The morning session will deal with *Energy Efficiency of Coal-Fired Power Plants*, and the afternoon session with *Haze/Fog Control Technologies and Policies for Coal-fired Power Generation*.

The morning session presentations include:

- Status analysis on the power generation efficiency of coal-fired power plants in China
- Case study of energy efficiency improving technology for coal-fired power plants
- Review of energy efficiency improvement of coal-fired power plants in APEC region.

The afternoon session presentations include:

- Status and prospect of ultra-low emission technologies for coal-fired power plants
- Deep removal technology for ultrafine particles from flue gas of coal-fired power plant
- Clean coal technology for the energy industry of USA
- Air pollution control by improving the energy utilization efficiency of industrial furnaces.

EGCFE CLEAN FOSSIL ENERGY TECHNICAL AND POLICY SEMINAR

The next annual EGCFE Seminar and business meeting are being planned for Kuala Lumpur, Malaysia, tentatively in early 2015. The Ministry of Energy, Green Technology and Water will host the event. The seminar will be scheduled as soon as the EGCFE Chair can confirm U.S. DOE financial support for the Seminar.

Chinese Taipei has expressed interest in hosting the following Seminar.

Scott, please update this section.