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Greenhouse Issues

In this Issue:

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Seasons Greetings

The IEA Greenhouse Gas R&D Programme wishes all readers of *Greenhouse Issues*, Seasons Greetings and Best Wishes for the New Year.

Changes in the IEA GHG Offices

There have been several recent changes in the IEA GHG offices to draw reader's attention to. Harry Audus has now retired from IEA GHG and we wish Harry a long and happy retirement.

Kelly Thambimuthu the Chairman of the IEA Greenhouse Gas R&D Programme thanked Harry Audus for all his work for the Programme since its inception in 1991

Harry has been replaced by John Gale as the General Manager. John has been with the Programme since 1999 and has championed the Programme's activities on geological storage. He was one of the co-ordinating lead authors on the IPCC Special Report on CO_2 capture and Storage and has also been leading IEA GHG's involvement in the GHGT conference series. John can be contacted at: johng@ieaghg.org.

John Gale is the new General Manager to IEA GHG

Tim Dixon formerly with AEAT and the UK Department for Business, Enterprise and Regulatory Reform has agreed to join IEA GHG in January 2008. Tim will take over many of John's former duties and lead up IEA GHG's activities on geological storage and support activities for CCS implementation.

Louise Fazeli who has been the Programme's secretary for nine years has also moved on to pastures new and we wish her all the best in her new career. IEA GHG has appointed a new Office Manager, Tricia Watkins who has experience in account management and office finance from the Royal Bank of Scotland. Tricia will manage the Programme office and the IEA GHG accounts and finances.

IEA GHG Meetings in Korea

The 32nd Executive Committee meeting of the IEA GHG Programme was hosted by the Korean Electrical Power Research Institute (KEPRI) in Daejon, Korea; a series of meetings were held over a 4 day period. The last Executive Committee meeting held in Korea was 10 years ago. On the first day an International Forum on Climate Change Mitigation was organised by KEPRI which was supported by the Ministry of Commerce, Industry and Energy (MOCIE). The meeting was formerly opened by Dr Sang Dong Park, the President of KEPRI, and the welcome address was given by Choil Kyuchong, the Director of the Energy Technology Division of MOCIE.

The Forum provided the opportunity for Korean delegates and those from the international community to discuss and debate issues on greenhouse gas mitigation. From the international side Dr Sven-Olov Ericson from the Swedish Ministry of Sustainable Development presented the latest developments in European Community policy on the deployment of CCS. Dr Trygve Riis from the Norwegian Research Council provided an overview of CCS developments in Norway, whilst Dr John Carras from CSIRO Energy Technology in Australia gave a summary of research, development and demonstration activities on clean coal technology in Australia. From the Korean side Dr Seung-Jick Yoo, from the Korean Energy Economics Institute, provided a summary of climate change activities and policies in Korea. Korea has now embarked on its 4th National Action Plan which will embody a programme of improved energy efficiency to reduce greenhouse gas emissions from industry with increased R&D on the application of CCS in the power sector and for iron and steel plants as well as an aggressive policy on the introduction of renewable energy technology and hybrid fuel cell technology in the transport sector. Dr Chung-Kul Ryu of KEPRI provided an overview of the current status of research on CO_2 capture in Korea. In Korea, the power sector is the major emitter of CO_2 and to make deep cuts in these emissions they need to deploy CCS. However, the costs at present are high and KEPRI feel they can bring the costs down to \$25-30/t CO_2 with wet scrubbing, but dry sorbent technology and chemical looping combustion offer the potential to get costs to below \$20/t CO_2. All three options are being researched at KEPRI.

After the Forum the Executive Committee members were given the opportunity to visit KEPRI's extensive research facilities.

The forum was followed by the IEA GHG ExCo meeting which lasted for two days. On the final day a programme of technical visits were planned for the ExCo members. Members visited the Boryung coal fired power plant and they went on to Buyeo the former capital of the Baejke dynasty in Korea to visit its historic sights. The IEA GHG team by contrast gave a one day seminar on CO_2 capture and storage to 25 students and employees from KEPRI. The one day seminar provided an overview on CCS to those that attended. The seminar covered aspects such as:

- The need for CCS,
- The current technical status on CO_2 capture,
- Options for CO_2 transmission,
- The current status of geological storage of CO_2,
- The economics of CCS
- The legal and regulatory status of CCS
- Plans for wide scale implementation of CCS

Members of the IEA GHG ExCo visit the KEPRI research facilities after the international Forum

Members of the IEA GHG Programme Team with the KEPRI organisers and delegates at the CCS seminar in Daejon, Korea

Further details on KEPRI and their research activities can be found at www.kepri.re.kr

International Summer School on CCS

In August, the IEA Greenhouse Gas Programme in conjunction with Forschungszentrum Jülich (FzJ) held the first annual IEA GHG Summer School on CCS. The event was held at Kloster Seeon, near Munich, Germany between the 19th and 24th of August. The former monastery at Kloster Seeon was selected by FzJ as the venue for the meeting because it was a secluded venue situated on a lake, with good facilities while close to Munich International airport for ease of access (For further details of the venue see www.kloster-seeon.de). The meeting was also supported by the German Federal Ministry of Economics and Technology, Siemens, Statoil, Schlumberger, E.ON, RWE and the UK's DEFRA.

The summer school lasted 5 days and included a programme of lectures covering the full CCS system including discussion of both technical and non technical issues. To break up the lecture programme the students were split into 5 working groups and each group were assigned a study task which they reported back on at the end of the workshop. The programme for the summer school can be found on our web site at www.ieagreen.org.uk/summerschool. An excursion was organized in the middle of the week to the Herrenchimsee, a castle built by King Ludwig II and modeled on the French palace at Versailles.

Fifty four students (both graduate and post graduate) studying in 22 different countries attended the school. Students were selected using a combination of technical distribution (the aim was to try to have groups with a wide range of backgrounds) and geographical distribution (about 60% of the students were drawn from both Western and Eastern Europe). Student participation from developing countries was encouraged, with students attending from China, India, Iran, Macedonia, Malaysia, South Africa and Ukraine.

Students pose for a photograph at the start of the summer school

Over twenty experts from the CCS industry were also in attendance and these experts were drawn from both industry and academia. The experts led the lecture sessions as well as helping with the group work carried out by the students throughout the week.

On the final day of the event the experts were called upon to select the outstanding students of the week and an award was given to the best student group based on their approach to and the final presentation of their work. All the student group presentations were excellent demonstrating the way the students had applied themselves to the task that had been set and the hard work they had put in. The winning group was Team 4, whose project was: The potential for capture, transport and storage in the North Sea. The team comprised; Leila Faramarzi, Marcus Johansson, Takeshi Kuramochi, Hans Meerman, Jochen Oexmann, Birte Oppermann, Stephane Renard, Nikolett Sipøcz, Pierre Tardif d'Hamonville and Runia Xu.

The best student award was donated by IEA GHG and Elsevier and given to the students whose contribution to the event was considered to have been outstanding by the experts attending. This assessment was made across every aspect of the week, including input to the lectures, the group work and during the social programme. The students selected will have their costs covered to attend the GHGT-9 conference to be held in Washington D.C in November 2008 and they will also be asked to submit a paper on the work they are currently doing. It was initially intended to select the two best students but this had to be increased to three when the experts could not split the selected students.

The best students selected this year were, in alphabetical order; Elizabeth Heischkamp from Duisburg-Essen University, Patricia Seevam from the University of Newcastle, and Prachi Singh from Twente University.

Patricia, Prachi and Elizabeth with their best student certificates

The organisers are very pleased to say that the feedback received since the summer school shows that it was very much enjoyed by everyone

involved, students and experts alike. The next IEA GHG Summer School will be held in Canada in August next year. A call for applications will be made in this newsletter closer to the event. If you are interested in attending please also keep a look out on our web site for details; www.ieagreen.org.uk/summerschool.

GHGT-9 Call for Papers

The organisers of the GHGT-9 conference are pleased to announce that the Call for Papers is now open. A brochure should be included with this copy of *Greenhouse Issues* outlining the call requirements and deadlines. If the booklet is not included with your copy of *Greenhouse Issues* the information will also be available on the conference web site at http://mit.edu/GHGT9.

Prospective authors are invited to submit papers and posters on related topics within the scope of the conference. Abstracts will only be accepted if they are submitted online through the conference website. Abstracts should be between 250 and 500 words, in English and contain the paper title, author(s) name(s) and organisation(s). The abstract should also clearly demonstrate the scope of the proposed paper or poster, contain enough information for the reviewers to make an informed decision, and be received by the organisers no later than 28th March 2008.

The Programme Committee will organise the assessment of the abstracts and will select and assign papers for oral or poster presentation. You may indicate your preference upon abstract submission. In the selection of papers for the conference, emphasis will be placed on the presentation of results and new developments. The late replacement of papers or posters will not be accepted. A condition of submission and acceptance is that at least one author will register. Presenters will be required to pay the full registration fee.

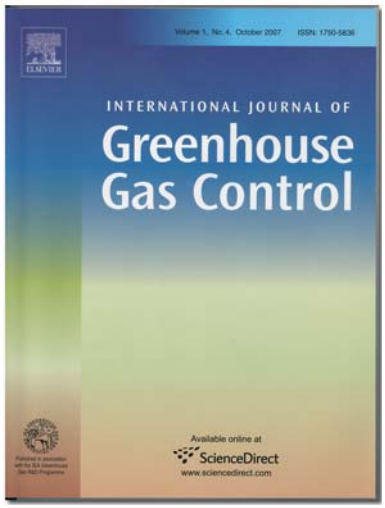
You will receive notification of your paper acceptance or rejection by the end of June 2008. If the paper is accepted, a full copy must be submitted in mid-October 2008 (exact date to be determined) to guarantee publication on the conference web site and inclusion in the conference proceedings.

Abstracts will be available on the conference website by the end of July 2008.

International Journal on Greenhouse Gas Control

By Henri van Dorssen, Elsevier

The new launch of the International Journal of Greenhouse Gas Control in 2007 has exceeded all Elsevier's expectations thanks to a very favourable response by the R&D community and institutions active in the field. The strong article submission rates and the topical diversity on offer has enabled the Editors to be selective and establish a strong reputation right from the start for publishing high quality, authoritative reference articles. We can see this reflected in the very encouraging citation rates of articles in Scopus, as well as in the strong online usage figures of the new Journal in ScienceDirect. Authors benefit from quick review feedback thanks to a responsive network of referee, and attractive publication times. The awareness of the Journal seems high and is likely to continue to grow.



We would like to take this opportunity to thank John Gale, Editor-in-Chief, and the Associate Editors Stefan Bachu, Olav Bolland and Ziqiu Xue, as well as the members of the Editorial Board, for their tremendous work in making this new launch such a success. Thanks are also due to the IEA GHG R&D Programme for its publicity and support. We have no doubt that 2008 will continue to build on the very strong start in 2007. Elsevier and the IEA GHG will continue to work together to ensure the International Journal of Greenhouse Gas Control becomes the premier journal in its field.

Small Scale CO_2 Capture and Collection

IEA GHG has recently published two complementary studies which examined the technology and cost of capturing and collecting CO_2 from smaller emission sources. Most studies of CO_2 capture processes have concentrated on capture from large power plants or other large scale industrial processes. It has to some extent been taken for granted that capture and collection from smaller sources would be significantly more expensive and thus not worth further investigation. In order to eliminate their emissions smaller scale facilities are thus left with the options of converting to carbon free carriers

such as electricity and Hydrogen. In order to better understand the relative costs and difficulty of implementing small scale capture the first study examines the type and size of smaller scale industrial CO_2 emission sources and the technology options which might become available in the future for capturing this CO_2. The second study examines the design, construction and costs of CO_2 collection networks to collect CO_2 from distributed sources in a typical industrial area. Together the two studies have yielded some valuable insights into infrastructure development needs. This article considers the main results of the two studies but also suggests some ways in which emitters in industrialized regions might work together to develop a more effective master plan to reduce their collective emission footprint.

Technologies for Small Scale Capture

This study focuses on 'medium scale' combustion installations in the industrial and commercial sectors. The commercial sector includes offices, retail and wholesale premises, hotels, hospitals and educational institutions etc and supply of energy to the residential sector through district heating schemes. Installations with a fuel input of between 1 and 100 MWth were considered covering CO_2 emissions in the range 1500 to 250,000 tons per year. The study reviews publicly available information on the capacities of medium scale sources of CO_2, particularly from the USA, the Netherlands and China. It includes a number of charts and tables illustrating the distribution of number and capacity of reciprocating engines, steam and gas turbines, furnaces and boilers in these countries.

The main applications of medium scale CO_2 capture for greenhouse gas abatement, if any, are likely to be beyond 2020. The study therefore includes some novel capture technologies which are under development and which may become commercially available by that time.

Five promising technologies suited to smaller scale capture in this market were identified and an analysis of their projected performance and costs is included in the report. They are:

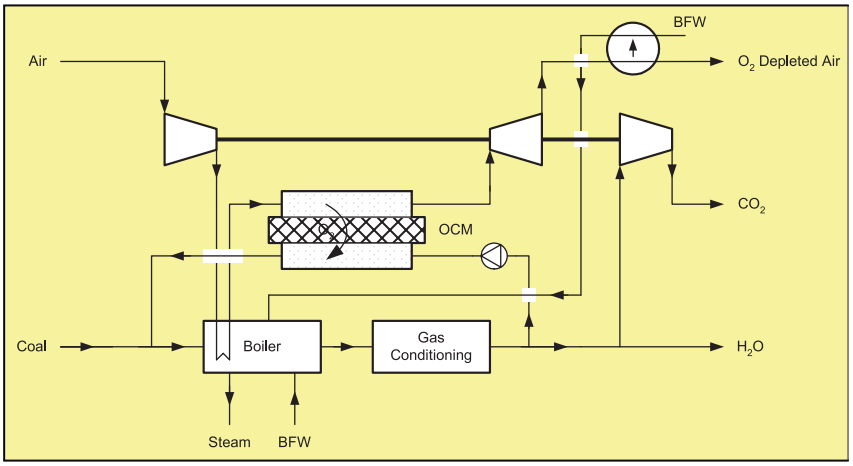
1. Natural gas and diesel oil fired reciprocating engines (1.5MWe) with post-combustion membrane assisted liquid absorption for CO_2 capture
2. Natural gas fired gas turbine (5 MWe) with pre-combustion PSA capture of CO_2
3. Oxy-combustion coal boiler (50 MWth) with membrane oxygen production
4. Oxy-combustion natural gas boiler (5 MWth) with membrane oxygen production
5. Solid oxide fuel cell (0.5 MWe) with oxygen conducting membrane after-burner

Costs of Small Scale CO_2 Capture

A more in depth analysis of the third item, a 50MWth oxy-combustion coal boiler using an integrated dense membrane oxygen separation, forms part of the report. Two designs, one burning only coal, and the other using supplementary natural gas to assist in heating air to the separation membrane were considered. The economic analysis estimated capture costs of the order of only $22 respectively $21 per ton which compares very favourably with estimated $70 per ton for the equivalent system using current MEA scrubbing technology. This compares with capture costs estimated to be around $35/ton for a large scale power plant with MEA scrubbing. This would indicate that smaller scale capture may be possible much more economically than had previously been thought. However, there are significant technical development issues which would have to be resolved before these costs could be achieved. The costs are also for plants operating at continuous full load but many smaller scale installations, particularly in the commercial sector, operate at much lower annual load factors and such installations would have higher costs.

Design of a CO_2 Collection Network

Even if the cost of smaller scale CO_2 capture were low there remain significant costs for compressing and piping this to a geological storage site. The sister study examines the design and costs of a CO_2 capture network for smaller scale sources. This study was based on a real industrial area in order to generate realistic designs and costs. The area chosen was the UK's Deeside and Merseyside basin which is a heavily industrialised area with several power plants, a big refinery and chemical and other industries. A notional storage location in the nearby offshore Liverpool Bay oil and gas province was selected and the location and size of all sources of emission greater than 5000 tpa mapped.



Oxy-combustion coal boiler with membrane oxygen production

A major contractor with experience in both trunk and distributed pipeline systems than designed a collection network using their extensive experience with design, construction and operational issues. A spreadsheet based sizing and cost calculation program was developed which calculates the sizes of pipes required and the costs of installing the network and associated compression system. This is available for use as part of the report and is currently being updated to include costs information for regions other than the United Kingdom. The most appropriate network design was found to be one with three pressure levels, a high pressure steel trunk system operating at around 100bar, a medium pressure plastic piping system operating at around 10 bar and finally a plastic piping system operating under slight vacuum where there are several small sources within a few kilometers of each other. This latter arrangement allows a single compressor to draw CO_2 into the system from several sources greatly reducing the costs of compression equipment.

Cost of Distributed Collection

For the case studied the costs of collecting CO_2 from five large emitters each of greater than 1million tpa was estimated to be $8.5/ton. When the next tier of emitters down to 50,000 tpa were added the marginal cost was $9.7/ton but when the system is extended to emitters of 5000tpa marginal costs go up considerably to $34/ton.

Options and Infrastructure Master Planning

The two studies show that the cost of capturing and collecting CO_2 from medium sized distributed industrial sources using future technology are not as unaffordable as previously suspected. Once there is a backbone CCS system consisting of a few major sources connected to nearby geological storage the marginal costs of capture and collection of CO_2 from other smaller sources in the vicinity could be economical. These smaller industrial and commercial emitters will be faced with ever reducing emission caps. The simplest option for them will be to buy emission certificates. Alternatively the industries could purchase supplies of hydrogen produced in centralised capture plants or capture CO_2 emitted from the fuel they use and pipe it into the capture network. Another alternative would be to switch to electric power which again places the burden of emission control on the supplier. Other options are to cut consumption of fossil fuel energy through efficiency improvements, to relocate or in the extreme to close down.

From the foregoing it is clear that for any industrial region it would be most helpful for planning if all the players were aware of each others needs and capabilities. Those planning to build CCS plants and hence market supplies of "emission mitigation products" could benefit from knowing what the future local demand for electricity, hydrogen and CO_2 storage will be. This would enable a better choice of type of installation and capacity and the option value of future markets to be factored into investment decisions. Those on the demand side of the equation would like to know the relative price and availability of the various options including the timing. They should also evaluate which of the options are actually technically feasible for their operations. Not every process can be successfully converted to electric power or hydrogen and likewise capture of CO_2 from some processes may be particularly difficult.

Some attempts are being made in industrial conglomerations to address the optimization of CO_2 emission reduction infrastructure, notably initiatives in the Port of Rotterdam, in the Mersey and Deeside basin, on Humberside and through the North Sea Basin Task Force. A sequence for such development is proposed as follows leading to production of a coherent "MASTER PLAN":

- Formation of an Association to examine options and make plans.
- Establishment of an initial budget and meeting/workshop/activity schedule
- Early identification and survey of CO_2 geological storage possibilities
- (Identifying a viable option is almost certainly a pre-requisite to further work)
- First pass survey of current emissions and future projections
- First pass survey of supply and demand – possible aspirations of suppliers, preferred CO_2 emission management paths of all players.
- Analysis of initial surveys and decision on potential viability of CCS in the region.

If the outcomes are positive:

- Construction of a second pass survey on a "what if" basis indicating products/services which might be made available (e.g H_2 supplies, CO_2 collection network) and at what relative cost.
- Second pass survey to test possible markets between the players
- Analysis of results and preliminary identification of preferred infrastructure development.
- Construction of a third pass survey to include further infrastructure options and revisit the main commodities which would be traded. (Additional items could be collection of waste streams for gasification, heat integration, use of by product industrial gases as well as location options for centralized CCS facilities, provision of sites for renewable energy systems.)
- Analysis of results and development of a MASTER PLAN with a few options
- Further studies and refinements to the MASTER PLAN with eventual emergence of a preferred plan for the region.

It is unclear at present whether additional infrastructure and integration of industries can further defray the costs of CO_2 emission reduction or whether such additions will always be at increased marginal abatement cost. The logic of sustainable systems suggests that deeper integration should be cheaper and better as long as the

interdependencies do not make the overall system too complex and impractical to operate. Facilities can, at a cost, be designed to tolerate upsets, for example by retaining dual fuel capability following a conversion to hydrogen.

The two studies just completed better define the costs of the distributed CO_2 capture option and also highlight the importance of planning for a larger regional emission reduction infrastructure.

Risk Assessment Network

The IEA GHG held the third meeting of the IEA GHG risk assessment network in August this year at Imperial College London. 60 people attended the event from industry, government and academia.

The aim of this meeting was to assess the current status of CCS risk assessment and further develop a number of risk assessment principles. Topics included whether to use quantitative, qualitative, or simple analytical methods to analyze CCS risk, risk assessment terminology, site characterization and the FEP risk assessment method. The IEA GHG also invited representatives from the well bore integrity network to provide the meeting with an overview of the status and lessons learned in the network and how they may apply to the risk assessment process.

The meeting was opened with an overview of the major risk assessment developments since the last risk assessment meeting in California in 2006. The most significant development was the amendment of the OSPAR and London Conventions to allow CO_2 storage in the sub-seabed. There was also information presented on risk assessment work that has recently been done on the Sleipner project as well as the FutureGen project.

The second session of the network meeting looked at site characterization, and in particular, how much site characterization is enough to achieve confidence in the integrity of the storage site. To address this tough question, the scene was set with information from the IPCC special report and an attempt to identify the exact site characterization needs for risk assessment. This was followed by two presentations giving the US and Australian perspectives on the issue.

The third session of the day was dedicated to risk assessment terminology. Looking at the terminology used in the area is of particular importance given the multiple definitions of many of the key terms used. The aim of Imperial College's work in this area is to develop and propose internationally harmonized generic and technical terms for CO_2 storage hazard/risk assessment. This will help facilitate the mutual use and acceptance of the assessment of CO_2 storage projects between countries, saving resources for both governments and the industry.

The final session of day 1 looked at the developments in the wellbore integrity network. As wellbores are seen as one of the largest risks when it comes to CO_2 leakage, it is very important to get feedback on this area from this parallel network. The two presentations in this session presented a glimpse at the type of research going on in this area, including studies into the effects of CO_2 and dissolved CO_2 on wellbore cement and steel. We also saw some of the monitoring and modeling techniques that are being used to assess the risks posed by abandoned wells on CO_2 storage integrity.

Day 2 started with a session looking at the risk assessment expectations on different parts of the CCS cycle. It was seen that risk assessment has a role to play throughout the lifecycle of a CCS project, from identifying risks and uncertainties in the planning phase to minimizing future risks at the time of decommissioning. This session also looked at the comparison between quantitative and qualitative risk assessment. It was shown that, to date, a lot of CCS risk analysis has been qualitative, often relying on expert judgment. It was also believed that this is likely to continue, at least in the near-term.

The final session of the network meeting looked at the use of FEPs – Feature, Event, Process method – for risk assessment. It was concluded in this session that although some people viewed the FEPs method as a very time consuming and cumbersome process that it does have its place in a risk assessment process but more as an auditing tool rather than the primary method.

At the end of the two day meeting a number of key conclusions and questions came out:

- A set of Standards or guidelines are required for CCS risk assessment
- We as an industry need to establish how best to communicate risks
- We need to formalize how expert panels are used in risk assessment
- FEPs are best suited in risk assessment auditing
- How long do we need to monitor for?

Delegates of the 3rd risk assessment meeting held at Imperial College, London, UK

The next meeting of this network will be as part of the 2008 Joint Network Meeting that will combine the risk assessment network with the monitoring and wellbore integrity networks. Following this the 4th Risk assessment meeting will be held in Australia in early 2009 hosted by the CO_2CRC.

Microalgae Biofixation Network Meets in London

The "International Network on Biofixation of CO_2 and Greenhouse Gas Abatement with Microalgae" met recently in London to assess progress made during its first five years and to discuss a path forward for the future. Current Biofixation Network member institutions include Eni S.p.A. (Italy), ONGC and TERI (India), CGTEE and Electrobras (Brazil), Pacific Northwest National Laboratory (PNNL) and the National Energy Technology Laboratory (USA). Chaired by Paola Pedroni (Eni S.p.A.), the focus of Technical Advisory Committee discussions on 21 October was on scientific uncertainties central to understanding the issue of algal solar energy conversion efficiency and its impact on productivity. Also addressed were technical issues underpinning debate on the relative economics of algal biomass production in closed photobioreactors versus open ponds. Both of these topics have been the subject of renewed debate as significant investments of private capital has launched a number of new enterprises around the globe, some of which are based on unsubstantiated claims of productivities greatly in excess of results to date from commercial operations with many years experience. This discussion concluded with an agreement that Network members would work with the IEA staff to produce a factual brochure and to build from that effort to produce a scientific impact piece for publication in a suitable scholarly journal.

The Biofixation Network meeting itself was held on 22 October. The meeting was chaired by F. Blaine Metting (PNNL) and organized by Dr. John Benemann, the Network Manager. Toby Aiken participated as representative of the IEA GHG Programme. In addition to representatives of member institutions, invited observers from Shell Global Solutions, ExxonMobil, and Newcastle University were welcomed and actively engaged in the discussions. About half of the day was devoted to technical presentations to update participants on projects being undertaken by Network members, such as the Eni S.p.A. project investigating the feasibility of using flue gases of differing make up to support growth of microalgae in closed and open production systems for which the outlook is positive. The final agenda item was a discussion of the future of the Biofixation Network. It was agreed that the Network had been worthwhile to the membership and should be continued for an additional five years and that a concerted effort be mounted to increase the membership. Any companies wishing to participate in the network should address their queries initially to Toby Aiken: toby@ieaghg.org.

MOVECBM, Development of a Pilot Project for ECBM in China

The EC funded MOVECBM project investigating Enhanced Coal Bed Methane in Poland has recently completed its first of two years of operation. There has been ongoing practical work at the site for some time, and the site is now undergoing decommissioning works while the second half of the project, interpreting and analysing the results, begins.

Another aspect of the project is to look into the potential for a pilot scale ECBM project to be set up in China. To that end, a meeting was held in the Netherlands in early October with MOVECBM partners, including representatives of Petrochina and China United CBM, to discuss the next steps necessary to realise such a project. The representatives from these companies presented a shortlist of five sites that could prove viable for ECBM, and a selection process was entered to determine the optimal site from this list. Two sites were selected and will be subjected to further investigation to determine the practicalities of establishing pilot ECBM projects. Further developments will be reported in *Greenhouse Issues*.

MOVECBM, General Assembly Meeting

Following the completion of field research and the anniversary of the commencement of the project, the General Assembly meeting was held in Krakow, Poland on the 11th and 12th of October. The meeting attracted representatives of nearly all of the partners, and a productive meeting ensued with individual meetings for each of the work packages as well as the general assembly itself. A field trip was also organised to the field site for those who were interested.

International Research Network on ECBM

On a related note, IEA GHG is planning to establish a new International Research Network on ECBM. The network will join the IEA GHG's existing research networks and will aim to bring together experts in the field from around the world to share experiences and best practices, develop a wider understanding of the processes and logistics involved with the process, and to map the objectives in the field of ECBM in the years to come. Anyone interested in participating in such a network, either as an attendee or as a speaker should contact Toby Aiken at the IEA GHG Programme on toby@ieaghg.org.

Weyburn-Midale CO_2 Project Update

By Ray Knudsen, Project Director; Petroleum Technology Research Centre; Regina, SK

The final phase of The Weyburn-Midale Project continues to move forward with sponsors and researchers on board, eager to work on the world's largest CO_2 storage project run in conjunction with enhanced oil recovery.

The first phase of the Project, operated at EnCana Corporation's field in Weyburn, Saskatchewan, Canada, demonstrated that the natural geological setting at the Weyburn field is highly suitable for long-term storage of CO_2. The final phase sees Apache Canada Ltd. come on board adding the adjacent Midale field to this research project. The goals of the second phase are: further the understanding of, the feasibility of and requirements for carbon storage; to develop a best practices manual; and to develop advice and information to support the development of supportive public, regulatory and fiscal policies required for effective implementation of carbon storage.

The first Project Integration and Sponsors' Meeting (PRISM) will be held in late November in Calgary. This PRISM brings together national and international representatives from industry, government and research organizations, including current project sponsors and potential new sponsors. This meeting will be held to review activities that have taken place since the completion of the first phase, present the proposed research program for the final phase and obtain feedback from project sponsors. PRISMs will be held on a basis during the course of the final phase.

Phase 1 of the Project culminated in release of the Summary Report (IEA GHG Weyburn CO_2 Monitoring & Storage Project Summary Report 2000-2004) and presentation of numerous technical papers at the GHGT-7 Conference in Vancouver in September, 2004.

In the interim time period between the first phase and the final phase, a number of field activities continued, including a geochemical sampling survey in Weyburn, a follow-up soil gas survey in the fall of 2005, baseline shallow ground water sampling and produced fluid sampling/analysis in the Midale field area and follow-up ground water survey in the Weyburn field in 2006-2007. Work for development of a drill-bit design for side-wall core sampling was also supported.

The most recent geochemical fluid sampling trip to the Weyburn field will take place in November, 2007.

The organizational framework for the technical and policy components of the project is in place. The project themes and theme leaders are outlined in the table below.

Research Provider Agreements and Statements of Work have been finalized with several research

Technical Themes	Theme Leaders
Theme 1 - Geological Integrity	Dr. Ben Rostron, University of Alberta Dr. Steve Whittaker, Canada Capital Energy
Theme 2 – Wellbore Integrity	Dr. Chris Hawkes, University of Saskatchewan Craig Gardner, Chevron
Theme 3 - Storage Monitoring Methods-Geophysics	Dr. Don White, Natural Resources Canada-Geological Survey
Theme 3 – Storage Monitoring Methods-Geochemical	Dr. James Johnson, Lawrence Livermore National Laboratory
Theme 4 – Risk Assessment	Dr. Rick Chalaturnyk, University of Alberta
Theme 5 – Shared Data Environment (PTRC)	
Policy Themes	**Theme Leaders**
Public Communications & Outreach	Anne-Marie Thompson, Natural Resources Canada
Regulatory	Andy Ridge, Alberta Environment Scott Robinson, Saskatchewan Environment
Business Environment	To be determined

providers, with research activities underway in the 4th quarter of 2007. Work is progressing on the evaluation of modeling tools for geomechanical analysis and well integrity modeling.

The Public Communications & Outreach Theme developed a short brochure and one detailed booklet on carbon capture and storage in Canada. These will be used to inform public audiences about the technology and its use in Canada. Work was also undertaken to develop a Canadian CO_2 Capture and Storage Network Website and Newsletter.

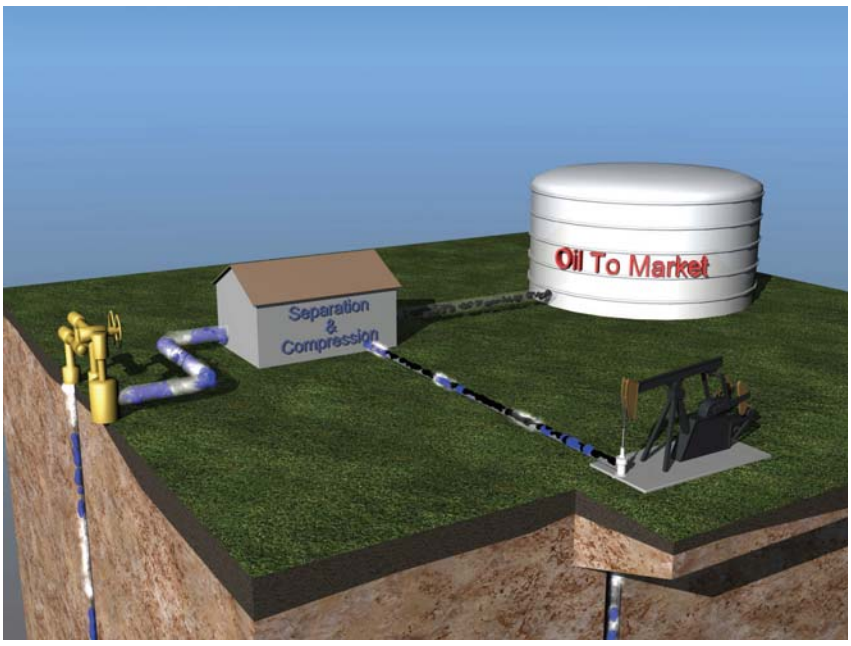
In terms of project funding, the Weyburn-Midale CO_2 Project was proud to receive sponsorship from two new companies with Aramco Services Co., subsidiary of Saudi Aramco, and OMV Austria signing on this year. Further announcements of additional sponsors are expected based on continued strong interest in this project.

More good news followed the sponsorship announcements as familiar faces were welcomed to take on leadership roles with the Project.

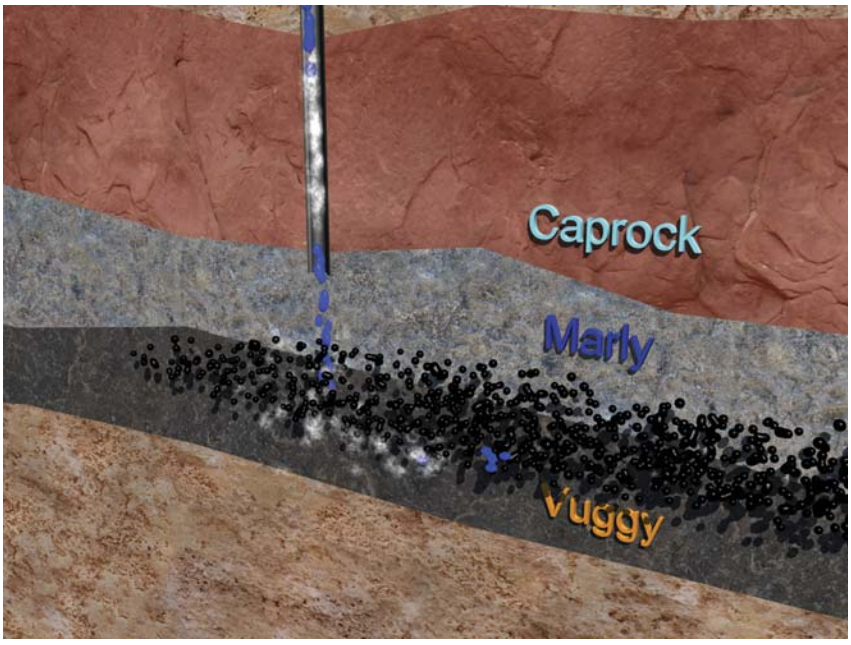
The PTRC was pleased to announce Dr. Carolyn K. Preston as the new Executive Director. Carolyn brings much experience and knowledge to the PTRC, having worked as the Project Integrator from January 2006 and prior to that Natural Resources Canada's research manager responsible for the Project and the PTRC's EOR Program.

Dr. Frank Mourits from Natural Resources Canada has stepped into the role of Project Integrator, ensuring the coordinated progression of both the Technical and Policy Research Components of the Final Phase. Frank is familiar with this role, having acted as interim Project Integrator in the first quarter of 2007.

For more information on the project, visit: www.ptrc.ca or email: info@ptrc.ca.



Water (blue) and CO_2 (white) are compressed and injected into oil reservoirs for enhanced oil recovery. Roughly 30% of the CO_2 returns to the surface with the oil (black), where it is separated and recycled.



Water (blue) and CO_2 (white) are used in the Weyburn and Midale fields for enhanced oil recovery in the Marly and Vuggy layers. It is the dense, impervious caprock which research shows, is capable of securing CO_2 underground, in the Marly and Vuggy layers, post-production.

CO_2GeoNet Training and Dialogue Workshop on CO_2 Geological Storage

CO_2GeoNet, the European Network of Excellence on geological storage of CO_2, held its first Training and Dialogue workshop entitled 'What does CO_2 geological storage really mean?' on October 3rd 2007 in Paris, at the Salons Hoches. The aim was to deliver clear and unbiased scientific information and to encourage dialogue on essential questions concerning the technical aspects of CO_2 geological storage.

Six state-of-the-art presentations were prepared by a panel of eminent scientists from CO_2GeoNet, based on the experience acquired over more than a decade of research and demonstration projects worldwide:

1. Where and how much CO_2 can we store underground?
2. How can we inject large quantities of CO_2?
3. What is the fate of CO_2 in the storage reservoir and are there any related physical and chemical changes?
4. Could CO_2 leak from the storage reservoir and what would be the effects on humans and ecosystems?
5. How can we monitor the storage site at depth and at the surface, and why is this necessary?
6. What safety criteria - i.e. conditions for safe storage - need to be imposed and respected?

Two dialogue sessions were held to encourage participants to ask questions and exchange views on the presentations and the technology in general. More than twenty questions were raised by the audience, covering:

- technical aspects (does CO_2 injection modify reservoir pressure or displace the fluids?, what is the impact of impurities?);
- the experience gained from decades of EOR techniques;
- safety issues;
- what is being done to match CO_2 sources and sinks?;
- what can be learnt from the demonstration projects? (how successful is the modelling?; can we predict what will happen?);
- site selection (do the reservoirs offer sufficient capacity to achieve the targets of reducing CO_2 emissions?; could we use low-permeability reservoirs?);
- eventual leakage (is there an acceptable rate?; how can this be detected/predicted?; what would be the worst case scenario?);
- is the storage reversible?; could we recover the CO_2?

The audience spanned a wide range of stakeholders, industrialists, engineers and scientists, policymakers, journalists, NGOs, sociologists, teachers and students: in total, 170 people from 21 different countries subscribed and had the opportunity to share their views and gain a better vision of the whole picture of CO_2 geological storage.

The feedback from the workshop proved it a great success, with many participants highly satisfied and much encouragement to renew the experience elsewhere in Europe as soon as possible.

For further information contact: the CO_2GeoNet Secretariat: info@co2geonet.com or visit www.co2geonet.eu where the workshop presentations can be downloaded.

The CO2GeoNet meeting in progress at the Salons Hoches in Paris

3rd Oxy-Combustion Workshop

IEA GHG will be holding the 3rd International Oxy-Combustion Workshop in Yokohama, Japan on the 4th to 6th of March 2008. The workshop will be hosted by IHI, JPower and JCoal.

The planning is now in full stream. We have now closed the call for abstracts and have received more than 30 proposals. These are currently being reviewed and a draft agenda will be published by the end of 2007.

Please note that if you need a letter of invitation to apply for a visa to attend this workshop, please contact Stanley Santos (stanley@ieaghg.org) or Sian Twinning (sian@ieaghg.org) as soon as possible.

Further information and updates to the workshop will be posted on our website (www.co2captureandstorage.info).

Developments in Oxy-Combustion Technology with CO_2 Capture

2007 has been very interesting in the annals of the development of Oxy-Combustion Technology with CO_2 Capture for power generation.

Since the last update, presented during the 2nd International Oxy-Combustion Workshop, several new activities have been announced. Unfortunately, not all news has been good news.

Some of the important news in the development of oxy-combustion technology for power generation with CO_2 capture is summarised below.

Vattenfall's Schwarze Pumpe Pilot Plant Project, Germany. Construction started in the early part of this year. Last September, the 30MWth furnace module and CO_2 tank module were delivered and progress in the construction of the pilot plant is within schedule with commissioning of the plant expected to start by May 2008. (See related article).

TOTAL LACQ Project, France. The LACQ project has also been proceeding well, with major contract items having been awarded. The retrofitting of the existing boiler has been awarded to Alstom Power and the delivery of ASU, CO_2 processing and compression unit, and the oxy-combustion burners has been awarded to Air Liquide. The retrofitting of the ~30MWth boiler is expected to start in the early part of 2008. It was estimated that plant will be commissioned by the end of 2008 or early part of 2009.

CIEMATS Oxy-Combustion Project, Spain.
CIEMAT announced in September that the contract for construction of the 20MWth oxy-PC boiler and 15MWth oxy-CFB boiler was awarded to Foster Wheeler. Construction of the CIEMAT Research Facilities for Carbon Capture technology is expected to start in 2008. Further details will be presented during the 3rd Oxy-Combustion Workshop in Japan.

Jamestown Public Utilities Oxy-Combustion Project, USA. Foster Wheeler and Praxair jointly announced in July the development of a 50MWe oxy-combustion power generation with CO_2 capture project for Jamestown Public Utilities in New York. The feasibility study is now on-going and investment decision for the project to proceed is said to be expected in early or mid 2008.

Doosan Babcock Oxy-Coal Burner Test, UK.
Doosan Babcock has now secured the funding for the 40MWth oxy-coal combustion burner test to be undertaken at their Renfrew facility in Scotland. This test is the world's largest oxy-combustion burner test to be implemented and the biggest UK Oxy-Combustion Project participated by the UK power generation industry and co-funded by UK BERR (formerly UK DTI). It is expected that the combustion test will start in 2008.

Babcock and Wilcox, American Air Liquide – Clean Environment Development Facility, USA. Last summer, B&W initiated the retrofitting of 30MWth furnace for oxy-combustion research. Key modifications include the addition of SO_2 and water vapour removal unit via a full scale scrubber, coal dryer, oxygen supply and distribution, Floxynator (oxygen and flue gas mixing device). Burner tests will proceed using various ranges of US coal.

SaskPower Oxy-Combustion Project, Canada.
It is very unfortunate that SaskPower announced in September plans to shelve their 300MWe oxy-combustion clean coal project. It was supposed to herald a very big step forward in the development of oxy-combustion; unfortunately, it clearly shows that cost of building such a plant has been spiralling upward.

Vattenfall's Schwarze Pumpe Oxy-Combustion Pilot Plant Project - Update

It is amazing that 2008 will be an important year in the development of oxyfuel combustion of coal with CO_2 capture.

Yet, looking back 30 years ago, this concept only existed on paper wherein the first feasibility study was undertaken by Babcock and Wilcox in 1978 for the oil and gas industry considering the option of capturing CO_2 from a coal fired power station for EOR application.

Next year, this type of plant is a reality. We are going to witness a very big step forward in the development of oxyfuel combustion technology.

This article will provide a brief update in the current development in the Vattenfall's 30MWth Oxyfuel Pilot Plant in Schwarze Pumpe, Germany.

The concept of oxyfuel combustion is simply explained as burning coal with nearly pure oxygen instead of air; and then using the heat provided by this process to produce steam that will drive generators to produce electricity.

What Makes Vattenfall's Project a Pioneering Project?

It is important to note that oxyfuel combustion for power generation with CO_2 capture is the least developed among the three leading options for capturing CO_2 in a power plant.

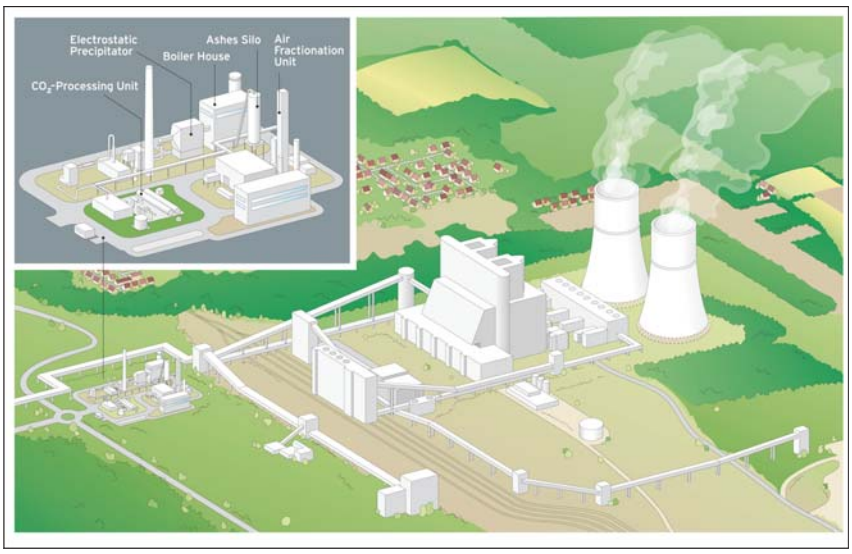


Figure 1: Artists impression of the Schwarze Pumpe Oxy-Combustion Pilot Plant (Courtesy of Vattenfall AB)

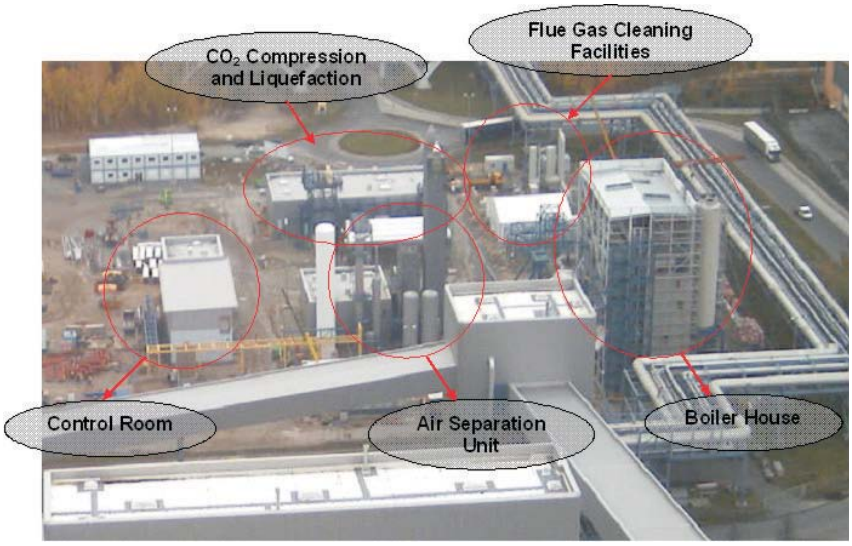


Figure 2: Schwarze Pumpe Oxy-Combustion Plant as of November 2007

Vattenfall's project would be a big step forward in establishing the needed confidence in this technology in the context of large scale application and operation of a complete capture plant. Any success to this work would further help in the maturity of this technology towards its commercialisation – particularly it is important to note that any experience gained from this project will provide an important contribution toward the development of this technology for new built power plant with CO_2 capture.

The artist view of the Schwarze Pumpe pilot plant is shown in Figure 1 above.

Brief Description and Update to the Vattenfall's Oxyfuel Project

The ceremonial ground breaking for the construction of the plant was in May 2006 which was led by her Excellency Chancellor Angela Merkel.

The construction of the boiler, burner and its auxiliaries was awarded to Alstom Power. The delivery and installation of the air separation unit, the CO_2 processing and compression unit was awarded to Linde Engineering. The construction of the plant started in early part of 2007.

As of November 2007, the tower furnace, the CO_2 storage tank and the main heat exchanger of the Air Separation Unit were delivered and installation of these units is on-going (Figure 2).

It was reported that construction works were on-time and commissioning of the plant started in May 2008 which included the start up, functional trials, and various trial runs for the test programme.

The main test programme commenced in August 2008 and the internal test trials will be completed by 2011.

The Future of Oxyfuel Power Plants

The future of oxyfuel combustion relies on the various pioneering projects to make it a reality for commercial application. Vattenfall's Schwarze Pumpe 30MWth Pilot Plant project is surely one of them.

The purpose of the pilot plant is to validate and improve technology around capturing carbon dioxide. Vattenfall has chosen to test the Oxyfuel Combustion capture technology at the pilot plant since it builds on existing power-cycle technology. Indeed this project will provide a very good platform in establishing the necessary confidence to this technology.

The commitment given by Vattenfall toward to the development of CO_2 capture and storage development truly deserve the accolade of pioneering work contributing towards the development of a competitive technology option of capturing CO_2 in a coal fired power plant.

A Capacity Building Effort for CCS and CDM in Africa

Recently the IEA GHG participated in two conferences that were organised for the CCS-Africa project. The objectives of the project are to raise awareness of CCS as well as to build capacity for CDM in the African region. The two regional workshops were aimed at multiple decision-making levels and were held in September 2007, in Dakar (Senegal) and Gaborone (Botswana). Each workshop attracted some 70 participants from government, non-governmental organisations and the private sector. This diverse group of stakeholders showed great engagement in the discussions around CCS and CDM, leading to lively discussions. Along with the IEA GHG the project was supported by Shell, Statoil, UK DBERR and the Norwegian Ministry of Foreign Affairs. The project was led by ECN and further implemented by ENDA in Senegal, and EECG Consultants in Botswana.

Both workshops followed a similar format with Day 1 focusing on CCS and Day 2 on CDM. Day 1 featured an array of presentations giving an introduction to the technology, cost, risks and other impacts of CCS including the status of CCS under the CDM process. Of particular interest were the presentations on CCS and its impact on local sustainable development. Day 2 involved presentations aimed at improving the implementation of CDM projects in African countries. This included looking at small-scale projects, bundling and programmatic CDM and a practical guide to completing a project design document (PDD). The workshops then separated into breakout groups, each of which was asked to come up with a hypothetical CDM project, complete its PDD and present it to the main group. Each day was concluded with a panel session to discuss issues raised throughout the day's presentations.

Extracting the most relevant issues from the discussions shedding light on relevance of CCS for African countries, the following conclusions can be drawn:

- The priority for Africa is economic development. In order to achieve this increase in energy consumption is necessary. As far as CCS can help this the technology could be useful, but climate change mitigation is not a priority for the continent.

Delegates of the regional workshop held in Dakar, Senegal

- There is potential for CO_2 capture from point sources in many African countries, as well as significant CO_2 storage potential in some regions. In addition, enhanced oil/gas recovery or enhanced coal mine methane provide interesting opportunities for synergies between climate change mitigation and fossil fuel resource utilisation.
- The CDM is the only mechanism currently that has the potential to incentivise CCS in Africa. In that light inclusion of CCS in the CDM can be considered by African UNFCCC parties.
- South Africa is hosting a meeting of the Carbon Sequestration Leadership Forum in April 2008 and this offers another opportunity to enhance CCS knowledge of the African participants.
- Early demonstration projects in the African region could help build more confidence in the technology and funds could be set up to support this.
- Further opportunities to hold similar forums of exchange of experiences and monitor progress with regard to CCS should be used. Power utilities should be involved particularly as they are the likely beneficiaries of CCS.

The lively discussions around the panel sessions on CDM in Africa raised general recognition and many suggestions for improvement from the panellists and participants, of which the major points are summarised below.

- The capacity for expanding CDM opportunities is there in Africa but requires coordination between national and local governments, private sector and CDM experts.
- There is a need for Africa to see CDM as a business investment opportunity
- A number of successful demonstrations that CDM is working well will provide more confidence to project developers and investors
- Africa needs to identify CDM champions, identify their CDM potential, and support project development.

- Africa regions suffer from a 'bad image' where unstable countries provide for a risky environment to invest in. This image needs to be improved, and in parallel the investment climate in African countries should be improved.
- Finance is available through the African Development Bank (AfDB) who are establishing a climate change unit in the environment unit that could handle issues of CDM.
- There are also significant resources being channelled to Africa for energy, hence there is a need to tap on those opportunities.
- It is generally recognised that CDM will continue beyond 2012 as some strong non-Annex I countries are quite advanced in promoting CDM and Annex I countries have expressed clear indications that CERs will continue to be used, ensuring demand for CDM projects after 2012.
- New developments in CDM such as Programmatic CDM and the possible eligibility of avoided deforestation are likely to provide valuable opportunities for African countries.

More information on the CCS Africa Project can be found at www.ccs-africa.org or by contacting Brendan@ieaghg.org or Heleen de Coninck (deconinck@ecn.nl).

Demonstration of CCS in Europe and China

Implementing the EU China Near Zero Emissions Coal Demonstration

On 2nd October 2007, over 50 Carbon and Capture and Storage experts from European Member States (including Norway, France and the Netherlands), the European Commission, Industry and Academia gathered at the British Ambassador's Residence in Paris to discuss 'Implementing the EU-China Near Zero Emissions Coal Demonstration.

Organised by the UK and the European Commission, the event was opened with introductory remarks by Defra Minister Joan Ruddock, who stressed the importance of encouraging the deployment of CCS technology in emerging economies such as China and India.

Nick Otter (Alstom) then outlined the work of the Zero Emissions Platform and the development of the Flagship Programme adding that the Industry platform was recommending that demonstration with China and India should be placed at the same strategic level as demonstration in Europe. Wiktor Raldow from (DG RTD) then described the connections between the current Framework Programme 7, the priority for CCS and the need to find a mutual 'win-win' arrangement with the Chinese. Finally, Matthew Webb (Defra) presented an update on current progress under the NZEC initiative, some initial estimates of costs of demonstration in China and a 'straw-man' model for implementing the NZEC demonstration objective.

A moderated discussion was then facilitated by Paal Frisvold (Bellona) considering questions, including: What was the critical pathway to implementing and financing the EU-China demonstration? How should the NZEC initiative be coordinated with the EU's aspiration for 10-12 demonstration projects by 2015?

A lively discussion followed. There was a general acceptance of the importance of engaging China on CCS and the essential role that projects like NZEC would need to play. On financing, the role of market mechanisms was emphasised and the rapid inclusion of CCS within the CDM raised as a key issue. Speakers noted that it was important to maintain the pace of demonstration in Europe at the same time as building capacity for deployment in China and India.

It is anticipated that further events will be held as the NZEC initiative gathers momentum. For further information about this or future events please contact matthew.j.webb@defra.gsi.gov.uk.

China and the IEA Agree to Collaborate on Energy Technology

The Chinese Ministry of Science and Technology (MOST) and the International Energy Agency (IEA) have agreed that their experts will work together on the development of advanced technologies for secure, clean and affordable energy supplies. The agreement follows two days of discussions between experts from MOST and the IEA. The discussions were led by Mr. Shi Dinghuan, a member of the State Council and Ambassador William Ramsay, Deputy Executive Director of the IEA. Ambassador Ramsay said "there are many joint issues to tackle and much common ground for future activities. I am delighted that we have reached this agreement."

This initiative is in response to the Plan of Action established when the G8 met in Gleneagles in 2005 with the President Hu Jintao of China and leaders of other major newly industrializing countries.

The 2nd in a series of outreach events by the IEA's Network for Expertise in Energy Technology. This was held on 1-2 November in Beijing, China

During the discussions, Mr. Zhang Zhihong, Deputy Director-General of the Department of High and New Technology Development and Industrialization of MOST, introduced measures to promote energy conservation and emissions reduction, and expressed sincere wishes to strengthen cooperation with the IEA in energy conversation and emissions reduction at the policy and technical level.

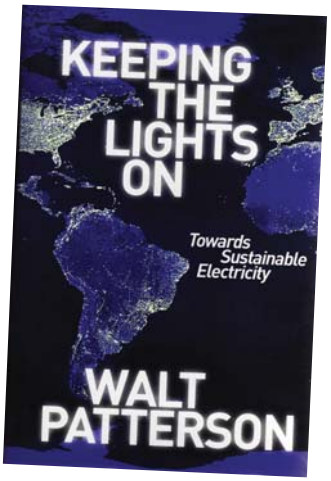
The areas for international collaboration include clean and efficient coal combustion, coal conversion, CO_2 capture and storage, renewable energies such as wind, solar, geothermal and bioenergy, heat pumps, hydrogen, and scenario analysis. The collaboration will involve the IEA's network for energy technology (NEET) collaboration which includes more than 5000 experts worldwide on all major energy technologies. China is already a full member of some of the technology agreements in this network and its participation is expected to increase. High level experts from 11 "Implementing Agreements" and Working Parties of the IEA network took part in the talks together with experts from MOST, the China Coal Research Institute, and other Chinese energy technology institutions.

This is the second in a series of outreach events of the IEA outreach initiative NEET (Networks for Expertise in Energy Technology) following the successful event held in South Africa in February this year. Further such events are planned for Brazil, India, Mexico and Russia.

For further information please contact Dr. Antonio Pflueger Tel: +33 6 07875098

Book Review - Keeping the Lights On

In Keeping the Lights On, Walt Patterson starts from the simple premise that we are making an unnecessary mess of electricity supply mainly due to the legacy of the old large power station and transmission network system. He explains his ideas for improving energy security and services while reducing costs and vulnerability.



In summary, Walt Patterson's message is this; electricity needs a new story. The old one is out of date, boring and wrong. In the traditional version, electricity is a fuel like any other. Someone makes electricity in power stations, and delivers it to users over networks of cables. A better power station is usually a bigger one, farther away. Producers and users sell and buy electricity as a commodity, by the unit. The power stations and networks have to be financed and built. The government imposes regulations to ensure that all participants are treated fairly. Electricity users are independent. They buy their own electrical equipment and attach it to the system as loads. As they switch loads on and off, the rest of the system has to respond accordingly. Someone has to keep the system stable, and ensure that the system has enough generation and network capacity to meet the maximum possible load that users can connect. Someone has to keep your lights on, someone else, not you.

However, in reality one-third of the world population does not have electricity at all, and the rest of us have trouble keeping the lights on. The main technologies of traditional electricity – large dams, coal-fired and nuclear power stations, and overhead transmission lines are in major financial and environmental trouble.

Patterson defines the elements of power generation and supply carefully. Electricity is not a fuel. It's not a commodity. It's a process, occurring simultaneously and instantaneously throughout an entire, interconnected circuit. A process cannot be stored. A fuel such as coal comes out of the ground, and is carried somewhere to be used. But you can start the electricity process anywhere, in a huge range of ways, from vast to minute. Electricity exists only in the infrastructure of assets that generate it, deliver and use it, and through which it flows. Electricity is thus a function of infrastructure. Electricity can be produced and used without fuel, but not without infrastructure. The flow of electricity through the infrastructure is easy to measure; but the price of a unit of electricity is ultimately arbitrary. The price of a unit depends on the price of any fuel, and on asset accounting, taxation, regulation, risk, subsidies, network and system effects, and other factors usually unmentioned. The arbitrary price of an ephemeral kilowatt-hour is not an adequate basis for the requisite finances, transactions and business relations.

What matters is the infrastructure of the electricity system – who owns it, who has access to it, who uses it and on what basis. To deliver electricity services more reliably and sustainably, we need not only to upgrade the electric infrastructure, especially the end-use technologies, but to transform it. The old centralized system of large remote power stations and a network including long high-voltage transmission lines used to make sense. It no longer does. Most

central-station generators operate either intermittently or at only partial load most of the time, misusing costly assets. Fuel-based central generators waste two-thirds of the fuel energy before it even leaves the power plant. On many systems line losses cost another significant fraction. The configuration is inherently vulnerable to disruption. Traditional electricity assumes that every load is essentially equivalent, requiring the same high quality of electricity, whereas much is used for undemanding services such as heating and cooling.

Patterson concludes that a better way is possible. Wind turbines, microhydro, biomass generators, photovoltaics, gas engines, microturbines, fuel cells, Stirling engines, and microcogeneration all exhibit economies not of unit scale but of series manufacture. Small scale generators can often be located close to loads, even on site, dramatically altering network requirements and operation. Instead of a radial one-way network, a decentralized system would have a two-way meshed network, with loads and generators of broadly comparable sizes more or less uniformly distributed across the system. Monitoring and control technologies now indeed offer the possibility of completely self-stabilising systems, in which loads and generators talk to each other continuously and react accordingly.

Walt Patterson is a fellow of the Energy, Environment and Development Programme at Chatham House, the Royal Institute of International Affairs, in London.

Keeping the Lights on – towards sustainable electricity by Walt Patterson, 2007 Earthscan, 195 pp, ISBN 978-1-84407-456-3

Fossil Fuel Efficiency Projects to Come Under CDM

The Executive Board of the Clean Development Mechanism (CDM) has decided that projects that increase the combustion efficiency of fossil fuels can now qualify for registration under the CDM.

The Board has approved a methodology for monitoring emissions from fossil fuel efficiency projects and for setting the emissions baseline against which their emission reductions can be measured. A critical challenge that the Board had to overcome in fine-tuning the methodology was to find a way to prevent such projects from inadvertently prolonging the use of fossil fuel or competing against renewable sources of energy. One way the Board did this was by building in a phase-out feature that limits the number of certified emission reduction credits (CERs) that can be earned. Another way was by limiting the number of projects eligible in a given country, based on a percentage of the fossil fuel (covered by the project) used in the country.

The new methodology became valid on 14 September 2007 and can be applied under the following conditions:

- the project activity is the construction and operation of a new fossil fuel fired grid-connected electricity generation plant that uses a more efficient power generation technology than that which would otherwise be used with the given fossil fuel
- the project is not a co-generation plant
- data on fuel consumption and electricity generation of recently constructed power plants is available
- the identified baseline fuel is used in more than 50% of total generation by utilities in the geographical area.

Baseline and monitoring methodologies are key features of each CDM project type, and are, among other things, designed to ensure that the reductions claimed are real, measurable, verifiable, and additional to what would have occurred without the project. To identify the baseline scenario in this methodology for new electricity generation plants, the following steps must be taken:

1. Plausible baseline scenarios should be identified, to include all possible realistic and credible alternatives that provide outputs or services comparable with the proposed CDM project activity.
2. The most economically attractive baseline scenario alternative should be identified, using investment analysis.

Furthermore, the additionality of the project must be demonstrated and the project boundary must be defined. When calculating the project emissions, only CO_2 is considered. 'Fossil fuel will remain a big part of the world's energy mix for decades to come. It's essential that we burn that fuel as efficiently as possible' said Hans Jürgen Stehr, Chair of the CDM Executive Board.

Under the CDM, projects in developing countries can earn saleable CERs by reducing greenhouse gas emissions. Industrialised countries can use these CERs to meet a part of their commitments under the Kyoto Protocol. The potential to earn CERs is expected to help reduce the high cost barrier to developing and then deploying clean-burn technologies.

As of September 2007, there were more than 780 CDM projects registered in 48 countries. These projects, and the roughly 1320 others in the registration pipeline, are expected to generate 2.2 billion CERs, each equivalent to 1 tCO_2, by the end of the first commitment period of the Kyoto Protocol in 2012.

US DOE Launches First Three Large-Scale Carbon Sequestration Projects

The US DOE announced in October that tests will be conducted for three large-scale carbon sequestration projects in the USA. The projects have been planned by the US DOE's Regional Carbon Sequestration Partnerships and will conduct large volume tests for the storage of 1 mtCO_2 or more, in deep saline reservoirs. The US DOE plans to invest $197 million over 10 years in the projects, whose estimated value is $318 million.

Twenty-seven US states and the Canadian provinces of Alberta, Saskatchewan and Manitoba are participating in the projects.

The formations to be tested during this third phase of the regional partnerships programme are recognized as the most promising of the geologic basins in the USA. Collectively these formations have the potential to store more than 100 years worth of CO_2 emissions from all major point sources in North America. The projects will demonstrate the entire CO_2 injection process at large volumes, including pre-injection characterization, injection process monitoring, and post-injection monitoring, to determine the ability of different geologic settings to store CO_2 permanently.

The three projects are: the Plains CO_2 Reduction Partnership; Southeast Regional Carbon Sequestration Partnership; and Southwest Regional Partnership for Carbon Sequestration.

Plains CO_2 Reduction Partnership

This project is led by the Energy and Environmental Research Center at the University of North Dakota, and it will take place in the Alberta and Williston Basins. The Williston Basin project in North Dakota will couple enhanced oil recovery (EOR) and CO_2 storage in a deep carbonate formation that is also a major saline formation. The CO_2 for the project will come from a post-combustion capture facility at a local coal-fired power plant. A second test will take place in northwestern Alberta, to demonstrate the co-sequestration of CO_2 and hydrogen sulphide from a large gas-processing plant into a deep saline formation. This should provide data about how hydrogen sulphide affects the sequestration process. Total project cost: $135,586,059 (DOE share $67,000,000).

The Plains Partnership has already begun a small-scale geologic field test studying CO_2 storage in a lignite seam in Burke County, North Dakota. In Phase 1, data about the coal seam will be collected in order to evaluate the seam's potential to produce coalbed methane. Five tests wells will be drilled to complete a geologic characterization of the coal seam. In Phase 2 CO_2 will be injected into the coal seam, and there is the potential to recover coalbed methane. The validation phase test will inject at least 400 tons (360 t) of CO_2 at a depth of about 1200 feet (360 m).

Southeast Regional Carbon Sequestration Partnership

The Southern States Energy Board is leading this project to demonstrate CO_2 storage in the lower Tuscaloosa Formation Massive Sand Unit. This geologic formation stretches from Texas to Florida and has the potential to store more than 200 years of CO_2 emissions from point sources in the region. CO_2 will be injected at two locations to assess different CO_2 streams and how the heterogeneity of the formation affects the injection and containment of CO_2. Injection of several million tonnes of CO_2 from a natural deposit is expected to begin in late 2008. A second injection into the formation using CO_2 captured from a local coal-fired power plant will take place subsequently. The results will help with the development of future CO_2 capture and storage opportunities. Total project cost: $93,689,242 (DOE share $64,949,079).

Southwest Regional Partnership for Carbon Sequestration

This project is co-ordinated by the New Mexico Institute of Mining and Technology. Several million tonnes of CO_2 will be injected into the Jurassic-age Entrada Sandstone Formation in the southwestern USA. The Entrada formation stretches from Colorado to Wyoming and is a significant storage reservoir in the region. CO_2 will be injected into the formation after extensive baseline characterisation and simulation modeling. The project will test the limits of injection and demonstrate the integrity of the cap rock to trap the gas. Information gained from the project will be used to evaluate locations throughout the region where power plants are being considered for the future. Total project cost: $88,845,571 (DOE share $65,437,395).

During the first 2 years of these projects, the injection sites will be characterized, and the modeling, monitoring and infrastructure improvements needed before CO_2 can be injected will be completed. Thus a baseline will be established for future monitoring after the start of CO_2 injection. Then, in each project, a large volume of CO_2 will be injected into a regionally significant storage formation. The injected CO_2 will be monitored and modeled to determine the effectiveness of the storage reservoir.

These three projects will double the number of large-volume carbon storage demonstrations in operation worldwide. The other large projects

are the Weyburn Project in Canada, Sleipner in Norway and In-Salah in Algeria. The new projects launch the third phase of the Regional Carbon Sequestration Partnerships programme which began in 2003. In Phase 1 more than 3,000 billion t of potential storage capacity in promising sinks was identified, which represents more than 1,000 years of storage capacity from point sources in the USA. In Phase 2 a portfolio of small-scale geologic and terrestrial sequestration projects was implemented.

CCS Demonstrator Will Put UK Ahead in Global Race for Clean Coal

The design specification for the UK's first Carbon Capture and Storage (CCS) plant was significantly refined at the start of October as John Hutton announced that the UK Government will support a single post-combustion coal-fired project.

Setting out the key criteria ahead of the planned formal launch of the Government's CCS competition in November, the Business and Enterprise Secretary said: "Finding cost-effective ways of using fossil fuels more cleanly is vital in meeting the twin challenges of climate change and energy security. " John Hutton has committed the UK Government to backing the construction within 7 years of one of the world's first commercial-scale coal-fired CCS projects. He continued by saying "our analysis shows that post-combustion capture is the most relevant technology to the vast proportion of coal-fired generation capacity globally. A commercial-scale demonstration of this technology, as part of a full CCS chain, opens up huge possibilities, not just for Britain but also for the world. It has the potential to remove and safely store up to 90% of damaging CO_2 emissions. The capture technology can also be retro-fitted to existing coal-fired plants. This will be vital in tackling climate change on a global scale – China alone built an average of one new coal-fired power station every four days in 2006. By 2030, wider deployment could see up to a third of Britain's electricity generated in this way and UK exporters of CCS technology and expertise cornering business worth many billions in a global market."

In the UK Budget in March, the then Chancellor Gordon Brown announced that the Government would launch a competition to support the building of a Carbon Capture and Storage demonstration in the UK. The current Chancellor, Alistair Darling, confirmed this commitment in the Pre Budget Report.

The project should demonstrate post-combustion CCS on a coal-fired power station, with CO_2 stored offshore. The Government will consider a phased approach to the project as long as the full CCS chain is demonstrated by 2014, and the project captures around 90% of the CO_2 emitted by the equivalent of 300MW generating capacity as soon as possible thereafter.

This competition will ensure the UK is a world leader in bringing forward this globally important technology for tackling climate change, relevant to the UK, to the EU's aspiration to have 10-12 demonstration projects by 2015, and vital for the transition to a low-carbon economy in China and India. The competition remains on track to be launched in November. John Hutton is launching a short period of discussion with industry, prior to the planned formal launch, starting with an Industry Day for prospective participants in the demonstration.

For further information see the Department for Business, Enterprise & Regulatory Reform website at www.berr.gov.uk and the Energy White Paper at www.berr.gov.uk/energy/whitepaper/page39534.html

UK's First CO_2 Capture Technology Pilot

RWE npower, the UK's largest electricity supplier, recently announced plans to design and build the first CO_2 capture pilot plant at a UK coal power station. The first phase could be fully operational by 2010 and will be located at Aberthaw Power Station in South Wales.

An initial £8.4m investment will focus on a 1MW capture plant, with further investment planned to support a capture and storage demonstrator plant of at least 25MW. This will act as a crucial test-ground for the potential of CCS technology as a means to generate low-carbon energy.

Both plants will be designed using post-combustion technology, which unlike alternative CCS approaches, can be applied to existing coal power plants. The pilot will enable RWE npower to develop a full understanding of both the technical and commercial issues relating to CCS and will allow the CCS concept to be tested in as close to real operational conditions as is possible. The larger capture and storage demonstrator plant would form part of one of their new, high efficiency supercritical power stations which are currently under feasibility and planning at existing sites in Tilbury, Essex and at Blyth, Northumberland.

Announcement of the RWE npower pilot plant comes ahead of the anticipated November launch of a government-sponsored competition for funding to support CCS development.

For more information see www.rwe.com/generator.aspx/presse/language=en/id=76864?pmid=4001863

CCS Network Planned For Northern England

A consortium of 25 businesses and research organizations are planning a shared carbon dioxide capture and storage (CCS) network in northern England. Apparently CO_2 would be collected from major industrial plants in Humberside and the Aire Valley region of Yorkshire and transported via pipeline to gas fields in the North Sea, for long term storage. This CCS infrastructure could sequester up to 60 mtCO_2 a year if industries along the River Trent were involved. (The UK emitted just over 560 mtCO_2 in 2006.)

Yorkshire Forward is the development agency that is reported to be leading the project, but at the moment it is not releasing any details. Businesses approached for the scheme include UK Coal and BP. A UK Coal spokesman said that it has been involved in discussions about the project, but only in a 'passive way'. BP said it had attended a meeting, but had not yet made a commitment. BP is still looking for opportunities in the UK after its planned CCS plant in Peterhead fell through due to delays in a decision on government support.

The businesses would work together to submit a regional bid, rather than individual/multiple bids, for a government competition, due to begin in November 2007, for funding to build the world's first end-to-end commercial-scale CCS plant. The competition was announced in June in the Energy White Paper and will provide financial support to a CCS project under the conditions that it has a capacity of at least 300 MW, at least 90% of the CO_2 is captured and it will be fully operational between 2011 and 2014.

Yorkshire Forward estimates that a worthwhile demonstration project is likely to cost about £250 million ($495 million), but 'would be a significant coup for the region' according to a board meeting report. Jeff Chapman, chief executive of the Carbon Capture and Storage Association (CCSA) said: 'A common infrastructure for Humberside would be most desirable. It is a good location due to a large amount of good, natural storage'.

Greenhouse Cuttings

BP and Powerspan Collaborate on CO_2 Capture Technology

BP Alternative Energy and Powerspan Corporation have announced their collaboration on Powerspan's CO_2 capture technology for power plants, called ECO_2. They will conduct pilot testing of an ammonia-based CO_2 capture technology, which would be the first test of its kind to demonstrate both CO_2 capture and sequestration at a conventional coal-fired power plant. The CO_2 captured will be sequestered in an 8,000 foot (2,400 m) test well. The testing is scheduled to begin in early 2008 at FirstEnergy's plant in Shadyside, Ohio. The US DOE's Midwest Regional Carbon Sequestration Partnership is also collaborating on the project.

After testing the pilot plant, BP and Powerspan hope for full-scale commercial deployment of the technology. US DOE estimates that the ammonia-based CO_2 capture process could be more cost effective than commercially available amine-based capture technologies, and could be retrofitted to existing coal-fired power plants.
www.bp.com/genericarticle.do?categoryId=7014&contentId=7035282

NRG and Powerspan Announce Large-Scale Demonstration of CCS for Coal-Fueled Power Plants

NRG Energy, Inc. and Powerspan Corporation have just announced their memorandum of understanding to demonstrate at commercial scale, one of the most promising technologies for CO_2 capture from conventional coal-fueled, electric power plants using Powerspan's ECO_2(TM) technology. The post-combustion, regenerative process uses an ammonia-based solution to capture CO_2 from the flue gas of a power plant and release it in a form that is ready for safe transportation and permanent geological storage.

To date, CO_2 capture demonstrations on coal-fueled power plants have been conducted only at pilot scale, or one to five megawatts (MW) of electricity. This CCS demonstration, which will be conducted at NRG's WA Parish plant near Sugar Land, Texas, on flue gas equal in quantity to that from a 125 MW unit, is expected to capture and sequester about one million tons of CO_2 annually -- ranking it among the world's largest CCS projects and potentially the first to achieve commercial scale capture and sequestration from an existing coal-fueled power plant.

Once captured, the CO_2 is expected to be used in enhanced oilfield recovery operations in the Houston area. Powerspan's ECO_2 demonstration facility will be designed to capture 90 percent of incoming CO_2 and is expected to be operational in 2012.

For more information visit www.snl.com/irweblinkx/file.aspx?IID=4057436&FID=5109620 www.nrgenergy.com and www.powerspan.com

Tokyo Climate Change Strategy

In June 2007 the Tokyo Metropolitan Government announced its Climate Change Strategy. The strategy has five policies:

1. In the business sector, CO_2 emissions from large emitters will be capped and financial institutions will be asked to expand their ranges of environmental investments and loans.
2. Domestic emissions of CO_2 will be reduced by a campaign to eliminate incandescent lights and by encouraging household photovoltaic power generation.
3. A 'no-carbon' style of urban planning will be promoted by applying strict energy-efficiency standards to all city-owned buildings.
4. Emissions from cars will be reduced by establishing preferential regulations for fuel-efficient cars, and by a project to facilitate the use of more environmentally-friendly fuel.
5. Tokyo's own programmes to reduce CO_2 emissions will be created by supporting the efforts of smaller companies and households and by the introduction of a tax system to promote energy conservation.

See www.japanfs.org/db/1822-e

'Cool the Earth' Competition

A 'Cool the Earth' competition was organised by the Eco Business Creation Association in Japan. It called for ideas to reduce CO_2 emissions. Prototype projects will be conducted in Japan, based on the ideas received. The ideas were judged on three criteria:

1. Innovative – ideas are sought that are creative and innovative
2. Viable – concrete goals or plans of action should be demonstrable
3. Effective – the idea should be able to actually reduce emissions of greenhouse gases.

Eighty seven applications were received and the winners were announced in October. The winning ideas included reducing our consumption of meat and dairy products, and the introduction of a personal carbon credit system. There was also a special prize for the idea of launching a Japanese Environment Day when school children would plant trees. See: http://eco.goo.ne.jp/topics/cooltheearth/english/result.html

Alcoa Alumina Industry in Australia to Store CO_2

Bauxite residue is a mixture of minerals left behind when alumina is removed from bauxite. The residue retains some alkaline liquor and requires long-term storage. Alcoa in Australia has developed a process known as residue carbonation which adds CO_2 to the bauxite.

Adding CO_2 to the residue reduces its pH level to that found naturally in many alkaline soils. In this state the residue then has the potential to be re-used in road base, building materials or soil amendments. The carbonation process also fixes the CO_2, which is a by-product from a nearby ammonia plant. In addition, residue carbonation reduces residue drying times and the area required for residue storage. Carbonated residue is also less dusty. Since January 2007, the Kwinana carbonation plant has been operating at full capacity, treating all of the residue produced by the refinery. The plant will lock up 70000tCO_2/y.

Alcoa's Technology Delivery Group is conducting further research to support the deployment of carbonation in refineries that do not have a nearby CO_2 supply like the Kwinana refinery. The research is looking at options for extracting CO_2 from powerhouse emissions and using it to carbonate residue. Alcoa plans to deploy the technology across all three Western Australia refineries, leading to annual savings of 300 000 tCO_2. For information visit: www.alcoa.com/australia/en/info_page/pots_rd.asp

First Annual US Coal Mine Methane Conference

The first annual US coal mine methane (CMM) conference was held in September in St Louis, Missouri. There were over 80 participants from the coal industry, technology and project developers, and carbon funds. The conference covered the technical, legal, regulatory, policy and finance issues surrounding coal mine methane project development in the USA. Innovative technologies and case studies of successful CMM projects were presented. There was also a field trip to CMM projects at two abandoned mines in Southern Illinois. For more information, visit www.epa.gov/coalbed

Three German Groups to Develop CO_2 Scrub System

Power company RWE, chemicals giant BASF and Linde a leading industrial gas maker have announced their co-operation in building and operating a pilot plant 'to test new developments and solvents from BASF for the capture of CO_2 – so-called CO_2 scrubbing'. Linde is to handle engineering and construction of the pilot facility, which will be located at an RWE power plant in southwestern Germany. The aim of the plant is the long-term testing of new solvents and the improvement of CO_2 capture technology. More than 90% of the CO_2 from the combustion gas of a power plant should be able to be removed with new technology.

After the pilot tests, the German group plans to build a demonstration plant in 2010, and the goal is to apply CO_2 capture commercially in lignite-fired power plants by 2020. RWE has allowed around 80 million to develop, build and operate both the pilot and demonstration facilities. For information visit: www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MjY0Mzg

US EPA to Develop Regulations for Geologic Storage of CO_2

The US EPA has announced plans to develop regulations to establish a clear path for the geologic storage of CO_2. The regulations will aim to ensure that there is a consistent and effective permit system under the Safe Drinking Water Act for commercial-scale geologic CO_2 storage programmes. The US EPA is working with the Department of Energy as it carries out its carbon storage R&D programme and is also co-ordinating efforts to evaluate potential impacts on health, safety and the environment.

The Safe Drinking Water Act established the Underground Injection Control (UIC) programme to allow the safe injection of fluids into the subsurface in a manner that does not endanger current or future underground sources of drinking water. The US EPA plans to propose regulatory changes to the UIC programme in the summer of 2008 and will invite the public and stakeholders to provide input throughout the rule development process.
For more information, see www.epa.gov/safewater/uic/wells_sequestration.html

Workshop on Treating CBM Produced Water

Catalyx Fluid Solutions, a division of RG Global, hosted a workshop on 25 October in Gillette, Wyoming to compare a range of technical solutions to mitigate the environmental impact from coalbed methane (CBM) produced water and to reduce the treatment costs of the produced water.

A number of governments, such as the USA, Canada, China and others are pushing for the increased use of CBM as a clean-burning unconventional fuel to reduce dependence on traditional fossil fuels. However, environmental concerns and costs have been major factors limiting its use. The workshop addressed these factors and the ability of CBM produced water to comply with state and federal requirements for discharge water. Various CBM produced water treatment options were covered, including reverse osmosis, ion exchange, electrodialysis and others. Technical comparisons were made of new technologies that are being used by some of the largest natural gas and CBM production companies in the Powder River Basin and other areas.

For further information, see www.CBMwatertreatment.com

Saskatchewan Decides on its Energy Supply

The Government of Saskatchewan has made its energy supply decision for the medium-term (2010-2014). The strategy includes investing in up to 400 MW of simple cycle natural gas-fired generation (SCGT). SaskPower will offset the greenhouse gas emissions from these turbines by using a carbon credit system (which is still to be established). The SCGT has a capital cost of about $525 million, which makes it a relatively low capital cost option.

SaskPower is also going to expand its Green Power portfolio to include:
- Wind generation, with a goal of an extra 100 MW by 2012.
- Waste heat recovery projects, with a goal of 50 MW by 2010.
- Biomass forestry projects, with a goal of 20 MW by 2010.
- A net metering programme to allow customers to generate their own electricity and sell excess electricity to the grid, thereby encouraging small-scale renewable energy projects.
- Phase 3 of the Environmentally Preferred Power Program, to encourage further renewable power projects from the private sector.
- Energy efficiency and conservation programmes.
- The establishment of a Hydroelectric Development Unit.

These projects should help Saskatchewan achieve its goal of having 30% of electricity generated from renewable sources by 2020.

In preparation for this supply decision, SaskPower investigated and analysed a number of supply options, including clean coal, polygeneration and large-scale hydro. SaskPower will continue to explore these and other options for its next supply decision, due in 2009.

'We remain fully committed to exploring clean coal as a supply option in the longer-term' Pat Youzwa (President and CEO, SaskPower) said. 'Over the last year, our feasibility work has given us a great deal of confidence in clean coal from a technology perspective. But, given the need for new supply by 2010, and given the costs of clean coal at this early stage in its development, it would have been premature to proceed to the construction phase at this time'.

SaskPower will continue to study clean coal, and it will be one of the supply options considered again in 2009 for the post-2014 period.

For further information see www.saskpower.com/poweringyourfuture/

ZeroGen, Australia

The Australian ZeroGen power plant project aims to combine Integrated Gasification Combined Cycle (IGCC) technology with CO_2 capture and storage (CCS). The linking of IGCC with CCS has the potential to reduce CO_2 emissions by over 75% for the demonstration plant, and by up to 90% in full scale commercial plants. It is proposed that the ZeroGen plant will be built next to the existing Stanwell Power station near Rockhampton in central Queensland. The CO_2 will be captured at the site and transported 220 km by pipeline for storage in deep underground reservoirs in the Northern Denison Trough.

In the first phase of testing, known as Drilling Program One (DP1), two test wells were drilled, both up to about 1500 m deep. DP1 has been completed successfully. Results have established that CO_2 can be safely injected and stored in saline formations in the Northern Denison Trough. The second phase, DP2, aims to identify reservoirs with sufficient capacity to store safely the CO_2 from the proposed IGCC plant (up to 400,000 t/CO_2/y). It will also investigate cost considerations associated with on-shore CO_2 storage, and effective monitoring and verification techniques. The combined analysis of the results from both DP1 and DP2 will have to confirm the ability of cost-effective and secure storage of CO_2 in deep saline reservoirs. This is a critical decision point that will influence significantly whether or not the project proceeds.

The ZeroGen feasibility study will consider issues such as plant engineering, the design of the CO_2 injection and storage programme, pipeline easement and land access, native title and cultural heritage, an environmental impact statement, and comprehensive stakeholder engagement with landholders, the community, government and environmental NGOs.

Approval to commit to construction of the plant and pipeline infrastructure could be in place by late 2009. The plan is for construction to be completed by late 2011, with the demonstration plant operational shortly after.
www.phillipsgroup.com.au

News for IEA GHG Members

This section is provided specifically for readers in member countries and sponsor organisations (see list on the back page). Reports on IEA GHG studies are freely available to organisations in these member countries and sponsor organisations. Please contact IEA GHG for further details. For Non-Member countries, reports can be made available by purchase at the discretion of IEA GHG. Reports recently issued include:

- **CO_2 Capture from Medium Scale Combustion Installations (Report No. 2007/7)**
  This report assesses the potential application of CO_2 capture to medium scale (1-100MWth) combustion installations. The study reviews the types of medium scale combustion installation and their capacities in selected regions. CO_2 capture technologies are reviewed and costs are estimated by way of case studies. Amine scrubbing plants for capture of CO_2 from medium scale gas fired boilers are commercially available. Novel technologies, for example based on membranes, offer the possibility of lower costs but major development work is still needed. Costs of capture depend strongly on local conditions, particularly the operating load factor.

- **2nd Meeting of the Risk Assessment Network. (Report No. 2007/10)**
  The second meeting of the international risk assessment network was held in California, USA and was hosted by Lawrence Berkeley National Laboratory. The workshop aims were to: review of the current status of risk assessment using case studies, assess the role of risk assessment in the framework of risk management, and to assess how best to communicate the results of RA studies to a broader non technical audience.

  The meeting continued the progress made at the launch network meeting, in developing our understanding of the status of risk assessment in its application to CCS and developing the role that risk assessment can play.

- **Remediation of Seepage from CO_2 Storage Formations (Report No. 2007/11)**
  It is important to ensure that CO_2 once injected into a geological formation, is effectively contained there. This study has reviewed the potential for remediating seepage of CO_2 from geological storage formations. A 5 point plan is then proposed to minimise seepage. This plan comprises a combination of detailed site characterization, risk assessment, a monitoring programme, modeling of the CO_2 plume and remediation planning in the event that seepage is identified. The costs of such a plan have been considered and overall, based on a case study, would add between $0.45 and 0.5/t to the cost of a CO_2 capture and storage operation. Compared to the total cost of a CCS project ($35 -50/t CO_2) the additional cost for remediation planning can be considered as low.

- **Distributed Collection of CO_2 (Report No. 2007/12)**
  This study examines the design issues and costs of collecting CO_2 captured from multiple distributed sources down to quantities of 5000 tpa. It includes a spreadsheet model for sizing pipelines in a branched collection network with multiple pressure levels. This model also estimates overall collection costs including those for compression using unit costs for construction in the UK.

Conferences & Meetings

Emerging Opportunities in Carbon Markets. 17th-18th January 2008, The Westin Colonnade Coral Gables, Coral Gables FL, USA Contact: Environmental Finance Conferences, Tel: +44 (0) 20 7251 9151 Fax: +44 (0) 20 7251 9161 www.environmental-finance.com/conferences/2007/Miami08/programme.htm

World Future Energy Summit. 21st-23rd January 2008, Abu Dhabi National Exhibition Centre, Abu Dhabi, UAE Contact: Lynne Evans, Tel: +44 20 8275 5189 Fax: +44 20 8275 5401 info@wfes08.com www.wfes08.com

Bioenergy World Europe 2008. 7th-10th February 2008, Verona, Italy. Contact: BioEnergy Events and Services. Tel: + 33 (0)3 84 86 89 34 Fax: + 33(0)3 84 43 24 03 nadiahalaimia@bees.biz www.bioenergy-world.com

8th UK Advanced Power Generation Technology Forum (APGTF) Carbon Capture and Storage Workshop. 27th February 2008, DBERR Conference Centre, 1 Victoria St, SW1H 0ET, London, UK. Contact: Judy Henson, Alstom Power, Newbold Road, Rugby CV21 2NH, UK Tel: +44 1788 531478 judy.henson@power.alstom.com www.apgtf-uk.com/

GLOBE 2008, International Conference and Trade Fair on the Business of the Environment. 12th-14th March 2008, Vancouver, BC, Canada. Contact: Tel: +1 604 775 7300 info@globe2008.ca www.globe2008.ca/

Workshop on Numerical Models for Carbon Dioxide Storage in Geological Formations. 2nd-4th April 2008, Stuttgart, Germany. Contact: Maria Costa, Tel:+49 711 685-60399 Fax:+49 711 685-60430 maria.costa@iws.uni-stuttgart.de www.iws.uni-stuttgart.de/co2-workshop/

7th Annual Carbon Capture & Sequestration Conference. 5th-8th May 2008, Pittsburgh, PA, USA. Contact: Cheryl Joe, Exchange Monitor, 4455 Connecticut Ave NW, Suite A700, Washington, DC 20008, USA. Tel: +1 865 966 7124 Fax: +1 865 966 7231 carbonsq@exchangemonitor.com

The Clearwater Coal Conference: 33rd Annual International Technical Conference on Coal Utilization & Fuel Systems. 1st-5th June 2008, Clearwater, FL , USA. Contact: Barbara A. Sakkestad, The Clearwater Coal Conference, 601 Suffield Drive, Gaithersburg, MD 20878, USA. Tel: +1 301 294 6080 Fax: +1 301 294 7480 barbarasak@aol.com www.coaltechnologies.com

Green Science and Technology Conference. 8th-12th June 2008, Regina, Saskatchewan, Canada. Contact: Victoria Muzychuk victoria.muzychuk@uregina.ca, Tel: +1 306 337 2296 www.co2-research.ca.

First IEA GHG Joint Network Meeting. (Monitoring, Risk Assessment and Well-bore Integrity networks). 10th -12th June 2008, Chicago, USA. Contact: Sian Twinning, Events Manager, IEA Greenhouse Gas R&D Programme, Orchard Business Centre, Stoke Orchard, Cheltenham, Glos. GL52 7RZ, UK. Tel: +44 1242 680753 Fax: +44 1242 680758 sian@ieaghg.org www.co2captureandstorage.info

19th World Petroleum Congress (WPC). 29th June – 3rd July 2008, Madrid, Spain. Contact: WPC Tel: +44 20 7596 5136 / 5000 Fax: +44 20 7596 5106 /5111 info@19wpc.com news.ite-exhibitions.com/t/9926/81691/8/0/ www.19wpc.com

GHGT-9. The 9th International Conference on Greenhouse Gas Control Technologies. 16th-20th November 2008, Omni Shoreham Hotel, Washington DC., USA. Contact: Mary Gallagher, LFEE, Room E40-445, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, USA. Tel: +1 617 258 0307 Fax: +1 617 253 8013 ghgt9@mit.edu http://mit.edu/ghgt9/

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