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GHGT-9 Update

By John Gale, IEA GHG

The GHGT-9 conference is now only two months away. The conference will be held at the Omni Shoreham Hotel in Washington D.C. between the 16th and 20th November 2008. Judging from the number of abstracts received we expect that the conference will exceed the previous event, GHGT-8 held in Trondheim, Norway, which attracted some 960 delegates.

The organisers received around 900 abstract submissions for GHGT-9, which was the largest number ever submitted. The Programme Committee and the reviewers have worked extremely hard to review the papers and prepare what we feel is an excellent and diverse technical programme. We apologise that there were delays in making the announcements on paper acceptance but the number and quality of the abstracts received surprised us. The quality of abstracts received was higher than for previous conferences and overall we only rejected some 50 abstracts outright. This left approximately 850 papers to be found a home in the programme. To accommodate the increased number of abstracts we have done two things:

- For the first time we have increased the number of parallel sessions for the middle two days from 5 to 6, meaning that 269 papers will be presented orally. This will be the highest number of oral presentations that have been given at a GHGT conference.

- Second, we have expanded the poster session to have two separate sets of poster viewings which will also be up for the first three days of the conference. In total 570 papers were invited to be presented as posters. Inevitably not all the authors will accept this invitation to give a poster.
- Third, we have kept the plenary sessions to a minimum. We will only have an opening and closing plenary. Otherwise, we will use lunch each day as a plenary, where we have invited a distinguished keynote speaker each day to talk on related climate change issues to give a broader context to CCS.

At GHGT-7 we set the precedent, which will be followed again, that we will not distinguish between oral and poster presentations in the proceedings. Each paper, irrespective of how it was presented, will be given eight pages in the proceedings. The papers will also be presented in technical themes, not segregated as papers and posters.

The technical programme for the oral presentations at GHGT-9 has now been finalised and can be found on the GHGT-9 web site at http://mit.edu/GHGT9. In addition, during the technical sessions we will have 5 discussion panel sessions on key topics for CO_2 capture and storage (CCS) implementation to promote debate and attendee participation. This is the first time we have done this during the conference itself, as a response to attendee feedback from previous conferences requesting more time for debate and discussion.

The programme for the week looks like this:

Registration will open on Sunday 16th November. In the evening there will be an opening reception held at the Omni Shoreham Hotel.

The Omni Shoreham Hotel

The hotel itself provides a magnificent backdrop to the conference. The Omni Shoreham is a four diamond, luxury hotel in Washington, DC that was built in the 1930s. It is a true historic Washington landmark and has hosted presidents, world leaders, sports personalities and entertainers since its opening as one of the premier hotels in the USA's capital. The conference rooms are spacious, consistent with the level of attendance expected for GHGT-9. The hotel is nestled on 11 acres in picturesque Rock Creek Park in northwest Washington, DC and is only steps away from the National Zoo. Also around the hotel are a varied range of restaurants catering to all tastes. The hotel is close to the metro line for easy access to downtown D.C.

On Monday we will open the conference and then have a short plenary session with two keynote speakers to give an overview of the status of CCS and the impacts of climate change. After the plenary session we then split into three parallel sessions. These sessions on capture, geological storage and policy each contain three invited papers. They will set the tone of the conference and set out the challenges and issues we need to address for global implementation of CCS to be realised. After lunch we will split into the first of our parallel technical sessions. This session will be followed by the poster session.

The following two days (Tuesday and Wednesday) will comprise a series of technical sessions in six parallel sessions. Embedded in the technical sessions are the 5 discussion panel sessions, described above.

The conference dinner will be held on Wednesday evening at the Smithsonian National Air & Space Museum. The Museum is situated on the National Mall in Washington, D.C. and has hundreds of original, historic artefacts on display, including the Wright 1903 Flyer, the Spirit of St. Louis, the Apollo 11 command module Columbia and many more. Further details can be found on their web site at: http://www.nasm.si.edu/museum.cfm. The plan is for this to be an informal event with a buffet dinner, open bar and entertainment. All the exhibits will be open, as well as the museum gift shop. We plan that the evening will be a relaxing interlude for all the delegates to mix and socialise during the conference.

Air Space Exhibit

On the final day we will return to 5 parallel technical sessions in the morning. After lunch we then begin to wrap up the conference. The first afternoon session will involve a panel discussion followed by an open debate on what have we learnt from the conference and what are the challenges ahead. This will effectively set the scene for GHGT-10 to be held in 2010. After that we will have the traditional hand over to the next conference organisers for them to tell you all about their plans for GHGT-10.

We hope to see many old acquaintances as well as new faces at the conference. CCS is being recognised as a critical technology in the fight against climate change. The challenge is large, and it is important to bring in new faces to the CCS community if the industry is to grow and move forward.

G8 Meeting in Hokkaido

By Deborah Adams, IEA GHG

The Group of Eight summit in Hokkaido, Japan ended on 9 July without a major breakthrough on climate change negotiations. As Australian Prime Minister Kevin Rudd said: 'There's been no major breakthrough at this particular meeting, it is one step along the road'. However, a successor agreement to the Kyoto Protocol is needed urgently, as the existing Kyoto commitments expire in 2012.

At the close of the summit, in a G8 chairman's statement, the member states confirmed their promise to 'consider and adopt in the UNFCCC negotiations, the goal of achieving at least 50% reduction of global emissions by 2050, recognizing that this global challenge can only be met by a global response'. There is obviously a considerable difference between the terms 'consider' and 'adopt', but the statement is still seen as a step forward.

Governments hailed the 50% pledge as a major breakthrough in climate negotiations. But critics argued that the statement amounted to little more than a repetition of an earlier pledge made at the start of the UNFCCC process. And the baseline for the 50% reduction was disputed. Some thought it should be 1990, but Prime Minister Yasuo Fukuda of Japan said that the starting point would be 'the recent situation'. This makes a difference as many big emitters' greenhouse gas levels have grown rapidly since 1990, including the USA. So the setting of a later start date eases the burden on these countries, while raising the risk of climate change. The need for interim targets to track towards the 2050 goal was acknowledged, but none were set.

On the final day of the summit the G8 countries, Canada, France, Germany, Italy, Japan, Russia, the UK and the USA were joined by eight other major polluters at the Major Economies Meeting. The eight are Australia, Brazil, China, India, Indonesia, South Korea, Mexico and South Africa. The major economies initiative was organized to try to convince large developing states to adopt greenhouse gas reduction targets along with the developed countries. But, the expanded group merely agreed to 'commit to combat climate change in accordance with our common but differentiated responsibilities and respective capabilities'. The group did confirm that developed states would 'implement, consistent with international obligations, economy-wide midterm goals and take corresponding actions in order to achieve absolute emission reductions' but largely avoided mention of any specific obligations for developing nations.

Apparently, Indonesia was the only emerging economy to support the 50% pledge at the meeting. But the developing nations group as a whole promised 'to pursue, in the context of sustainable development, nationally appropriate mitigation actions, supported and enabled by technology, financing and capacity-building'.

However, the 'G8+8' statement did refer to IPCC scenarios that sketch out what developed and developing nations must do to stabilize atmospheric concentrations of greenhouse gases. Rich nations must cut emissions by 80-95% from their 1990 output by 2050 for stabilization at 450 ppmCO_2eq, increasingly viewed as a borderline dangerous level. This is what the five major developing nations say they should commit to now. But under this scenario, developing countries in all regions would have to make 'substantial deviations' from business as usual.

Press Conference by the Chair (International Media Centre) © Ministry of Foreign Affairs of Japan

The Hokkaido statement also promised to establish an international initiative with the support of the IEA to develop roadmaps for innovative technologies and to co-operate on existing and new partnerships, including carbon capture and storage (CCS) and advanced energy technologies. Strong support was given for the launch of 20 large-scale CCS demonstration projects worldwide by 2010, with a view to beginning broad deployment of CCS by 2020.

Finland Joins Methane to Markets Partnership

By Deborah Adams, IEA GHG

Finland is the 26th country to join the Methane to Markets Partnership. The Partnership focuses on four major methane emissions sources: agriculture (animal waste management), coal mines, landfills and oil and gas systems. Finland plans to participate in Methane to Markets' technical subcommittees for the landfill and agricultural sectors in order to share their significant expertise as pioneers in biogas and landfill gas technologies. Finland is reducing methane emissions by installing biogas recovery installations at 33 of its landfills, and provides grants to its farmers who are investing in methane recovery and use projects. The Finnish government is providing grants that cover some of the costs of these domestic projects as well as funding projects overseas in nations such as Honduras and Nicaragua.

Methane to Markets was launched in 2004 as a public/private partnership that reduces greenhouse gas emissions by promoting the cost-effective, near-term recovery and use of methane, while providing clean energy to markets around the world. By 2015, Methane to Markets has the potential to reduce annual methane emissions by up to 50 MtC equivalent.

Membership of the Partnership includes: Argentina, Australia, Brazil, Canada, China, Colombia, Ecuador, the EC, Germany, India, Japan, Mexico, Mongolia, Nigeria, Pakistan, the Philippines, Poland, Russia, South Korea, Thailand, Ukraine, the UK, the USA and Vietnam. The network includes more than 750 private sector entities, financial institutions,

non-governmental agencies and other organizations.

See: http://www.methanetomarkets.org

Expert Meeting on Financing CCS

By Brendan Beack, IEA GHG

The Expert Meeting on Financing Carbon Capture and Storage (CCS) took place on 28-29th May in New York, USA. This meeting followed on from one held in London in 2007. The meeting was by invitation only and limited to 80 people including representatives from governments, industry, insurance, financial institutions, academia and research organisations. It was organised by the IEA GHG, the IEA Clean Coal Centre and the World Coal Institute, with support from Chevron.

The main purpose of the conference was to clarify the options available to finance CCS projects in North America and to increase the involvement of financial experts in discussions about possible economic instruments applicable to CCS. The ultimate outcome of this work will be to identify, encourage and develop world-wide collaboration and practical development of financial mechanisms to accelerate the progression of CCS projects from R&D to commercial reality.

The objectives of the meeting were to explore the options for:

- Identifying key drivers to the financing of CCS projects in North America;
- Contributing to building financial mechanisms for deployment of CCS projects;
- Gaining access to financial information relevant for all major stakeholders in CCS projects;
- Use of futures, derivatives and insurance markets to reduce financial risks of CCS deployment;
- Improving the awareness of the status of CCS technology within the financial community; and
- Use of insurance to address the financial risks of CCS demonstration plants.

There was plenty of discussion on the issues that are restricting the development of CCS in North America from a financial perspective. This included the possible options to overcome hurdles as well as ways to facilitate and encourage more CCS projects. Numerous unresolved issues and potential difficulties in the use of CCS still exist, including insurance, viable financial incentives and the need to establish a robust policy and regulatory framework.

Many of the speakers thought the difficulties and issues surrounding CCS can be resolved. However, from a private investment viewpoint, CCS in North America is a financially unattractive option without government incentives and a legal framework in place. There was also a general consensus that if the USA implements an emission trading system, the revenue generated would need to be put towards CCS. Reliance on a market derived carbon price alone would not be enough to make CCS a financially viable option in the near to medium term. The following points were noted:

- The investment banks' view is that there will be no major private investment in CCS in the USA until they can be offered a secure return on their investment.
- The development of CCS regulatory frameworks is well underway in a number of regions. The speed of development may be enhanced with the launch of the IEA CCS International Regulatory Network.
- There is a perception that an emissions trading scheme alone will not be enough to accelerate deployment of commercial CCS projects in the future and that other incentives will be required.
- There are several proposals in the USA investigating how to facilitate the deployment of CCS. For instance the proposed Lieberman-Warner bill includes the use of some of the revenues from the sale of allowances to fund low carbon technology projects including CCS. Further proposals discussed at the meeting were the use of the bond market and setting up a trust fund for CCS.
- There is a clear gap in the USA with the general public and within the financial sector regarding information on CCS and hence there is an urgent need to provide further information and to educate people about the risks and benefits of CCS.
- Legal and environmental liability is seen as an issue. Insurance companies currently have the business models to insure CCS projects during the operational phase but there is a lack of data to provide coverage for the long term liability that would exist post-injection. Development work in this area is critical.
- Quantifying the potential long term liability of CCS projects in dollar terms would allow insurance companies to assess the underwriting that is needed. Otherwise there is likely to be only limited insurance on a 1-2 year revolving contract.
- If financing of CCS is to occur from the private sector then the $30 trillion bond market must be utilized. This is unlikely to occur until there is greater regulatory certainty from the US government and the States, and greater certainty of cost recovery approval and permitting allowed by the local public utilities commissions. Ultimately, the willingness of ratepayers to have higher electricity bills to pay for CCS, will be critical to the financing of such projects.
- There are a number of CCS projects underway in North America and future possibilities through the restructuring of FutureGen. The Canadian

Government intends to have new coal fired plants capture ready by 2018.

The discussions on financing CCS projects have matured since the meeting in London last year. There has been progress, but much is still needed to establish CCS projects in terms of regulations, insurance and practical experience of stakeholders operating CCS plants. While there has been considerable work and interest in CCS and there are many players ready to move forward, there is a need for urgency and direction from governments. Governments will need to have robust CCS policies that provide certainty for investors and allow for the deployment of CCS projects. In addition, governments will also need to provide financial support for the first CCS projects.

Further information on the workshop can be found at: www.co2captureandstorage.info/techworkshops/Financingmtg2.htm

How Ready is 'Capture Ready'?

By Nils Markusson, Edinburgh University

The renewed interest in investing in coal-fired power plants creates a dilemma for government. Building new unabated fossil-fuelled power plants creates a risk of carbon lock-in, unless the plants can be guaranteed to be complemented with carbon capture and storage (CCS) systems as soon as the technology becomes available. If the new build of fossil fuel plants is to go ahead, the regulatory challenge is to steer power plant investments towards de-carbonisation as far as possible.

Two regulatory strategies are currently being discussed: emission limits and capture ready requirements. This article is based on a report from the Scottish Centre for Carbon Storage, focussing on capture readiness as a regulatory option.

The basic notion here is that preparations are made today to avoid a situation where it is impossible or prohibitively expensive to add a CCS system to a power plant tomorrow. Capture readiness as a regulatory requirement has been included in the recently proposed EU regulatory framework for carbon capture and storage. It has also been used in the UK over the last few years in permits granted for building new gas fuelled plants, but without much specification of what capture readiness really means, and it has not been applied in a uniform manner. There is clearly a need to investigate what capture readiness can and should mean as a regulatory requirement. The Government is planning a consultation on capture readiness this year.

Regulating technology that has not been fully developed is never easy. If you regulate too early, there is too much uncertainty involved and the properties of the ready-to-use technology cannot be predicted. Regulations then risk being quickly outdated and, as a worst case, counter-productive. On the other hand, if you regulate too late, when the technology is already on the market, there is a risk that it has become entrenched - locked-in - and that it is then very difficult to change. This is especially a risk for infrastructure technologies like power generation, where the technological components have co-evolved with the organisations, networks and institutions of the overall technological system. It is therefore worth scrutinising proposals about standards for capture ready power plants to avoid locking us in to more unabated power plants, whilst keeping in mind the uncertainty inherent in trying to predict the future development of the technology.

Existing proposals for a capture readiness standard often require very few changes to be made. Typically, the only requirements suggested are to make sure that there is enough space on the site to build a capture plant, and enough space in the power plant to add the pipes between it and the capture plant. This is insufficient in several ways.

Reports show that when considering future retrofitting of capture plant, all aspects of the design of power plants are potentially affected. This includes all layout, all equipment, and even the choice of the basic conversion technology. A comprehensive study of the design options is therefore required. Also, adding new technology raises issues about the skills and expertise of power plant staff, and this highlights the need for preparations throughout the organisation.

Capture readiness is most often understood as affecting only the power plant, but a capture ready power plant without sufficient preparations for transport and storage, is pointless. Preparations for transport and storage can include identification of routes for transport and sites for storage, securing planning permissions and ownership.

It is also a challenge to prepare for system integration. This is a technical matter, in terms of matching flow rates of the gas and availabilities of the assets involved, for example. But it is also a matter of planning, to co-ordinate the different actors that would have to be involved to manage the different parts of the overall system.

From the utility's point of view, capture readiness thus includes not just space on the site and layout in the plant. Capture readiness is a comprehensive set of technical and organisational choices, regarding the power and capture plants, the downstream transport and storage components as well as system integration.

Perhaps the biggest challenge for regulators is to ensure that future retrofitting actually takes place. The history of the introduction of flue gas desulphurisation shows that it takes considerable political will and clout to impose abatement technology on the power industry. There is a considerable risk of granting permits to power plants today, but that CCS retrofitting plans get delayed or

shelved, later on.

The earliest full-chain, full-scale demonstrations planned may be operational as early as 2012. Retrofitting of capture ready plant could be mandated within three years of that date. A robust capture readiness regulation could include a condition about revoking operating permits if CCS is not operational within this time frame. This would show a commitment from Government to ensure future CCS retrofitting.

Current capture readiness requirements in gas plant permits are much too vague, and not very robust, especially regarding the forcing of future retrofitting. It is hoped that the impeding consultation will highlight these problems.

However, the basic problem of basing regulation on a technical standard will always remain. As indicated above, specifying what capture readiness means can be complicated, especially as the technology is not yet mature. This may put the regulator at a disadvantage with regard to the utilities and developers who are likely to always know more about the technologies involved. An emissions limit may have the advantage of requiring less technical specification and so be easier to implement. At the end of the day, either option will require a strong political will.

Further reading

How ready is 'capture ready'? - Preparing the UK power sector for carbon capture and storage, Markusson, N. and Haszeldine, S., 2008, Scottish Centre for Carbon Storage, independent report prepared for the WWF UK.

Evading Capture - Is the UK ready for Carbon Capture and Storage?, WWF UK, 2008.

Six Thousand Feet Under: burying the carbon problem, Policy Exchange, 2008.

CO_2 capture ready plants, IEA GHG, 2007/4.

New Interactive Database of CCS Sites Around the World

By Yasmin Bushby

The Scottish Centre for Carbon Storage has developed an interactive resource for researchers, industry and all those interested in CCS. The resource provides the location of proposed CCS sites worldwide and details basic project information at www.geos.ed.ac.uk/sccs. It is available for free.

Locating accurate and up to date information on CCS sites is a time consuming and frequently frustrating exercise. Indeed, there can be conflicting information, company websites may be out of date or adequate information simply does not exist in the public sphere. In response, The Scottish Centre for Carbon Storage (SCCS) has developed an interactive, easy to use database for industry and individuals interested in the emerging CCS market. All full-chain and pilot project sites have been researched and are located geographically on a google map.

This google map is in place of a traditional database, and users can simply open the SCCS website and browse the interactive map. The website is designed for ease of use and gives a readily accessible overview of planned and on-going projects around the world.

Fig 1. Home page world view of all sites

The site also gives more detailed information about specific projects. Users are able to locate a site, zoom in and obtain the name, location, company name(s), general project description, separation technology, injection amount and proposed start date.

Fig 2. Zoom in to regional locality

The user can also click on relevant web links and instantly be connected to further websites about the particular project. The website can thus also serve as a starting point for the gathering of more detailed information about specific projects.

Fig 3. Access basic project information and link to the relevant website.

The site is designed as a resource for the emerging CCS industry and we invite industry to locate their relevant site on the google map and feed information into the SCCS, for inclusion on the map as their project progresses. The map has already had a great deal of interest from industry and we are expecting this to grow.

The database is funded by the Scottish Funding Council and will be provided as a free resource. Later in 2008 SCCS will also be launching a searchable database presented in a more traditional format.

The Scottish Centre for Carbon Storage Research is a partnership

between the University of Edinburgh, Heriot-Watt University and the British Geological Survey. It is a UK centre of research excellence that combines world-class expertise in petroleum and hydrocarbon geoscience based on geology, geophysics, geo-engineering and subsurface fluid flow. The aim of SCCS is to undertake primary and secondary research along the CCS chain and develop methods, processes, evaluation and de-risking technologies for carbon storage, to reduce CO_2 in the atmosphere.

For further information please visit www.geos.ed.ac.uk/sccs. If you would like further information about the database or would like to provide updates, please contact Yasmin Bushby at yasmin.bushby@ed.ac.uk Tel: (+44) 131 650 7010.

For all other enquiries, please contact Stuart Simmons at stuart.simmons@ed.ac.uk

CO2CRC Otway Project Progress

By Deborah Adams, IEA GHG

The CO2CRC Otway Project has reached its first major milestone, as 10,000 tCO_2 is now stored 2 km underground in a depleted natural gas reservoir. The project which is based in south-west Victoria, is the first demonstration of geosequestration in Australia. It was officially opened in April 2008.

In the project, CO_2 is compressed to a fluid-like state, piped, injected and stored underground. An important feature of the project is the demonstration of new geosequestration subsurface monitoring techniques.

According to Dr Peter Cook, the chief executive of CO2CRC 'We are closely monitoring the CO_2 through one of the world's most comprehensive geosequetration monitoring programmes and every indication is that the CO_2 is behaving just as researchers have predicted. The injection process is proceeding very well and we are now starting on our next 10,000 tonnes'.

See: www.co2crc.com.au

UK Government Moves Forward on CCS

By Tim Dixon, IEA GHG

The UK Government has recently unveiled further progress on the implementation of its flagship policies on carbon capture and storage (CCS). On 30th June the successful bidders at the pre-qualification (PQQ) phase of the UK CCS demonstration competition were announced. The launch of the consultation document: *Towards Carbon Capture and Storage* also represents progress towards CCS.

Last year, Prime Minister Gordon Brown launched a competition to identify the UK based commercial-scale CCS demonstration project which will receive government support. The winning project will use post-combustion technology to capture the CO_2 emissions from the generation of at least 300MW of electricity from a coal-fired power station. The captured CO_2 will subsequently be transported and stored offshore, under the sea bed.

Industry's response to the competition was very positive, demonstrating their interest in the development of CCS projects. Nine consortia submitted responses to the pre-qualification phase, four of which were successful. These were BP Alternative Energy International Limited, EON UK Plc, Peel Power Limited and Scottish Power Generation Limited. The Department for Business and Enterprise (BERR) will now work with each bidder to improve their understanding on the issues vital to the CCS demonstration (including design of the project, cost and the extent of the supply chain needed to support the technology).

The project remains on track to be operational by 2014, which will make it one of the first commercial-scale demonstrations of the full chain of CCS technologies in the world.

A fair, transparent and effective regulatory regime for the storage of CO_2 is a pre-requisite for CCS deployment. The UK is close to finalising the shape of the CCS regulatory regime, with clauses setting out the scope of the regime in the final stages of the Parliamentary process.

The consultation document *Towards Carbon Capture and Storage* builds on this primary legislation by setting out a basic framework for licensing the offshore storage of CO_2 in the UK and for dealing with liabilities. In addition, the consultation sets out the Government's views on CCS as a carbon abatement technology and asks what more it might do to promote the development and deployment of CCS technologies in the UK, EU and globally.

The results of the consultation will also be used to inform the government's negotiating position on the EU's draft Directive on the geological storage of CO_2, including what is meant by carbon capture readiness (CCR) and how it might be implemented. The CCR parts of the consultation draw extensively and primarily on the IEA GHG Report 'CO_2 Capture Ready Plants' (2007/4).

Energy Minister Malcolm Wicks said: "We need to think beyond demonstration of CCS if we are to realise our ambition of commercially viable CCS by 2020. In short, we

need to focus on the creation of a CCS industry. Power plants will need to be equipped with new technology and industry will need to address procurement, construction, programme management, supply chain management and operational challenges. Suppliers and operators will need to develop new ways of working together to turn the technical concept of CCS into a business - commercially, contractually and financially.

"Taking a new and complex technology from demonstration to commercial-viability in just over 10 years is a real challenge. To lay the foundations required for this new industry to develop in time it is crucial industry and government work together. CCS may still be in its first phase of development but we need to act now to speed the move towards deployment of this key climate change mitigation technology."

The consultation document can be accessed on the BERR website at the following address:

http://www.berr.gov.uk/consultations/page46811.html

US Environmental Protection Agency Proposes Regulations for Underground Injection of CO_2

By Anhar Karimjee, US EPA

The USA has taken initial steps towards a regulatory framework for geological storage of CO_2 by proposing new requirements under its federal Underground Injection Control (UIC) programme. The UIC programme, established over 30 years ago, currently regulates over 800,000 injection wells. The regulatory authority for the programme was established under the Safe Drinking Water Act (SDWA) which is focused on protecting drinking water supplies. Additional information on SDWA and UIC program can be found at: http://www.epa.gov/ogwdw/uic/.

The proposed rule will establish a framework for permitting CO_2 injection wells, but does not require any facilities to capture and/or geologically store CO_2. The elements of the proposal build upon the existing UIC regulatory framework, with modifications based on the unique nature of CO_2 injection for GS, including:

- Geologic site characterization to ensure wells are appropriately sited;
- Well-construction requirements and periodic testing of the mechanical integrity of the injection well;
- Ground water monitoring and tracking the location of the injected CO_2 to ensure protection of underground sources of drinking water;
- Periodic re-evaluation of the geological storage site to incorporate monitoring and operational data and to verify that the CO_2 is moving as predicted within the subsurface;
- Extended post-injection monitoring and site stewardship; and
- Financial responsibility requirements to assure that funds will be available for well plugging, site care, closure, and emergency and remedial response.

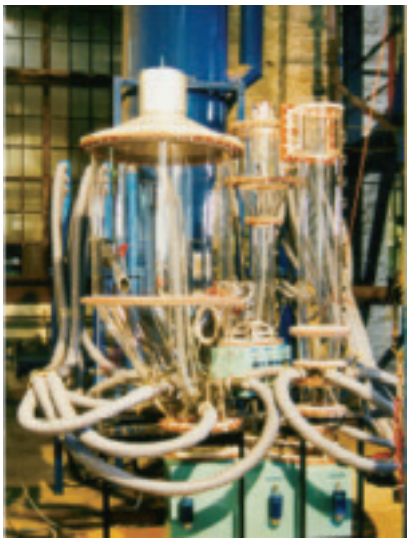
The proposed regulation was developed through a workgroup process that included other federal and state agencies. It was also informed by stakeholder and expert input and technical workshops. The USEPA encourages a transparent public dialogue on the key provisions outlined in the proposal. The proposal and supporting information can be accessed at: http://www.epa.gov/safewater/uic/wells_sequestration.html#regdevelopment. In the proposal, the USEPA specifically asks for input on certain topics and welcomes comments on these key issues. The public comment period will be open until 24 November, 2008 and the USEPA is also planning public hearings during this time.

The proposal will be revised to reflect information collected through the public comment period and any new data generated from ongoing projects and pilots. It is expected that final regulations will be published in late 2010 or early 2011. This adaptive approach will allow USEPA to maximize current knowledge on GS injection and operation.

Fourth International Workshop on In-Situ CO_2 Removal (ISCR4)

By Mike Haines, IEA GHG

The fourth International In-Situ CO_2 Removal workshop (ISCR4) was held in the chemical engineering faculty of Imperial College, London on 7-8 July 2008. The workshop was attended by about 40 researchers.



Cold flow model at TU Wien

In-situ CO_2 removal processes are based primarily on the use of calcium oxide (CaO) to remove CO_2 during reforming, shifting or combusting of fuels or gases derived from them. They make use of high temperature dual circulating beds which can also be used for chemical looping combustion.

A key application is post combustion CO_2 capture from coal fired power plant flue gases where the technology appears to offer substantially lower efficiency losses than competing technologies. The reason for this is that the process, consisting of carbonation and calcination, occurs at high temperature, 600+ and 900+ °C respectively. This allows all of the heat input to be recovered as steam at the most advanced supercritical conditions. The main energy input is for producing pure gaseous oxygen at atmospheric pressure for the calcination. The amount of energy required is only about 1/3 of that needed for full oxy-combustion. The other main parasitic load is for CO_2 compression. The expectation is that efficiency loss will be around 6 percentage points, which is several percentage points less than alternative processes.

At the workshop, researchers from the Technical University of Darmstadt presented a detailed Aspen simulation of the process and also details of a 1MWthermal pilot fluidised bed plant for testing of calcining and carbonation. The plant is under construction, with funds from the German Ministry of Economics and Technology (BMWi) and the various utility companies (E.ON; EnBW; Evonik and RWE)

Presentations from CANMET (Canada) and CSIC (Spain) also outlined results from calcinations/carbonation experiments and plans for larger pilot plants.

Other significant pilot plant activities are taking place at the University of Vienna. Researchers reported the results of chemical looping combustion experiments using nickel oxides in their 120 kW circulating dual bed pilot facility. They also reported on gasification of wood pellets with in situ absorption in their larger 8 MW pilot plant which has been in operation since 2001. They designed the required gas and solid flow conditions with a cold flow model using air and bronze particles. They were able to test a variety of natural limestones and raise the hydrogen content of reformed gas from the normal 38% to 60-70%, thus successfully demonstrating the carbonation/calcination cycle on a large scale.

30kW interconnected fluidised bed loop at INCAR-CSIC (Spain)

Several presentations concentrated on advances in how to understand and avoid two of the key barriers to successful development of the technology which are the rapid loss of absorption capacity and particle attrition. One phenomenon which may help is the discovery that the sorbent can be treated after a few carbonation/calcination cycles to recover a significant amount of capacity and retains a higher but declining capacity thereafter compared to untreated material. This process of 'self-reactivation' may enable sorbent life to be extended sufficiently to make the process viable. Results were also presented which showed that different types of limestone deposit show considerable differences in attrition resistance and capacity decline. This provides some hope that careful selection can lead to improved overall performance although the deposits with good attrition resistance generally show a greater decline in capacity.

In conclusion, high temperature in-situ CO_2 removal is coming of age and is moving rapidly from the laboratory to larger scale demonstration. The next annual international workshops are already tentatively planned for Spain in 2009 and The Netherlands in 2010. For further information contact Paul Fennel at p.fennell@imperial.ac.uk

CCS at the 19th World Petroleum Congress, Madrid

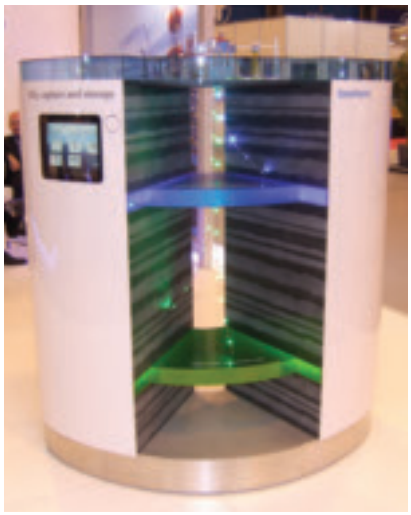
By Neil Wildgust, IEA GHG

The 19th World Petroleum Congress was held in Madrid from 29th June to 3rd July 2008. The event, which attracted over 4,000 delegates and considerable media interest, was run with the theme 'A World in Transition: Delivering Energy for Sustainable Growth'.

CCS had a much higher profile than at the previous congress held 3 years earlier in Johannesburg, reflecting growing concern over global warming and a widespread acceptance that the petroleum industry has to take a leading role in developing mitigation options. High profile speakers at WPC19 included Andris Piebalgs, the EC energy commissioner, who emphasised the European Union view that CCS can reduce CO_2 emissions on a 'massive' scale. The EU is planning 10 to 12 industrial scale demonstration projects and is committed both to providing the necessary legal framework to enable CCS implementation, and to continued support of research and development activities. The chief executive of Shell, Jeroen van der Veer, told the congress that the only realistic way to reduce emissions, whilst maintaining the energy supplies necessary

for world prosperity, would be through a combination of CCS and cap-and-trade systems such as the EU ETS. His counterpart from BP, Tony Hayward, expressed optimism that carbon trading, commencing in regional blocks such as Europe, Asia and the US, would soon link up and lead to the emergence of a global carbon price.

The first full day of the conference included an afternoon technical forum entitled 'Carbon Capture and Storage–Political,Technological and Economic Constraints'. Chaired by Trude Sundset (StatoilASA) with vice chairs Ian Potter (Alberta Research Council) and Phillipe Marcus (Gaz de France), this plenary session proved very popular with delegates who listened to presentations given by representatives from the IEA GHG, Alberta Research Council, StatoilHydro, ExxonMobil and Det Norske Veritas (DNV).



Sleipner Model, Courtesy of StatoilHydro

Neil Wildgust delivered the IEA GHG presentation on behalf of John Gale. He gave an overview of worldwide CO_2 storage potential in depleted oil and gas fields and described the current IEA GHG study programme in relation to these storage opportunities. Depleted oil and gas fields could offer a potential worldwide storage capacity of up to 1,000Gt of CO_2 (IPCC, 2005). This is less than that of deep saline aquifers but has considerable potential advantages, including proven trapping mechanisms and well characterised geological environments. Worldwide storage potential in depleted gas fields is the subject of a study being undertaken by Poyry Energy Consulting in conjunction with Element Energy Limited and the British Geological Survey. Storage opportunities associated with enhanced oil recovery (EOR) schemes will be addressed by a study to be commissioned later in 2008. This piece of work will focus particularly on factors which have led to the discrepancy between the widespread application of CO_2-EOR in North America, but its limited deployment elsewhere.

Brent Lakeman of the Alberta Research Council, described the international leadership given by Canada through both the IEA GHG Weyburn CO_2 Monitoring and Storage Project, and the Pembina Oilfield pilot CO_2-EOR flood in central Alberta. The latter project is testing the deployment of new monitoring tools and, by advancing the integration of monitoring technologies, it aims to provide recommendations for deployment of downhole technology for CO_2 storage observation wells. Brent also explained how these pilot projects have assisted the development of the Canadian CO_2 Capture and Storage Technology Roadmap. Canada is now developing a supportive policy, regulatory and fiscal framework for CCS projects, including an offset quantification protocol for CO_2-EOR schemes.

Olav Kaarstad of StatoilHydro presented a talk entitled 'Experience from Real CCS Projects – and the Way Forward'. Norway introduced the world's first CO_2 tax in 1992, which paved the way for viable CCS projects. Most prominently, 10Mt of CO_2 separated from Sleipner West natural gas field production, has been injected into the Utsira Formation deep saline aquifer since the mid 1990s. Other key projects include the Barents Sea Snohvit field, where 0.7Mt/y CO_2 is captured from a gas liquefaction plant and transported back to the field; the planned European CO_2 Test Centre at Mongstad, where CO_2 capture technology will be tested at Norway's largest oil refinery from 2010; and the Halten Project, where Statoil and Shell are assessing CCS potential for an 860MW gas-fired power station at Tjeldbergodden. Olav stated that critical issues for the advancement of CCS include cost, public acceptance, legal frameworks and successful early projects.

A presentation on the quantification of greenhouse gas emission reductions was given by Wishart Robson of Nexen Inc, on behalf of Haroon Kheshgi of ExxonMobil Research and Engineering Company. The talk described efforts by the American Petroleum Institute (API) and the International Petroleum Industry Environmental Conservation Association (IPIECA) to produce guidelines that promote credible, consistent and transparent quantification of greenhouse gas emission reductions from the oil and natural gas industry. These guidelines address both baseline/boundary conditions for scenario assessment and monitoring requirements. Case studies discussed comprised CCS and cogeneration of electricity and steam, although the guidelines could be applied to a wider variety of projects.

The final talk of the session, entitled 'CCS – Political, Technological and Economical Constraints', was given by Elisabeth Heggelund Torstad of DNV. Elisabeth described how CCS could contribute up to 55% of the emissions reductions needed to stabilise climate change at an average of 20°C. Although CCS can be regarded as an immature technology in terms of frame conditions, technology, economy, infrastructure and acceptance criteria, a key factor is the development and implementation of a regulatory framework that will allow CCS to emerge, in conjunction with financial incentives. The presentation stressed the importance of an integrated and transparent approach to managing risks, which may be societal, commercial and technical.

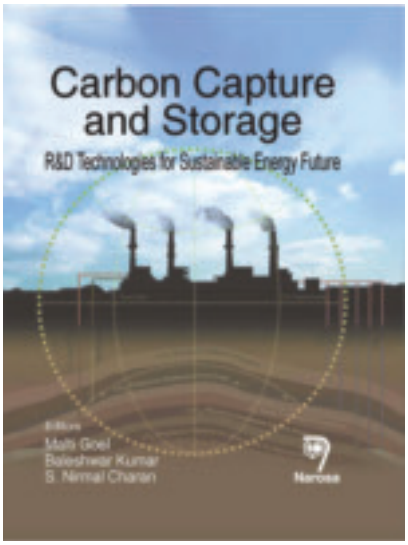
The talks were followed by a lively question and answer session and complemented by electronic poster presentations in the Exhibition Hall. The posters presented research results from the UK, Brazil, Poland, China and the USA which covered themes including CCS system flexibility, CO_2 conversion, CO_2-EOR, sustainability and CCS business models.

Details of WPC19, including copies of the daily congress newsletters which featured several articles on CCS, climate change or related topics, can be viewed at the congress website http://www.wpc-news.com/.

CCS – R&D Technologies for Sustainable Energy Future

By Dr. Malti Goel, Ministry of Science and Technology, Government of India

The proceedings of an international workshop held in Hyderabad, India on 12-13 January, 2007 have been published as 'Carbon capture and storage: R&D technologies for sustainable energy future'. The mitigation of CO_2 emissions is discussed in five sections. The opening part gives an overview of the Indian power sector and summarises the research priorities for CCS together with the growing concerns about energy security that result from climate change considerations. New research tools in enhanced oil recovery and the assessment of CO_2 storage capacity are covered. The kinetics of rapid mineralization reactions in flood basalts across the world are studied as a potential host for the permanent geological storage of CO_2. Further research is required in this area.



Research activity in India on novel materials, modified mono-ethanol-amine (MEA) solvents as potential absorbents and activated carbon amines as adsorbents with improved capacity to absorb CO_2 in flue gas at high temperature are included in section 2. Research on unconventional pressure swing adsorption cycles with zeolite adsorbent for increased CO_2 recovery and high purity are reported.

The third section presents UK policy perspectives on CCS research and the various technology routes that follow from UN FCCC regulatory mechanisms and IPCC guidelines.

Research aspects of CO_2 injection in different geological media such as oil and gas fields, basalt rocks and saline aquifers are covered in section 4. Geo-mechanics and seal integrity of cap rocks illustrate the critical linkages between geological and flow characterization. Safe long-term storage of CO_2 requires attention to reservoir well integrity issues, better understanding of physics and in-situ reaction kinetics through multi-scale monitoring and simulation studies. Challenges for CO_2 storage in coal seams, the role of gas clatharets and oil shale are also covered.

The final section covers US and EU initiatives on CCS. There are papers on the future of coal in the US and the global energy mix, industrial initiatives on hydrogen power, with carbon capture and research activities of CO_2GeoNet European Network in Excellence.
The book provides a first hand account of R&D challenges in CCS research, a country perspective of initiatives in India and international programmes in industrial research and networking policies.

Carbon capture and storage: R&D technologies for sustainable energy future. M Goel, B Kumar and S N Charan (eds.) 242 pp, Narosa Publishers, 2008

11th IEA GHG International CO_2 Capture Network

By Stanley Santos, IEA GHG

The 11th IEA GHG CO_2 Capture Network Workshop was held in Vienna, Austria from 20th to 21st May 2008. A visit to the Industrial Test facility for biomass pyrolysis/gasification and the incinerator plant of EVN / AVN concluded the successful meeting.

The IEA GHG would like to acknowledge the hospitality of EVN and their superb organization of the meeting. Likewise, we are grateful to the workshop sponsors - Wien Energie, Verband der Elektritzitatsunternehmen Osterreichs and the Federal Ministry for Transport Innovation and Technology.

The workshop was fully subscribed with 100 participants registered from 16 countries. There were 19 technical presentations and 6 short presentations during the panel discussion. The workshop covered a broad range of topics, including:

- Various fundamental studies on post-combustion capture such as updates on the development of current solvents (amine based);
- An overview of the development of the use of ammonia and other

Delegates of the 11th CO_2 Capture Network Meeting

novel solvents;
- Updates on the research activities of the University of Regina ITC, CSIRO, IFP, B&W and EPRI/ Alstom;
- A presentation of results from the EU Castor Project; and
- Updates on the commercial developments in amine based CO_2 capture from MHI, Fluor and CANSOLV.

The panel discussion was moderated by John Topper. Five leading experts initiated the discussion and the participants looked at the potential future of CO_2 capture technology.

Another important aspect of the workshop was the presentation of various activities seeking to demonstrate post-combustion capture technologies. For example, Vattenfall announced their progress in investigating the Vested aquifer, which is about 30 km from the Nordjyllands power station in Denmark. Vattenfall plans to extend this plant. A decision on whether to proceed or not is expected in 2010. In the USA, it is apparent that permission to proceed with the construction of unabated coal fired plants has become almost impossible to obtain. There have been a number of announcements of intentions to build plants fitted with CCS. The proposed CCS has been based on post combustion capture – in some cases using ammonia or chilled ammonia for the capture of CO_2. In the UK the government has launched a competition for CCS. This competition is to demonstrate CO_2 capture from a coal fired power plant of at least 300MWe by 2014. At the time of writing, the UK government has shortlisted 4 consortiums out of 9 organizations who expressed an interest.

These developments have transformed the importance of this workshop series. It is now a vital source of information and contacts on the development of post-combustion capture technologies.

Details of the workshop and all the presentations are posted on our website: http://www.co2captureandstorage.info/networks/Oxyfuel3rd.htm

For further information, contact John Topper at John.Topper@iea-coal.org

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Use of Fuel Cells to Produce CHP and Reduce GHG Emissions

By Mike Haines, IEA GHG

A study to be released shortly by the IEAGHG assesses the availability and performance of fuel cell systems both for domestic and small commercial applications. It goes on to estimate the contribution small fuel cell systems could make to reducing greenhouse gas emissions when applied to provide domestic heating and power. Combined heat and power systems (CHP) enable users to operate with increased overall efficiency thus reducing consumption of fossil fuels and greenhouse gas emissions. Fuel cells are well-suited to CHP.

CHP systems can operate in a heat lead or power lead mode. For this study a heat lead system was researched where the household thermal load is met and then any shortfall or surplus in electrical power is satisfied by import/ export from the grid. Thermal load curves were developed for typical cold, temperate and hot climatic zones based largely on prevailing dwelling insulation standards and the number of heating degree days. (Fig 1) (Heating degree days are the number of days heating is required multiplied by the average temperature difference between inside and outside temperature). A perhaps surprising finding was that the heat demands did not vary that much between regions because of the much higher insulation standards in colder climes.

The calculations in the study are based on upper and lower estimates of the percentage of heating system sales which are likely to be fuel cell based by 2050 and a standardized market penetration curve. A minimum of 5% and a maximum of

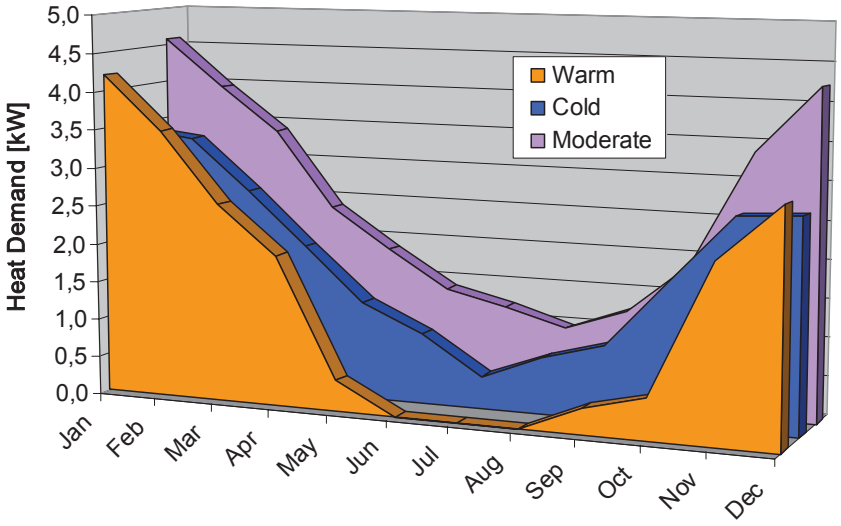


Figure 1. Heat demand for a typical single family house for 3 climatic regions

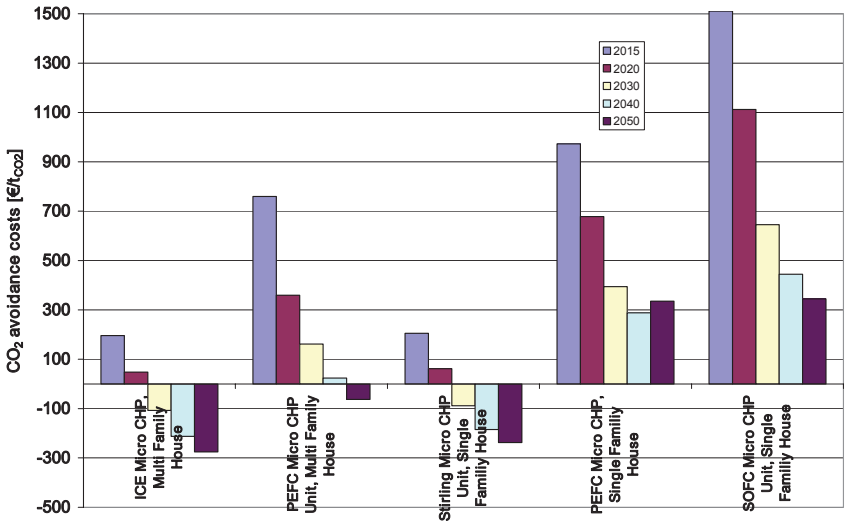


Figure 2 Cost in Euro per tonne of CO_2 abatement using various CHP systems

20% penetration are modeled. The emissions performance is compared to a baseline where power and heat is supplied conventionally, that is by fired domestic boiler and mains electricity. Comparisons are also made with domestic CHP systems using alternative power generation systems based on Sterling or internal combustion engines.

The study found that a small reduction in the range of 1-4% reduction is very sensitive to the carbon emission intensity of the electrical grid and could become negative in areas where this becomes very low. The cost calculations were done for two sizes of installation, one for a typical single family house and the other for a typical multi-unit dwelling such as a block of flats. The unit cost of reductions was also estimated based on predictions of the performance of fuel cell based systems and the expected development of their costs. The development of other parameters such as carbon intensity of the electric grid and gas and electricity prices was also built into the analysis. The study found that costs per tonne CO_2 avoided were rather high. The emission reduction costs of competing domestic scale CHP technologies were also calculated and found to be significantly cheaper than those based on fuel cells. (Fig 2.)

The study examined features of the commercial and industrial market both of which are already using significant amounts of CHP. However, it was not possible to collect enough information to make any predictions as to the potential for fuel cells to reduce emissions in these sectors.

In conclusion, fuel cell based CHP systems offer some potential for the reduction of GHG emissions in the domestic sector. But this seems to be expensive compared to other options and the reductions would be reduced or eliminated if significant decarbonisation of the electricity supply occurs.

India's National Action Plan on Climate Change

By Deborah Adams , IEA GHG

On 30 June 2008, Prime Minister Manmohan Singh released India's first National Action Plan on Climate Change. The Plan outlines existing and future policies and programmes to address climate change mitigation and adaptation. The Plan identifies eight core 'national missions' which run to 2017, and it directs ministries to submit detailed implementation plans to the Prime Minister's Council on Climate Change by December 2008.

The Plan emphasizes the priority of maintaining high economic growth rates to raise living standards, and 'identifies measures that promote our development objectives while also yielding co-benefits for addressing climate change effectively'. It says that these national measures would be more successful with assistance from developed countries, and pledges that India's per capita greenhouse gas emissions 'will at no point exceed that of developed countries even as we pursue our development objectives'.

National Missions

The National Solar Mission aims to promote the development and use of solar energy for power generation and other uses with the

ultimate objective of making solar competitive with fossil fuel based energy options.

Current initiatives under the National Mission for Enhanced Energy Efficiency are expected to yield savings of 10,000 MW by 2012. The Plan builds on the Energy Conservation Act 2001 and recommends:

- Mandating specific energy consumption decreases in large energy-consuming industries, with a system for companies to trade energy-savings certificates;
- Energy incentives, including reduced taxes on energy-efficient appliances; and
- Financing for public-private partnerships to reduce energy consumption through demand-side management programmes in the municipal, buildings and agricultural sectors.

The National Mission on Sustainable Habitat seeks to promote energy efficiency as a core component of urban planning.

As water scarcity is projected to worsen as a result of climate change, the National Water Mission sets a goal of a 20% improvement in water use efficiency through pricing and other measures.
The National Mission for Sustaining the Himalayan Ecosystem aims to conserve the biodiversity, forest cover and other ecology of the Himalayas, where glaciers that are a major source of India's water supply are projected to recede due to global warming.

The goals of the National Mission for a 'Green India' include the afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23% to 33% of India's territory.

The National Mission for Sustainable Agriculture aims to support adaptation to climate change in agriculture by developing climate-resilient crops, expanding weather insurance mechanisms, and a range of agricultural practices.

Finally, the National Mission on Strategic Knowledge for Climate Change envisions a new Climate Science Research Fund, improved climate modeling and increased international collaboration. It also encourages private sector initiatives to develop adaptation and mitigation technologies through venture capital funds.

A number of other initiatives are described in the Plan. These include:

- Power generation. The government is mandating the retirement of inefficient coal-fired power plants and supporting the R&D of IGCC and supercritical technologies.
- Renewable energy. Under the Electricity Act 2003 and the National Tariff Policy 2006, the central and the state electricity regulatory commissions must purchase a certain proportion of grid-based power from renewable sources.
- Energy efficiency. Under the Energy Conservation Act 2001, large energy-consuming industries are required to undertake energy audits and an energy labeling programme for appliances has been introduced.

Clean Development Mechanism

India has given host country approval for 969 Clean Development Mechanism (CDM) projects, as of June 2008. Renewable energy accounted for 533 of these projects, and energy efficiency for 303. India accounts for about 32% of the world total of 1081 projects registered with the CDM Executive Board. However, the projects from India are generally small.

The Plan concludes that India looks forward to enhanced international co-operation under the UNFCCC. Overall, it states that future international co-operation on climate change should address the following objectives:

- Minimise the negative impacts of climate change through suitable adaptation measures in the countries affected;
- Provide fairness and equity in the actions and measures; and
- Uphold the principle of common but differentiated responsibilities in actions to be taken.

The report is available at http://pmindia.nic.in/Pg01-52.pdf

Conference on CCS in a Low Carbon Energy Future

By Mike Haines, IEA GHG

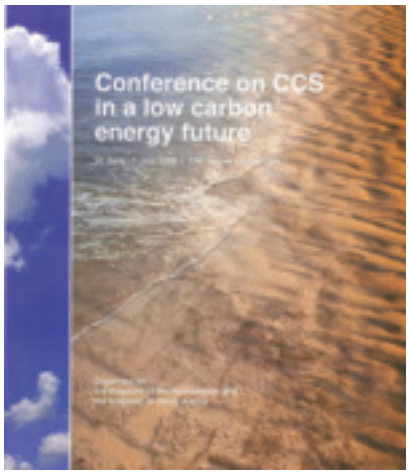
The Governments of The Netherlands and Saudi Arabia organised jointly a conference on "Carbon Capture and Storage in a low carbon energy future" which was held in The Hague on 30th June and 1st July. The conference was attended by about 100 delegates who listened to presentations on a wide range of issues by experienced speakers concerned with development and regulation in the energy and climate change arena. On the first day 5 key themes were explored, namely:

- International implementation strategies
- Legislative framework: risk sharing, liability and public acceptance
- Financing CCS
- CCS in a post-Kyoto framework
- Knowledge transfer.

The co-chairs of the conference prepared a set of conclusions and recommendations on each of these themes. Highlights of these were:

It is essential for early adopters of CCS to show that CCS works in order to persuade others, including developing countries, to follow. They need to demonstrate all

facets including risks, financing, regulation and public acceptance. Risks should not be denied but addressed by the international community.



As long as CCS is in the pre-competitive phase it will need financial incentives and support. CCS should become part of a post-Kyoto framework and should be part of the CDM but a limited period pilot phase in the CDM might be the next step.

CCS should be positioned in the transition to a sustainable energy system and should not be there at the expense of renewable energy or energy efficiency. Governments have to create necessary conditions for CCS to be deployed and the knowledge base which is building up has to be shared internationally. Further intergovernmental events similar to this conference in other regions should be organized to facilitate this.

On the second day sessions were held on business and regional CCS initiatives. During the day a visit was made to "Tomato World" and the harbour of Rotterdam. At "Tomato World" details of the CO_2 distribution grid were explained. CO_2 is transported to greenhouses, and there is a possibility of extending the pipeline system to storage locations under the North Sea. The delegates continued the conference on board a ship which toured the harbour whilst presentations continued. There was one about the Rotterdam Climate initiative which has ambitious plans to cut emissions of the city, its port and industries, by 50% by 2025.

Further information on the outcome of the conference can be obtained from Femke Hoogeveen at the Netherlands Ministry of Foreign Affairs at femke.hoogeveen@minbuza.nl

The IEA GHG Joint Network Meeting

By Brendan Beck, IEA GHG

This year the IEA GHG held the inaugural joint meeting of its three International Research Networks focused on storage – the Risk Assessment Network, the Monitoring Network and the Wellbore Integrity Network. The event was held from 11th-13th June in New York, USA and was hosted by the US Environmental Protection Agency with support from EPRI and Oxand.

The aims of the meeting were: to ensure that the current networks are working in the most efficient way without duplication or gaps between them; to identify common areas that require the input from more than one network; and ultimately, to set the framework for the future direction of the networks. Finally, the Joint Network was asked to assess the merit of a Modelling Network as a potential 4th IEA GHG storage network.

The three day meeting commenced with overviews from each of the networks followed by discussion. On the second day there was a presentation on current modelling activities both within and external to the networks. This was followed by discussion as to the merit of a new modelling network. Then the attendees were split into groups to discuss the different phases of the CCS life cycle: site selection and permitting, site operation, site closure and finally post-closure. The purpose of this cross-network breakout session was to get the attendees thinking outside the bounds of their individual network to identify possible topics that are currently not covered in the existing network structure. The final day of the meeting saw people return to their network groups to discuss their future work programme. Each network then presented their final summary of the meeting.

Wellbore Network

The Wellbore Network identified a number of key issues to be addressed at future network meetings:

- Overarching wellbore questions remain about optimal abandonment practices, the range and type of wells which should be studied, demonstration of well performance, the impact of impurities in the gas stream, and how to improve the history matching between lab and field experiments;
- Analysis of wellbore materials including steel and cement performance in the wellbore and the use of chemical sealants to stop formation leaks of CO_2;
- Evaluation of the range of wellbore modelling applications including geomechanical models of well history, numerical models of well kill, and numerical studies of well leakage;
- Better use of case studies in wellbore integrity analysis.

The network also identified areas for collaboration with the other networks. For example, the Wellbore Network would value information on the well logs from the Nagaoka project from the Risk Assessment Network, and details on monitoring methods and requirements from the Monitoring Network.

Risk Assessment Network

There was a consensus that the

Network has been working towards achieving its aims as described in the IEA GHG Risk Assessment Network brochure. The Network then went on to identify the gaps that they need to address in the future. The gaps were divided into technical and network gaps.

The technical gaps that were highlighted were:

- Risks and quantification, in particular the risks of leakage into shallow marine environments and potable aquifers, and the risks associated with co-contaminants.
- Risk assessment modelling and the application of process models for risk assessment needs, as well as the different models and modelling techniques that can be used.
- More could be learned from the review of existing projects and the Network should do more with case-studies.
- Risk assessment communication, in particular identification and engagement of regulators, insurers, NGOs and the public.

The following network gaps were highlighted:

- Collaboration between the Risk Assessment Network and the Monitoring Network given that monitoring is an integral part of the risk assessment process, and vice versa.
- Collaboration with the Wellbore Network, in particular the statistics, classification and causes of leakage through wells and how this influences the risk assessment process.
- Communication with experts outside the network process as there is a lack of information on other groups and individuals in this field.

Monitoring Network

In its review, the Monitoring Network felt that its size, content and level of attendance were excellent. However, it was suggested that it could address more specific topics or issues, provide more information before the meeting, and begin each event with a review session to enable the attendees to be more prepared for the meeting and understand the context surrounding the topics to be discussed. The Monitoring Network identified a number of key issues to be addressed at future meetings:

- Monitoring for fault activation and pore pressure including issues surrounding CO_2 moving through a fault (how, why and when?);
- Monitoring for dissolved CO_2 in situ;
- How to plan a monitoring programme;
- Innovative emerging monitoring technologies; and
- How modelling fits into monitoring.

To conclude, the Monitoring Network discussed the longer term aims of the network, which are to increase the learning from current and new projects and to be closer to having quantitative performance limits for monitoring.

Conclusions

In the final session from the IEA GHG, a number of conclusions were drawn. The IEA GHG suggested an initial scoping study for a proposed modelling network and a preliminary meeting on modelling for the 2008-09 period. The study and meeting will focus on reservoir and cap-rock modelling, while the other modelling applications will be covered in the existing networks. The future of a Modelling Network will be decided after the preliminary scoping study and meeting. A number of proposals were made for new networks including a CO_2 infrastructure safety/risk network and a site characterisation network. The IEA GHG currently has two studies underway looking at these topics and will review the need for these networks following their completion.

A number of suggestions were made to improve communication between the networks and external stakeholders:

- Annual co-ordination of the steering committees where the agendas of each of the network meetings can be discussed;
- Network orientated reports from each network meeting on 'learning points' for other networks;
- Cross-network working groups to address specific issues for a limited time;
- Linked network meetings;
- Future joint meetings to be held regularly;
- Closer co-ordination with those network members who interface with regulators;
- Networks to have input to the IEA CCS Regulators Network; and
- The networks could better identify, support and include experts that advise regulators.

For more information on the IEA Joint Network Meeting please contact Brendan@ieaghg.org or Sian@ieaghg.org

Trials and Tribulations of the International Traveller

The epic story of one man's quest to return home

Following the ending of the IEA GHG Joint Network Meeting all attendees began their journey home. This was the beginning of a woeful travel tale for the intrepid journeyman John Kaldi.

In an email to his office, the tale shall unfold.

Got my own travel horror story now; got on board at New York JFK Saturday, 3:00 PM on schedule. Plane taxied out and then the weather-from-hell hit.

So bad that JFK shut completely with about 200 planes, including yours truly's, stuck out there on tarmac pummelled by hail and lightning, pitch black in afternoon. Ten (yes, 10) hours later... still on tarmac. Airport now open but flight crew would exceed use-by date if flight took off. So back to gate... but by now all gates full of all those other flights that were similarly cancelled. Two hours later (now 3:00 AM) and plane finally back to gate. Ah, but there's no one there... 3:00 AM after all... so jet way cannot be rolled out to meet plane. One hour later jet way driver found & jumbo full of tired, grumpy passengers surges off, charging toward single Cathay agent in terminal.

Now told that there are no hotels available (remember all those hundreds of other planes that also were cancelled?) and no taxis (what 3rd world country did I say I was in?) Cathay agent runs for life to escape clutches of aforementioned disgruntled passengers.
Agent re-appears... generously offers voucher for breakfast... ah, but restaurant only opens at 9:00.

And when you thought it couldn't get much worse… the tale continues

Sorry, folks, here are some blankets, try to get as comfortable as you can. So, your correspondent finds relatively quiet corner of business class lounge & dosses on floor (bringing back memories of misspent youth?)

And so, to complete this sorry tale...

Fast-forward to morning. Cathay reinforcements have arrived but however nice they are trying to be (self preservation?) none of them seems to know anything. Finally, from behind protective cover of ticket booth, one agent advises that the equipment we were on is, unfortunately, already earmarked to be used for the flight already scheduled for today... and, also unfortunately, that flight is already totally full, so no room for unwashed floor dossers on this one. Hmm, but wait... Cathay staff just had wonderful news for us... they are going to bring another aircraft in! Fantastic... minor detail is that it will be flown in from Hong Kong... now only 15 hours before that one gets here! And that's where our story pauses... and, if all goes well, I may be back by Tuesday... (although judging from experience so far... maybe Wednesday?) Anyway, could you reschedule any meetings or appointments we may have scheduled, please? Make up any excuse; the truth would be too unbelievable!

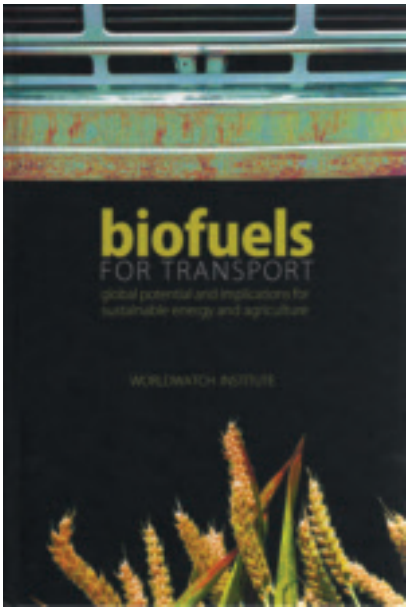
Just a word to the wise should you consider a career in International Travel!

John Kaldi: International Traveller

Book Review – Biofuels for Transport

By Deborah Adams, IEA GHG

The world is on the verge of an unprecedented increase in the production and use of biofuels. Rising oil prices, national security concerns, the desire to increase farm incomes, and a host of new and improved technologies are propelling many governments to enact powerful incentives for using these fuels, which is, in turn, sparking a new wave of investment. There are a number of implications for the increased use of biofuels, for the economy, for the environment, for global security and for the health of societies.



Currently, biofuels comprise only a small portion of the transportation fuel used globally, but their production has already begun to affect commodity markets. For example, in 2005, about 15% of the US corn crop was used to provide about 2% of that country's non-diesel transport fuel. In Europe, more than 20% of the rapeseed crop was tapped to provide about 1% of all transport fuel.

Biofuels for transport is a comprehensive survey of the subject, guided by the principles of sustainable agriculture, energy and transport. The first parts of the book discuss current and future feedstock options, production technologies and potentials. It addresses key economic, social and environmental concerns that will be raised by the large-scale production of biofuels. Later sections detail the fuel, engine, vehicle and infrastructure technologies that may be deployed to facilitate the greater use of biofuels in the world's transport fuel markets. The various policy frameworks being used to promote biofuels are assessed, as well as

new ideas under active discussion. Recommendations for decision-makers are given and five country studies are described – for China, India, Tanzania, Brazil and Germany.

The book concludes that there is a vast potential market for biofuels, but that a wide range of issues need to be addressed, in particular the competition for land with agricultural food production. The potential benefits of biofuels will only be realized if a host of new environmentally sustainable technologies are employed, ranging from new crops and farming methods to advanced conversion technologies and highly efficient vehicles. An important and anticipated innovation is the development of cellulosic ethanol derived from plant stalks, leaves and even wood. Synthetic diesel, made from an even broader range of energy crops or waste streams, also holds great promise.

The transport sector is responsible for about one-quarter of energy-related greenhouse gas emissions. Biofuels, combined with energy efficiency improvements are an option to reduce oil consumption. However, the overall climate impacts of biofuels will depend on several factors, the most important being changes in land use, choice of feedstock and management practices. The greatest potential for reducing greenhouse gas emissions lies in the development of next-generation biofuel feedstocks and technologies.

The book concludes that biofuels have a large potential to substitute for petroleum fuels and, together with a host of other strategies, can help the world achieve a more diverse and sustainable transport system. However, policies are needed that will steer the development of biofuels in the right direction.

Biofuels for transport: global potential and implications for energy and agriculture, prepared by Worldwatch Insitute with the German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), Earthscan, 2007

GeoCapacity - Digging Deep to Reduce Carbon Emissions

By Neil Wildgust, IEA GHG

CO_2 capture and storage (CCS) could help to make huge cuts in greenhouse gas emissions, but for this to happen, a large-scale assessment of the CO_2 storage potential across Europe is essential. The GeoCapacity project focuses on countries in eastern, southern and central Europe which have not previously been covered in detail.

The work of GeoCapacity includes data collection and mapping of emissions, infrastructure and storage sites. Advanced evaluation techniques (DSS & GIS) are applied to the datasets and economic evaluations are undertaken. This will enable source-to-sink matching across Europe. Site selection criteria, standards and methodologies for capacity estimations are created and applied to the project. Locating potential CO_2 storage sites may be essential to the emergence of a hydrogen economy. Production of hydrogen will be heavily reliant on fossil fuels – at least in its early development – and will have to consider CO_2 reduction strategies.

In addition, the project aims to work towards a structure for international cooperation especially with countries such as China, India and Russia. Focusing on technology transfer may help these countries to undertake similar studies of their own.

In detail, the objectives of the GeoCapacity project are to carry out:

- Data collection and mapping in 13 European countries (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Italy, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia and Spain), and reviews of four neighbouring states (Albania, Bosnia-Herzegovina, Luxembourg and Macedonia,) as well as updates for six other countries (Denmark, France, Germany, Greece, the Netherlands and the UK).
- An inventory of major CO_2 emission point sources.
- Assessments of the local and regional potential for the geological storage of CO_2 for each of the countries involved.
- Analysis of source-transport-sink scenarios and economical evaluations of these scenarios.
- Provision of consistent and clear guidelines for the assessment of geological capacity in Europe and elsewhere.
- Development of further mapping and analysis methodologies (i.e. GIS and DSS).
- Development of technical site selection criteria.
- Initiation of international collaborative activities with China with a view to further and closer joint activities.

Geological studies, mainly in Western Europe and including the northern North Sea, map considerable potential for CO_2 storage sites, but they are unevenly distributed geographically. Analysis shows the geological storage of CO_2 to be a real option in the majority of the countries studied. The storage of about 1 million tonnes of CO_2 annually at the Sleipner gas field demonstrates the technical feasibility of the method.

It is vital for Europe to develop and deploy the full range of technologies that make up CCS, including the geological storage assessment methods that will be developed in the GeoCapacity project. The alternative is to import the technology for CO_2 capture from overseas, but a 'home-grown' solution would provide export opportunities, particularly to some of the rapidly evolving economies, such as China, India and Brazil.

The participants in GeoCapacity throughout Europe are in a unique position to carry out research and development studies. The distribution and composition of hard rocks and sediments in the subsurface of Europe have been mapped by various organisations for many years, even centuries in some cases. The project partners have access to large amounts of accumulated knowledge of the subsurface geology of Europe obtained from work with mineral exploitation, geothermal studies, hydrocarbon activities such as seismic mapping and drilling for oil. The variety of existing maps, other data and previous work makes it possible for the project partners to produce reasonable evaluations of the CO_2 storage capacity for the selected study areas.

Based on the methodologies developed in previous activities – particularly the EU FP5 GESTCO project – the GeoCapacity project is designed with distinct roles for the partners. The Coordinator GEUS oversees all activities, having made working relationships and agreements with all of the other partners and leads the work on capacity standards and site selection criteria. The British Geological Survey (BGS) leads all work relating to GIS while the Dutch Geological Survey (TNO) leads the economic work.

The work on assessment of geological storage capacity is divided into three geographical groups. Co-operation is facilitated between the participants of these groups, and the group leaders assisting the project coordinator. The groups are:

- North Eastern Group. Led by SGUDS of Slovakia, the other members are MEERI PAS and PBG of Poland, Vattenfall AB (of Sweden/Poland), Tallin University of Estonia, LEGMA of Latvia, IGG of Lithuania and CGS of the Czech Republic.
- Central East Group. Led by ELGI of Hungary the other members are GeoEcoMar of Romania, Sofia University of Bulgaria, and IGME of Greece (covering Albania and Macedonia – FYROM).
- South Group. Led by the Croatian University of Zagreb, the other members are IGME and Endesa Generacion of Spain, OGS and EniTecnologie of Italy, GEO-INZ of Slovenia while Bosnia-Herzegovina is covered by the University of Zagreb.

Three industrial partners support the groups, which adds considerable value to the project:

- Vattenfall AB is heavily involved in RTD on CO_2 capture and is the most active European power company involved in the development of CCS. General RTD input is provided by Vattenfall AB – the corporate HQ is in Sweden – while Vattenfall Poland provides national input.
- EniTecnologie is actively engaged in investigating the potential for CCS in Italy and possesses experience, technical skills and data, which will improve the quality of the project work. EniTecnologie has already initiated work on standards and procedures for CCS.
- Endesa Generacion, while being one of the large power companies in Europe, is a relatively new player in the field of CSS. It is part owner of one of the only two IGCC power plants (advanced coal-fired technology) in Europe, making evaluation of geological storage potential in that region of Spain particularly interesting.

IFP of France leads the work with evaluations of storage potential in hydrocarbon and coal fields. The international co-operation is led by BRGM of France, working closely with the Chinese Ministry of Science and Technology. Contributions are provided by GEUS, BGS and TNO on key issues.

The GeoCapacity project has been designed specifically to provide contributions to CCS standards within the following four areas:

Site selection criteria

The understanding of the basic geological/technical site selection criteria is important and they have been described together with their related geological/physical parameters. A set of site selection criteria for the selection of a proper storage site are being produced including features such as depth, integrity of seal, storage capacity and petrophysical reservoir properties. The resulting standardised set of criteria is anticipated to be a valuable contribution to future practical work and to the development of regulations in the area.

Storage capacity estimation standards

A number of assessments of geological storage capacity of different countries, areas and regions have shown that the quality of work is very varied, ranging from regional assessment using simple parameters over a whole sedimentary basin to detailed evaluations using state-of-the-art tools. GeoCapacity aims to define and adapt standards for the proper geological assessment of storage capacity.

The work on establishing internationally recognised standards for capacity assessments was initiated by the Carbon Sequestration Leadership Forum (CSLF) about a year before the start of the GeoCapacity project and a CSLF Task Force has been active since. GeoCapacity has contributed to the work of the Task Force and

has continued the progress on this issue in Europe. The applications (for example, in GeoCapacity) of the methodologies described by the CSLF have already led to the initiation of further work by the Task Force, proving the synergy between projects.

GIS-based inventories & mapping

The basic methodology for devising GIS-based inventories and maps of CO_2 emissions and geological storage capacity was developed in the GESTCO project. In GeoCapacity, the GIS system has been further developed, to improve its functionality and make the system more user-friendly. The database now covers 25 countries in Europe, including two countries covered in GESTCO but not updated in GeoCapacity, and a web-based GIS has been made available to the project partners. The GIS database also provides input for the Decision Support System (DSS) economic evaluations. Overall, it has been the aim to produce work of such quality and detail that it sets the standard for building this type of GIS system.

The DSS Economic Evaluation method

The Decision Support System (DSS) software tool for economic evaluation of 'source–transport–storage' scenarios was also developed first in the GESTCO project, and it has already set the standards for evaluation of source-sink scenario economics. The GESTCO DSS has been used for evaluation work for the IEA GHG and it was recognised that a number of features need to be developed. New facilities developed in GeoCapacity include multi-source and multi-sink evaluations, a stochastic approach in calculations and web application of the tool.

Fine tuning

The EU GeoCapacity project has half a year left of the three-year project period and the process of collecting and working on data for the GIS database is almost at its end. What remains are final checks, and the fine tuning of the capacity estimates according to the standards developed through the lifetime of the project. The GIS database will provide updated CO_2 emission data, infrastructure such as pipelines and locations of potential geological storage capacity in deep saline geological formations, hydrocarbon and coal fields. The emission data will include technical information on the type of industry (e.g. power, cement, iron and steel, paper), fuel, technology, capacity etc. and the pipeline data e.g. diameter and length. The storage data will include geological information and physical properties of the reservoir and sealing formations as well as estimates of the storage capacity of each of the identified potential storage possibilities. The results of the study will be provided in a summary report at the completion of the project and it is the intention that the technical and geological results will be able to provide a solid foundation on which the application of the CCS concept in Europe can be judged, and – hopefully – be found sufficiently sound to warrant wider application.

Greenhouse Cuttings

CO_2 Capture in Latrobe Valley

CO_2 has been captured from power station flue gases in a post-combustion capture pilot plant at Loy Yang power station in the Latrobe Valley, Victoria, Australia. The 10.5 m high pilot plant is designed to capture up to 1000 tCO_2/y from the power station's exhaust gas. Future trials will involve the use of various CO_2-capture liquids.
See: http://www.csiro.au

24 Japanese Companies to Work Together on CCS

A joint venture has been launched by 24 Japanese companies to work on CO_2 capture and storage (CCS). The companies include Tokyo Electric Power Co, Kansai Electric Power Co and Idemitsu Kosan Co. The companies plan to invest ¥3 m each, to raise a total of ¥72 m in capital and capital reserves. CO_2 will be separated from the exhaust gases of large industrial plants and injected into an aquifer about 1000 m below ground in the form of a compressed supercritical fluid. It is estimated that 150 billion tCO_2 could be stored underground in Japan. The goal of the venture is to reduce the cost of CCS.
See: http://www.tepco.co.jp/en

New Laboratory at Babcock and Wilcox

The Babcock and Wilcox Power Generation Group has begun work on a new $11.8 m facility for the study of CO_2 capture technology at its research centre in Barberton, Ohio. It will provide additional research facilities for Regenerable Solvent Absorption Technology (RSAT) as a post-combustion

scrubbing process to capture CO_2 from a flue gas stream. CO_2 is absorbed and chemically reacted by the solvent, and the clean gas is exhausted. The liquid solvent, rich with captured CO_2, is then pumped into a regenerator where it is heated and the absorbed CO_2 is removed. It can then be prepared for long term storage or other uses, while the liquid solvent is recycled in the process.
See: http://www.babcock.com

Asian Development Bank Funds

The Asian Development Bank has established a new fund that will use carbon credits generated beyond 2012 to finance clean energy projects in the Asia-Pacific region, thus extending the current regulatory framework set by the Kyoto Protocol. The initial size of the new fund is US$100 m, which might be doubled, if necessary. The new Future Carbon Fund will be able to stimulate new investments in clean energy projects even before a new international agreement is reached.
See: http://www.energycentral.com/centers/news/daily/article.cfm?aid=10641204

MHI and E.ON Energie Working Together on CO_2 Capture

Mitsubishi Heavy Industries and E.ON Energie AG will test technology to recover CO_2 from the flue gas emissions of a coal-fired power plant in Germany. The CO_2 recovery test plant will use MHI's technology and its KS-1 solvent to capture up to 100 tCO_2/day. The plant will begin operation in 2010. Work at the plant will focus on reducing the amount of energy consumed in the CO_2 capture process. In Germany, E.ON Energie will build a CO_2 recovery pilot plant including a flue gas cooling tower, a CO_2 absorption tower using the KS-1 solvent, and a CO_2 desorption tower for separating CO_2 from the absorbent. MHI will supply part of the facility equipment and the KS-1 solvent.
See: http://www.mhi.co.jp/en/news/story/0807031245.html

New Plan in Michigan, USA to Advance Gasification and CCS

In June 2008, the Michigan Senate approved a proposal that embraces new energy technology such as gasification and CCS. The energy plan allows for power generated by gasification and CCS to be classified as renewable energy, making it eligible to be considered under a statewide renewable portfolio standard. M&M Energy has called the energy plan 'a step in the right direction' as it plans to build an IGCC project at the Great Lakes Energy Research Park in Alma, MI, that will use ConocoPhillips' E-Gas technology. The IGCC would be equipped with CCS.
See: http://www.mandmenergy.com

Japan and China Co-operation

Japan and China are to co-operate in a $300 m project to reduce CO_2 emissions from a thermal power plant. CO_2 will be captured from a coal-fired plant in Harbin, Heilongjiang province, northeast China and transported to the Daqing oil field, 100 km west of the plant for enhanced oil recovery (EOR). Currently the plant emits more than 1 $mtCO_2$/y and Daqing produces about 40 mt/y crude oil.
Source: Reuters

Western Kentucky Carbon Storage Foundation

Peabody Energy, ConocoPhillips and E.ON US have formed the Western Kentucky Carbon Storage Foundation to work with the Kentucky Geological Survey on a project that includes drilling a well to test CO_2 storage in the Knox and Mount Simon geological formations in Hancock County. The potential and suitability of Kentucky for storing CO_2 will be researched. CO_2 injection should begin in the first half of 2009.
See: http://www.energycentral.com/centers/news/daily/article.cfm?aid=10683605

MHI Working with ECPL, Pakistan

Mitsubishi Heavy Industries has signed an agreement for CO_2 recovery technology with Engro Chemical Pakistan Ltd (ECPL) which produces urea fertilizer in Pakistan. ECPL will use the technology to recover CO_2 from flue gas emitted from its petrochemical plant and utilise the captured CO_2 to increase urea production. The recovery units can capture 340 tCO_2/d. The CO_2 recovery plant is due for completion in July 2010. The MHI technology using KS-1 solvent will separate and recover CO_2 from flue gas emitted during the urea production process and provide the captured CO_2 as feedstock for urea and methanol synthesis.

ECPL is building a grass-roots ammonia/urea complex in Daharki, Ghotki District in Sindh Province. It will have a production capacity of 3835 t/d urea using a single production train. It will be the first CO_2 recovery plant in the world to be incorporated into a urea plant from the design stage.
Source: http://www.mhi.co.jp/en/news/story/0807011243.html

Methanation Technology for Kentucky SNG Project

Cash Creek Generation LLC (CCG) has awarded a contract to Davy Process Technology to supply a technology license and basic engineering design for the methanation unit that will produce substitute natural gas (SNG) from coal-derived syngas

at CCG's SNG/power project in Henderson County, Kentucky. The SNG produced at CCG facility will be injected into natural gas pipelines that will connect the facility with a 720 MW combined cycle power plant. The project is expected to be completed by 2012. The process plant will separate a highly concentrated CO_2 gas stream from the syngas that can be compressed and injected into a pipeline for EOR use.
See: http://www.davyprotech.com

Powerspan and Basin Electric CCS Work

Powerspan and Basin Electric have completed a feasibility study for a carbon capture technology to be demonstrated at Basin Electric's Antelope Valley Station (AVS). The demonstration project is designed to capture about 1 $mtCO_2$ from the exhaust gas from Unit 1 at AVS. The captured CO_2 would then be fed into an existing CO_2 compression and pipeline system owned by the Dakota Gasification Company. It is hoped that operation of the carbon capture system will begin in 2012.
See: http://www.basinelectric.com

MEGTEC Systems Wins EPA Award

In May 2008 the US EPA held its 10th annual Climate and Ozone Layer Protection awards. MEGTEC Systems received an award for their work on developing and implanting an innovative technology to capture and recover energy from the dilute methane emitted from coal mine ventilation shafts. MEGTEC's thermal oxidation system converts coal mine ventilation air methane to electricity at a site in Australia.
See: http://www.epa.gov/cppd/awards/2008winners.html

Hawaii Joins US DOE Programme

Hawaii is the 42nd state to join the US Department of Energy Regional Carbon Sequestration Partnership Program (RCSPP). The RCSSP was launched in 2003 as a nationwide co-operation of federal, state and private sector partnerships that are determining the most suitable technologies, regulations, and infrastructure for future CCS in different areas of the USA. In Phase 1 the Program characterized the potential for CO_2 storage in deep geologic formations. In Phase 2 a portfolio of small-scale geologic and terrestrial storage projects were implemented. In Phase 3, the partnerships will perform large-volume tests to validate that the capture, transport, injection and long term storage of over 1 $mtCO_2$ can be done safely, permanently and economically.
See: http://www.fossil.energy.gov/sequestration/partnerships

GE Energy and Schlumberger Agreement

GE Energy and Schlumberger Carbon Services have signed a carbon storage alliance agreement to accelerate the use of cleaner coal technology. The agreement aligns GE's experience in integrated gasification combined cycle (IGCC) systems with proven carbon capture capabilities and Schlumberger's geologic storage expertise and capabilities for site selection, characterization and qualification.
Source: http://pepei.pennnet.com/display_article/329879/6/ARTCL/none/INDUS/1?GE,-Schlumberger-sign-'clean-coal'-alliance/?domp=PENews

CBM/CMM Power Generation Workshop in China

A workshop on coalbed methane and coal mine methane (CMM) power generation was held in May in Dalian, Liaoning Province, China. About 100 people attended from China's coal and gas industries and from the investment and carbon credit communities. The workshop covered the assessment of the CMM resource in place, drainage of the methane resource to generate acceptable qualities and quantities of gas and options for the utilization of the recovered gas to generate power.
See: http://www.epa.gov/cmop/newsroom/international.html

Clean Coal Plant for Beijing

CSIRO-Australia and TPRI-China have signed an agreement for the research and testing of clean coal technology in Beijing. TPRI will install, commission and operate a post-combustion capture pilot plant at the Huaneng Beijing Co-generation power plant as part of CSIRO's research programme. The pilot plant is designed to capture 3000 tCO_2/y from the power station and will start the process of adapting this technology to evaluate its effectiveness in Chinese conditions.
See: http://www.coalassociation.org

Pump Canyon CO_2-ECBM Pilot Project

ARI is the site manager for the Pump Canyon pilot project in the San Juan Basin, New Mexico, USA which is part of the US Southwestern Partnership on CO_2 Sequestration. In April and May 2008 a new injection well was drilled, a CO_2 pipeline was installed and various measurement, monitoring and verification devices were deployed. The injection of 20,000 tCO_2 into the Fruitland coals of the San Juan Basin began in June.
See: http://www.southwestcarbonpartnership.org

Carbon Storage Testing in Mississippi

The US DOE is sponsoring the Southeast Regional Partnership's field test at Mississippi's power plant Daniel, involving Southern Co, EPRI and ARI. So far, the project has drilled two deep wells – one CO_2 injection and one monitor well, into a large capacity saline formation, the Lower Tuscaloosa Massive Sand. Detailed formation characterisation is being integrated with modeling of the CO_2 plume. CO_2 injection is planned for October 2008.
See: http://www.secarbon.org

Masdar and Abu Dhabi Ports Company Agreement

The Abu Dhabi government's clean energy initiative, Masdar, has signed an agreement with infrastructure developer Abu Dhabi Ports Company to cut greenhouse gas emissions at its industrial facilities in the Khalifa Port and Industrial Zone (KPIZ). The agreement paves the way for the introduction of a scheme for CO_2 capture from industrial facilities as well as the development of carbon emission reduction and opportunities under the Clean Development Mechanism.
See: http://www.ameinfo.com/160034.html

Clean Coal Victoria

A $102 m (AUS$110m) fund has been launched for commercial-scale CCS demonstration projects in the Latrobe Valley, Victoria, Australia. There is also an AUS$12.2 m fund to establish an organization designed to maximise Victoria's coal resources, called Clean Coal Victoria. Another AUS$5.2 m will finance research and modeling to investigate the storage potential of the Gippsland basin in southeastern Australia.
Source: http://www.premier.vic.gov.au/newsroom/$127.4-million-to-secure-victorias-clean-coal-future.html

Siemens Gasification Technology for Latrobe Valley

Two 500 MW coal gasifiers have been ordered from Siemens by the Australian Energy Co Ltd. The gasifiers will be installed at a fertilizer plant in Latrobe Valley, Victoria, Australia, where they will gasify lignite for ammonia production. In an adjacent plant, the ammonia will be used to produce 1.2 mt/y of urea by 2012. From 2015, in Phase 2 the CO_2 generated during fertilizer production may be transported via a pipeline to be stored in the Bass Strait, off the south coast of Australia.
See: http://www.australiancoal.com.au/news.html

Qatar and Shell in Carbon Storage Research

Qatar Petroleum, Qatar Science and Technology Park and Shell have launched a $70 m, 10 y joint research project at Imperial College, London to investigate the storage of CO_2 in carbonate reservoirs. The project aims to develop CO_2 storage and enhanced recovery technologies that can be implemented in the Middle East region. Most of the oil and gas reserves of the Middle East are contained in carbonate reservoirs, and no more than 40% of oil from carbonate reservoirs is recovered. The complex structure of the rock also makes it difficult to use depleted carbonate reservoirs for CO_2 storage. The aim is to establish an in-depth knowledge of rock structures and the way fluids like oil, water, and natural gas and CO_2 move within them. This will improve understanding of how these rocks trap gas and fluids.
See: http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/newssummary/news_9-6-2008-14-55-41

Springfield, Missouri to store CO_2

City Utilities (CU) of Springfield, Missouri, USA is preparing to inject food-grade CO_2 from its Southwest Power Station into a 2000 ft (600 m) deep saline formation. CU will work with a number of partners over the next 3 y to determine whether the geological storage of CO_2 is an economic and safe method for reducing GHG emissions. The Southwest plant generates 3562 tCO_2/d. CU officials hope that successful testing will free the utility from the cost of building pipelines to transport CO_2 to injection sites in northern states.
See: http://www.cityutilities.net/community/missouricarbonproject.pdf

Spectra Looking at Carbon Storage in Canada

Spectra Energy Corporation plans to examine the viability of building a large-scale carbon storage facility at its natural gas plant in northeastern British Columbia, Canada. CO_2 would be stored in a depleted natural gas reservoir, 2 km underground. The reservoir has the potential to store 1 $mtCO_2$/y, a figure equivalent to the plant's CO_2 production over the next 20-50 y. Previously, Spectra has captured and stored 200,000 tCO_2 in depleted natural gas reservoirs.
See: http://www.oilweek.com/news.asp?ID=16312

CCS Project in Nova Scotia

A CCS project led by the Carbon Storage Research Consortium of Dalhousie University, Nova Scotia Power, and Nova Scotia's Energy Department will start in 2008 by searching for potential CO_2 storage sites in Cape Breton and northern Nova Scotia. The project will examine the regulatory issues

and economic impacts facing CO_2 storage, as well as assessing the geology of northern Nova Scotia's oil reservoirs and deep coalbeds. It has been estimated that Nova Scotia could store up to 10,000 tCO_2/d by 2018-2020.
See: http://thechronicleherald.ca/Business/1060298.html

Vattenfall to Build CCS Demonstration Plant

Vattenfall plans to build a demonstration plant equipped with CCS technology at one of their 500 MW blocks at the Jänschwalde facility, in Brandenburg, Germany. Full-scale operation is expected by 2015. The CCS-equipped block will house two boilers: a newly built boiler with oxyfuel technology and a boiler retrofitted with post-combustion technology. Technology will be tested for storing the captured CO_2 in a depleted natural gas field in Altmark, Germany.
See: http://www.vattenfall.com

Potential for CO_2 Storage Under the Seafloor

Researchers at Columbia University's Lamont-Doherty Earth Observatory think that deep volcanic rocks up to half a mile below the ocean bottom may suitable for the storage of CO_2. Undersea storage may be one of the safest repositories for CO_2, but the costs of collecting, compressing and piping the gas could make it uneconomic. The Lamont-Doherty team is calling for a test well in the Pacific Northwest.
See: http:// www.guardian.co.uk/environment/2008/jun/18/carboncapturestorage.carbonemissions

Alberta Investing in CCS

The government of Alberta has two new funds totalling $4 billion to reduce GHG emissions. The province will create a $2 billion fund to advance CCS projects and a second $2 billion fund will promote energy-saving public transport in Alberta. The province has issued a request for expressions of interest to begin identifying the CCS proposals with the greatest potential of being built quickly, and those which provide the best opportunities to reduce GHG emissions significantly.
See: http://www.syngasrefiner.com

Australian Clean Coal Fund

The Australian Government is to use its $500 m clean coal fund to form the National Low Emissions Coal Council and the Carbon Storage Taskforce. Industry and state governments will contribute a further $1 billion. The council will work on a strategy to speed up the use of low emissions technologies in coal while the taskforce will establish a plan for carbon mapping and infrastructure.
See: http://www.abc.net.au/news/stories/2008/07/28/2316511.htm

CO_2 Injection in Illinois, USA

The Midwest Geological Sequestration Consortium (MGSC) became the first of the seven Regional Carbon Sequestration Partnerships (RCSP) to inject CO_2 into a coal seam in the USA in a field project in Wabash County, Illinois. The project will test the viability of turning unmined coal deposits into a source of useable energy by extracting coalbed methane trapped in the coal. Estimates are that there is up to 3.6 billion tons (3.3 Gt) of storage capacity in the Illinois Basin, with more than 10 trillion cubic feet (0.2 trillion m^3)of recoverable coalbed methane from the unmined bituminous coal seams.
See: http://www.sequestration.org

CO_2 Capture Planned in North Dakota, USA

Basin Electric Power Cooperative and Powerspan Corp plan to capture 1 $mtCO_2$/y from one of the two units at the 900 MW Antelope Valley Station in North Dakota. Post-combustion technology using an ammonia-based solution will be used. The CO_2 captured will be piped to Canada and used for EOR.
See: http://www.eenews.net/Greenwire/2008/06/18/13/

Alberta, Canada Investing in CCS

The Government of Alberta will invest CAN$1.98 billion over the next five years to launch several large-scale industry run CCS projects. In one of the first initiatives, Royal Dutch Shell plc will test for ways to capture and store CO_2 at its Scotford Upgrader near Fort Saskatchewan, Alberta. Shell's project, Quest, would reduce emissions from their oil sands operations by 1$mtCO_2$/y beginning in 2015.
See: http://www.premier.alberta.ca/media/mediaPage.cfm

US EPA Proposes Regulations for CO_2 Storage

The US EPA has proposed regulations for the long-term underground storage of CO_2. A new class of injection wells would be established under EPA's existing Underground Injection Control programme, and the Safe Drinking Water Act would be updated. Under the proposals, a new category of injection well would be established to monitor the long-term geologic storage of CO_2. A final rule is anticipated by early 2011.
See: http://www.epa.gov/safewater/uic/pdfs/prefr_uic_co2rule.pdf

Hydrogen Energy Plans a Petcoke-based IGCC Project

Hydrogen Energy International LLC, a BP/Rio Tinto joint venture, is applying to the California Energy Commission for permission for a proposed petcoke-based 400 MW project producing hydrogen fuel for power generation in Kern County, California. HEI's application initiates a comprehensive regulatory review process and, on approval, grants permissions for the construction of the nation's first industrial-scale low-carbon power plant with CCS.
See: http://www.hydrogenenergy.com

EU ETS Carbon Allowance Auctions

Phase II of the EU Emissions Trading Scheme will be quite different to Phase I. In Phase I, the average price of carbon was low and allowances were given freely to large emitters. From February to July 2008, the start of Phase II, the average carbon price was much higher, at €20.55. From this, Datamonitor estimates that the aggregated cost of carbon in the UK, Germany, Spain, Italy and Poland alone will be about €21.5 billion during Phase II. In the UK, the power sector will have to buy almost a third of their allocation permits, instead of receiving them all free of charge as they have done since the start of Phase I.
See: http://www.energycentral.com/centers/news.daily/article.cfm?aid=10781676

Japan Steelmakers to Cut CO_2 Emissions

Japan will spend ¥25 billion to cut steelmakers' CO_2 emissions by at least 30% within 10 years, according to the Japan Iron and Steel Federation. The reductions will be achieved by storing captured gas underground and using hydrogen instead of coking coal in processes under development. The project will be funded by the Ministry of Economy, trade and Industry.
See: http://search.japantimes.co.jp/cgi-bin/nb20080731n4.html

Vision for a Low-carbon Japan

Prime Minister Yasuo Fukuda of Japan has set out a long-term plan to reduce Japan's carbon emissions by 60-80% by 2050. To achieve this aim Japan will have to be innovative in the areas of technology, energy, financing and society. 'Putting a price on carbon' will play a significant role, thus additional carbon costs will be included in the prices of goods and services. All of society will be involved in achieving the carbon reduction goals.
See: http://www.japanfs.org

Biomass Co-combustion with Coal Cuts CO_2 Emissions

The Electric Power Development Co (known as J-Power) has carried out combustion tests on coal mixed with BDF at the Matsuura thermal plant in Nagasaki, Japan. They found that the maximum mixture rate of BDF should be 1% (about 90 t/d). Burning 1200 t BDF can reduce the use of coal by 1100 t, which will result in a reduction of 2600 tCO_2.
See: http://www.japanfs.org/db/1373-e

Fujitsu Establishes 'Green Policy 2020'

The Fujitsu Group has launched Green Policy 2020, its medium-term environmental vision. It estimates that its initiatives will result in reducing CO_2 emissions in Japan by 30 mt/y in 2020. The policy is based on creation, collaboration and change: creation of advanced technologies and business solutions; collaboration with customers, business partners and other key stakeholders in the international community; and the promotion of change within the Fujitsu Group.
See: http://www.fujitsu.com

HTC Purenergy and EPCOR Looking at CO_2 Capture

HTC Purenergy and the EPCOR Power Development Corporation have agreed to deliver a process design and site integration engineering study to look into the potential of a CO_2 capture facility on a coal-fired plant. The study will help EPCOR determine whether post-combustion amine based CO_2 capture technology can be used in larger-scale coal fired power plants.
See: http://www.htcenergy.com

Eden Energy Creates Hydrogen Company

Australia-based Eden Energy has formed Eden Hydrogen by integrating two US subsidiaries to capitalize on the emerging US hydrogen economy. For example, a US-backed study has recommended government funding of $55 billion over the next 15 y to ensure that hydrogen vehicles become competitive in the USA.
See: http://www.energycentral.com/centers/news//daily/article.cfm?aid=10743793

CCS in the UK

Britain has announced a shortlist of firms in a tender to build a commercial-scale power plant that will incorporate CCS. The eventual winner will get financial help from the government. The shortlisted firms are: BP Alternative Energy International, E.ON UK, Peel Power and Scottish Power Generation. The EU wants 12 full-sized pilot projects to be running by 2015, and the technology commercially viable by 2020.
See: http://www.reuters.com/articlePrint?articleId=USL30517126

Funding for CO_2 Storage in Saline Aquifers

Sustainable Development Technology Canada has granted CAN$5 million to the Petroleum Technology Research Centre to assist in a project to store CO_2 deep underground in a saline aquifer. The Aquistore Project in Saskatchewan represents the first large-scale application of saline aquifer storage of CO_2 in North America. The eventual aim is to send 500 t/d CO_2 down a pipeline to an injection site 10-12 km away.
See: http://www.co2network.gc.ca

Alberta Saline Aquifer Project (ASAP)

ASAP is a broad-based, industry-supported initiative that will run in 3 phases. In phase 1 suitable sites for the long-term storage of CO_2 in saline aquifers will be identified. In phase 2 storage sites will be designed to receive injected CO_2 in a pilot project. Phase 3 and subsequent phases will involve expanding the project to a large-scale, long-term commercial storage operation.
See: http://www.co2network.gc.ca

Redwater Project, Alberta

The Redwater Leduc reef in Alberta, Canada has the potential to store the current oil sands cumulative CO_2 emissions for the next 20 years. The Redwater CCS pilot project is focused on CO_2 storage within the deep saline aquifer portion of the Redwater reef. The potential exists to inject over 1000 tCO_2/d per well in the aquifer portion of the reef. The top of the reef offers the potential for CO_2 enhanced oil recovery and the rest of the reef has a large capacity for CO_2 storage, estimated up to 1 billion t.
See: http://www.co2network.gc.ca

CCS Project in British Columbia, Canada

A large-scale integrated CCS project in British Columbia has been announced. The feasibility stage of the project aims to determine whether deep underground saline reservoirs are appropriate for CCS. The project is part of a programme run by the Plains CO_2 Reduction (PCOR) Partnership. As part of the project, Spectra Energy will drill two test wells to determine whether the surrounding geology is suitable for the permanent storage of CO_2 and hydrogen sulphide.
See: http://www.spectraenergy.com

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 in the Cement Industry (Report No. 2008/3)**
  This report assesses the technical feasibility and costs of capturing CO_2 in cement plants. Cement production is one of the largest sources of CO_2, accounting for 1.8Gt/y of emissions. The report includes assessments of post-combustion solvent scrubbing and oxy-combustion at cement plants. Pre-combustion capture is not assessed in detail because it does not capture the CO_2 from carbonate mineral decomposition, which is the source of almost two thirds of the CO_2 from a modern cement plant. Oxy-combustion is the lowest cost option but it is not yet technically mature enough for deployment. Post combustion capture is the most suitable option for retrofit to existing plants.

- **4th Wellbore Integrity Workshop (Report No. 2008/6)**
  The fourth meeting of the Wellbore Integrity Network was help in Paris, France in March 2008. The meeting was hosted by Schlumberger, and included presentations in four categories; field investigations of wellbore integrity, experimental studies of wellbore integrity, numerical modelling and monitoring, risk and development of best practice. The discussions highlight the progress made since the 3rd meeting, and also the ongoing need for further research and knowledge development.

- **Production of Hydrogen and Electricity with CO_2 Capture - Updated Economic Analysis (Report No. 2008/9)**
  Costs of building power generation plants in general and fuel prices have increased rapidly in recent times. This report provides information on costs of electricity and hydrogen production by coal gasification with CO_2 capture on a 2nd quarter 2008 basis. This is an update of information presented in IEA GHG report 2007/13.

Conferences & Meetings

Carbon Capture, Storage & Transport Summit 2008, 22-24 September 2008, Café Royal, London, UK. Tel: +44 (0)207 368 9300. Fax: +44 (0)207 368 9301. www.iqpc.co.uk/carbon. enquire@iqpc.co.uk

25th Annual International Pittsburgh Coal Conference. 29 Sep-2 Oct 2008, The Westin Convention Center, Pittsburgh, PA, USA. Contact: International Pittsburgh Coal Conference Secretary, University of Pittsburgh, 1249 Benedum Hall, Pittsburgh, PA 15261, USA. Tel: +1 412 624 7440 Fax: +1 412 624 1480. Email: pcc@engr.pitt.edu. http://www.engr.pitt.edu

Carbon Capture Status and Outlook. 20-22 Oct 2008, Crowne Plaza Downtown, Houston, TX, USA. Contact: Infocast, 6800 Owensmouth Ave, Suite 300, Canoga Park, CA 91303, USA. Tel: +1 818 888 4444. Fax: +1 818 888 4440. Email: mail@infocastinc.com

2008 US Coal Mine Methane Conference. 28-30 Oct 2008, Omni William Penn Hotel, Pittsburgh, PA, USA. Contact: Eastern Research Group Inc, 110 Hartwell Ave, Lexington, MA 02421. Tel: +1 781 674 7374. Fax: +1 781 674 2906. http://www.omnihotels.com/FindAHotel/PittsburghWilliamPenn/MeetingFacilities/USCoalMineMethaneConference10.aspx

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, Cambridge, MA 02139, USA. Tel: +01 617 258 0307 Fax: +01 617 253 8013 ghgt9@mit.edu. http://mit.edu/ghgt9/

2nd Annual European Carbon Capture and Storage Summit. 2-3rd Dec 2008, Marble Arch, London, UK. Contact: Tel: +44 207 156 5190. Fax: +44 207 156 5233. http://www.cityandfinancial.com/conferences/index.asp?id=227

4th International Conference on Clean Coal Technologies 18-20 May 2009, Maritim Hotel and International Congress Centre, Dresden, Germany. Contact: IEA Clean Coal Centre, 10-18 Putney Hill, London SW15 6AA, UK. Tel: +44 20 8780 2111. Fax: +44 20 8780 1746. Email: mail@iea-coal.org.uk. http://www.cct2009.org

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