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Greenhouse Issues

In this Issue:

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GHGT-9 – The Biggest Yet

The latest conference in the GHGT series (GHGT-9) broke all existing records relative to attendance, oral and poster presentations, and number of sessions. In total 1469 people from 42 countries registered for GHGT-9. The highest single country attendance was from the host USA with 576 delegates. 158 students attended the conference. A total of 269 oral presentations were given, which necessitated the addition of a sixth parallel session, and about 450 posters were presented. The dinner, held at the Smithsonian National Air and Space Museum in Washington D.C., was attended by over 1400 people - significantly exceeding the 1000 people that sat down to dinner in Trondheim, Norway for GHGT-8.

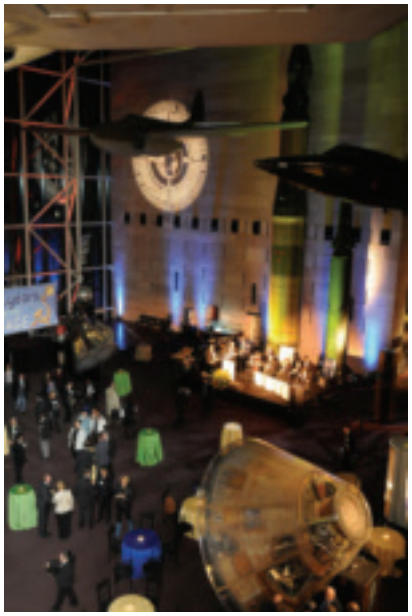
Based on the statistics, there is no doubt that the GHGT conference series can claim to be the biggest international technical conference of its kind on greenhouse gas mitigation in the world. However, going beyond the numbers, the information presented at GHGT-9 highlighted significant advances in science, technology, and policy that will be required by a world that most agree needs to significantly reduce its greenhouse gas emissions. Many of these issues will be included in the conference synthesis report, due to be released in early 2009.

Plenary lecture in the Omni Shoreham Hotel at GHGT-9

We invited attendees to give their feedback and we are pleased to say that the feedback from delegates has been extremely positive, which we feel is a testament to the hard work put in by the organisers (MIT, USDOE and IEA GHG). We should not forget to thank our many sponsors that helped with their financial support for the event itself and for the lunches delivered with such ease by the Omni Shoreham catering staff. The opening plenary included an opening address from Jeffrey Kupfer (Deputy Secretary of the US DOE) as well as keynotes on the role of CCS in climate stabilisation (Jae Edmonds, PNNL) and the status of CCS technologies and the challenges ahead (Kelly Thambimuthu, (cLET). The lunch time keynote talks provided us with very interesting perspectives on post Kyoto deliberations (Jake Jacoby, MIT) the science of climate change (Susan Solomon, NOAA) and on

risk communication (David Ropeik, Harvard). Also the hotel itself is a Washington landmark and its superb facilities and staff proved to be an excellent venue for the conference.

The conference dinner, which many viewed as a most memorable, event received particularly positive feedback. Certainly there was something for all with outstanding food, great entertainment and of course the back drop of the museum itself with all its exhibits and theatres.



GHGT-9 Conference Dinner at the National Air & Space Museum

In keeping with GHGT tradition we acknowledge individual contributions to the cause of greenhouse gas mitigation; this acknowledgement is in the form of an award, known as the Greenman award. The Greenman is an ancient Celtic archetype of a human face peering through growing foliage which is often depicted on buildings, churches, and cathedrals. It symbolises the mysteries of creativity, compassion, healing, new beginnings, and especially our connection with nature and the power of humankind. The winner of the 2008 Greenman award was Dr Bill Gunter who has recently retired from the Alberta Research Council in Canada. Bill has a long history of working with IEA GHG and is a world renowned expert on the geological storage of CO_2.

Kelly Thambimuthu the Chairman of IEA GHG presents Bill Gunter with his Greenman award

A photo gallery from the conference will be made available on the conference web site: http://mit.edu/ghgt9 for all those wanting to download photos from the conference and the dinner.

We have also had a number of useful comments and ideas from delegates on how to improve the conference in the future which we will definitely take on board in our future planning.

However, whilst the GHGT-9 event itself is now over, the work still goes on. We will provide all delegates with a CD of the conference proceedings which includes all the papers presented at the conference. Until that time the papers will still be available through the Online paper database. See http://mit.edu/ghgt9 for details and to download pre-prints of papers. The papers will also become available to all on Elsevier's new Energy Proceedia web site. The aim of this is to make the technical information from the conference as widely available for future reference as possible.

Please note that the conference will not be publishing or making available presenter's PowerPoint slides or posters. If you would like a presentation or a poster - please directly contact the author yourself. Delegate contact details were given in your conference pack.

The organisers intend to produce a synthesis report of the key messages from the conference which will be available early in the New Year as a web based product. One of the key themes running through the conference was "what have we learned to date" and what are the challenges ahead to make CCS globally implementable.

In addition, a small number of papers from the conference will be invited to provide an extended paper that will be included in a Special Issue of the International Journal on Greenhouse Gas Control that will be produced next year. This journal has now been in existence for two years and has become the main peer reviewed journal for technical articles on greenhouse gas mitigation and CO_2 capture and storage research. Further details can be found at: http://ees.elsevier.com/jggc/

Details of the conference series and future conference events can be found at one web site, http://ghgt.info. We feel that it is important for the continuity of the series to have a one stop shop for all GHGT related information and activities for the future. This new web site will become active early in the new year and will serve as the host web site for the next conference in the series, GHGT-10, which will be held in Amsterdam, the Netherlands in September 2010. Further information on this conference will become available in early 2009. But it is still worth bookmarking the web page now.

Signing of a Memorandum of Understanding between IEA GHG and CO2GeoNet

By Isabelle Czernichowski-Lauriol, BRGM and CO2GeoNet

A Memorandum of Understanding (MoU) was recently signed between IEA Greenhouse Gas R&D Programme (IEA GHG) and CO2GeoNet, the European Network of Excellence on the geological storage of CO_2. Initiated by the EC's 6th research framework programme in 2004, this Network has been transformed in 2008 into

a legally registered Association to provide a European scientific reference body on CO_2 geological storage, engaged in enabling the safe and efficient deployment of the CO_2 capture and storage technology (CCS) for mitigating climate change and ocean acidification.

The purpose of the MoU is to outline cooperation arrangements between the two Parties, for example collaboration through exchanging information on developments in CCS, regular updates on activities, promotion of the other party's activities through documentation, Web site and at international conferences, joint training activities, calling upon the technical expertise of the other party, etc.

Although collaboration between IEA GHG and CO2GeoNet is not something new for example, CO2GeoNet supported IEA GHG's first two international CCS summer schools in 2007 and 2008 by providing technical experts, the signing of the MoU will enable both parties to build upon this and strengthen relations.

Two future events where this collaboration will be put into practise are:
IEA GHG CO_2 Geological Storage Modelling Workshop to be held in BRGM, Orléans, France, from 10-12 February 2009 (see IEA GHG full announcement in this issue).

For this first joint event after the signature of the MoU, CO2GeoNet will assist as co-organiser, publicise the event within the 13 member institutes and on its Website, and provide specialist modelling practitioners to participate and give presentations.

CO2GeoNet Open Forum to be held in Venice, Italy, from 18-20 March 2009. Details available at: www.co2geonet.com/venice2009

The final event under the EC contract promises to be a major international event attended by a variety of stakeholders concerned by the geological storage of CO_2, including Decision-makers, Public authorities, Industry, NGOs and Scientists from Europe and farther afield. Amongst the high-level guest speakers, John Gale, General Manager of IEA GHG, will be welcomed back for the second year in a row to give a talk about International developments and collaboration with CO2GeoNet. The main theme this year is to grasp the concept that geological storage forms an essential part of the CO_2 capture and storage (CCS) chain... in other words, *"There is no sense in capture without storage"*. In addition to presentations of the results and fruit of 5 years of the Network's integrated research, spanning site characterisation, monitoring and safety issues, dialogue will be encouraged on CO2GeoNet's domains of activities, namely:

- Research,
- Training and capacity building,
- Scientific advice, and
- Information and communication.

Participants will also have the opportunity for setting up collaborations with the CO2GeoNet Association.

More information can be obtained from the Secretariat: info@co2geonet.eu

Signing of the MoU between IEA GHG and CO2GeoNet at the GHGT-9 IEA GHG booth in Washington, 19 November 2008.

South Africa Joins IEA GHG

IEA GHG are very pleased to announce that South Africa have joined the Programme. South Africa will be represented by the South African Energy Research Institute (SANERI). SANERI is the public entity entrusted with the coordination and undertaking of public interest energy research, development and demonstration. SANERI is a relatively new body, established by the then Minister of Minerals and Energy in October 2004, as a subsidiary of CEF (Pty) Ltd, the state energy company in South Africa. The Department of Science and Technology, together with the Department of Minerals and Energy, are joint custodians of SANERI and assist in providing political and strategic focus for the company.

Further details on SANERI and its research activities can be found at: http://www.saneri.org.za and an article on their activities follows below.

Carbon Capture and Storage in South Africa

By Tony Surridge, SANERI

A coal based energy economy and an increasing coal based energy infra-structure bestows on South Africa a high per capita carbon dioxide emission rate. With few other economically exploitable energy resources, and in common with similarly placed countries, such emissions are likely to continue, in spite of renewable energy programmes and energy efficiency measures. Consequently, South Africa is investigating the use of carbon capture and storage as a green-house gas emission mitigation measure through the Clean Development Mechanism – as a transition until renewable and nuclear energies can play a greater part in the South African energy economy.

Although South Africa became a Member of the IEA GHG IA during November 2008 [with the South African National Energy Research Institute SANERI as the contracting Party], it has been active in the carbon capture and storage arena since 2002. Following the joining of the Carbon Sequestration Leadership Forum CSLF, South Africa's Department of Minerals and Energy commissioned a study [of the CSIR] to ascertain the potential for carbon capture and storage in the country. That study indicated that indeed South Africa has capture-suitable sources of carbon dioxide and possible storage. Further, at a workshop held during 2006, it was decided that geological storage should be investigated as a priority – it was also decided that other storage possibilities such as ocean storage had too many unknowns at that stage. That workshop was the commencement of a broad stakeholder engagement in South Africa on carbon capture and storage matters.

Apart from participation in CSLF meetings and the hosting of such a meeting in Capetown during February, 2008, South Africa has also been participating in other international CCS forums. For example, SANERI contributed to the UN DESD meeting during September, 2007 and the GEF UNEP meeting during October, 2007.

The next such gathering was a conference during February, 2008 organised by the South African Fossil Fuel Foundation. The level of interest in carbon capture and storage in South Africa was indicated by the 110 registrations. That Conference was followed by a workshop that addressed research priorities – of which one of the urgent requirements was the development of a carbon dioxide geological storage atlas.

A preliminary study (M Cloete of the Council for Geoscience) has indicated that at least 100 gigatonnes of carbon dioxide geological storage could be available – more than four times the capacity required to store 240 million tonnes per year of captured emissions for 100 years. Most of that pertains to deep saline aquifers, with some extra prospects of depleted gas fields and enhanced coal-bed methane recovery.

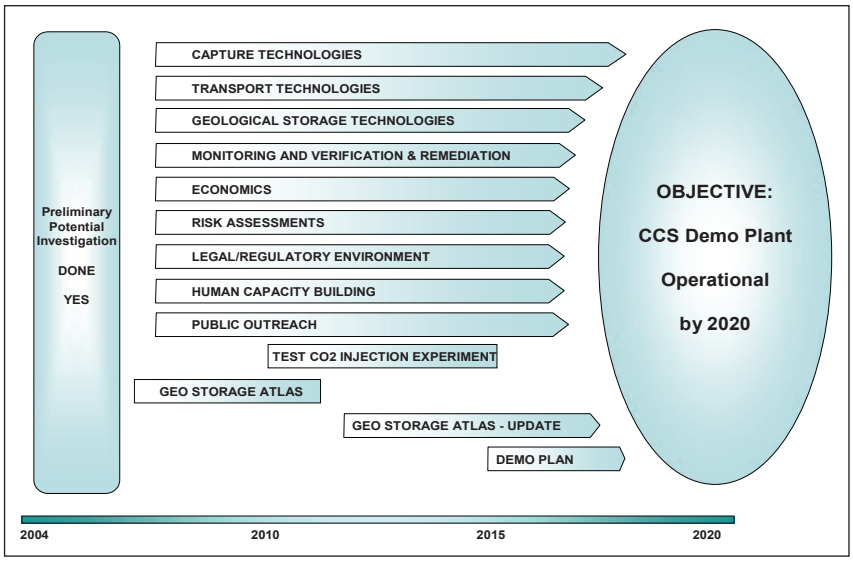
A detailed study to ascertain potential storage sites and their characterisation will be addressed in the form of a carbon geological storage atlas that commenced September, 2008 and is scheduled for completion by April, 2010. The South African Geological Carbon Dioxide Storage Atlas is a partnership with financial support from PetroSA, Anglo-Coal, Eskom, Sasol and SANERI. The Atlas compilation is being undertaken by the CGS (Council for Geological Sciences) with some data from PASA (Petroleum Agency of South Africa).

South Africa is in the unique position of having substantially sized synthetic fuel plants. Of the more than 400 million tonnes of carbon dioxide emitted per year (of which approximately 60% is suitable for capture), approximately 30 million tonnes per year of ~95% pure carbon dioxide is emitted by the synthetic fuel industry. Consequently, for approximately 10% of emissions, the capture phase of CCS has essentially already been done, thereby lowering total costs.

In order to develop capacity, both human and technical, in this relatively new field, a Centre for Carbon Capture and Storage is scheduled to be established April, 2009 in SANERI. The preliminary vision, mission and activities of the Centre are addressed as follows.

Vision: It is envisioned that a commercial carbon capture and storage demonstration plant be operational in South Africa by the year 2020.

Mission: The mission of the South African Centre for Carbon Capture and Storage is to develop in country human and technical capacity to



undertake the envisioned commercial demonstration plant.

Centre Work-Plan

The Work-Plan of the Centre and South Africa's programme for carbon capture and storage is expected to comprise four phases:

- *Preliminary Potential Investigation;* Already done. A preliminary investigation was undertaken by the CSIR for the Department of Minerals and Energy to ascertain whether South Africa had potential carbon dioxide sources and storage sites. Results of that investigation, released during 2004, showed capture-suitable emissions and potential storage sites.
- *Geological Storage Atlas;* Underway. Following a preliminary study that revealed South Africa could have up to one hundred years of storage capacity for all current capture-suitable emissions, a study to derive more authoritative storage information commenced September, 2008. The Carbon Dioxide Geological Storage Atlas is scheduled to be published April, 2010.
- *CO_2 Injection Experiment;* To be done. The test injection of carbon dioxide into South African rocks is essential to the understanding of the suitability of the local geology as a storage medium. It is also necessary to ascertain the dispersion and reactions of the carbon dioxide in the storage medium. This experiment will be informed by similar injection activities currently underway in the world. The planning of this experiment will be one of the first tasks of the Centre for Carbon Capture and Storage.
- *Demonstration Plant;* A commercial demonstration plant will test an integrated operating system under local conditions and forms an essential link between feasibility trials and a full scale commercial plant. This phase will be dependent on the outputs of the previous phases and the parallel supporting research and capacity building.

In parallel with the above four phases will be the supporting research and creation of human capacity and will encompass the following – see figure below;

i) Capture technologies
ii) Transport technologies
iii) Geological storage technologies
iv) Monitoring and verification
v) Remediation technologies
vi) Risk assessments
vii) Legal and regulatory regimes
viii) Public outreach

To these ends, international co-operation is essential. Already some international linkages have been formed. These need to be expanded.

A Centre for Carbon Capture and Storage is scheduled to commence operations April, 2009 within SANERI. The Centre will be a Private/International/Public Partnership and financed from local industry, SANERI and international sources. Initially, the Charter under which the Centre will operate will be for a period of five years. Thereafter, the success of the Centre will be appraised and continued work would be the subject of a new governing document.

Because of the global nature of greenhouse gas emission mitigation and in particular carbon capture and storage, international co-operation is absolutely essentially for any such activities in South Africa. For example, the most recent co-operation was the holding of a Carbon Capture and Storage Conference/Workshop 26/27 November, 2008 in Pretoria. That gathering was supported by the German Chamber of Commerce (with financial support from the German Federal Ministry of Education and Research) and visiting scientists and engineers from Germany (Brandenburg Technical University) and Brazil (Brazil Centre for Carbon Capture and Storage). The output of that Workshop assisted in the re-drafting of a work-plan for carbon capture and storage in South Africa.

Other international linkages include:

- Membership of the International Energy Agency Greenhouse Gas Research and Development Programme
- Membership of the Carbon Sequestration Leadership Forum (observer status)
- Verbal MoU with CSIRO, Australia
- Negotiating a MoU with the British Geological Survey
- Association with the Australian Global Carbon Capture and Storage Institute
- International Performance Assessment Centre – IPAC-CO_2

Other linkages need to be established to make full use of global advances of this new technology and to learn from others mistakes and successes.

South African students and researchers have already attended international courses and schools organised by the IEA GHG and CSLF;

- *CSLF USA 2007:* Attendance by ~5 Persons from South Africa
- *IEA GHG Summer School: Germany 2007* Attended by one University Witwatersrand Student
- *IEA GHG Summer School: Canada 2008* Scheduled Attendance by two University Witwatersrand Students

For further information, please contact: Dr A D Surridge, Senior Manager: Advanced Fossil Fuel Use, SANERI. Email: tonys@saneri.org.za

UNFCCC in Poznan

The remit in Poznan (UNFCCC meetings of SBSTA-29, COP-14, CMP-4) was to reach a decision on whether and how CCS could be included in the Clean Development Mechanism. This consideration has been underway for three years, with meetings twice a year.

After six negotiating meetings in Poznan, there was finally an agreed decision text on the table. This contained two options - CCS in the CDM (either fully or in a limited way) or CCS out of the CDM (moved to post 2012 mechanisms yet to be determined or to Activities Implemented Jointly – i.e. earning no credits). Some countries strongly want CCS in the CDM, and a few strongly do not. The final negotiating meeting just had to conclude to

Maciej Nowicki, Minister of Environment of Poland, who was President of COP 14

deliver these decision text options to Ministers here (as was the mandate) for them to decide between the two. However, an additional conclusion option was included to deliver it instead in Copenhagen in 2009 (to SBSTA, not Ministers). Whilst there was strong support for the delivery of the text to Ministers in Poznan, a few countries wanted the Copenhagen option. So, without being able to reach any agreement on this, no text could be forwarded to Ministers in Poznan. The final conclusions agreed and presented to SBSTA-29 were "The SBSTA considered the conclusions and the draft decision proposed by the Chair. However, it did not agree to adopt these conclusions and therefore could not conclude its consideration of this issue here". The issue will reappear on the agenda in SBSTA-30 in Bonn in June 2009, where it will start all over again with no text.

In addition, late in the last day, an action was placed by CMP on the CDM Executive Board to "assess the implications of the possible inclusion of carbon dioxide capture and storage in geological formations as clean development mechanism project activities, taking into account technical, methodological and legal issues" and reporting back to CMP-5 (Copenhagen).

IEA GHG again contributed evidence-base into these negotiations, in particular by Tim Dixon presenting the results of the recent study into 'Market Effects of CCS in CDM' at the EC's packed side-event on 'CCS in developing countries'. This most comprehensive study yet on the subject showed that the early low-cost CCS projects would be CO_2 from natural gas separation, that there would be only a limited amount of these in the CDM by 2012 (so not flooding the CDM market), and whilst there would be more CCS projects by 2020 this would still contribute less than 10% of the CDM market, although with some effect on carbon prices then. Potential countries for these early natural gas separation CCS projects are in South East Asia, Africa, and the Gulf. These results were used in the subsequent negotiations.

CCS was also starting to appear elsewhere in UNFCCC work-streams. More information on these will be provided in the next newsletter when the higher-level negotiations have concluded and been reported by UNFCCC.

Barbara Buchner of IEA, presenting the World Energy Outlook 2008

Historic EU Climate Deal Delivers Vital CCS Funding

EU leaders on Friday 12 December agreed a package of measures to deliver a unilateral commitment to reduce greenhouse gas emissions by 20% by 2020 compared to 1990 levels. They also made a clear commitment to increase this target to 30% in the context of an international climate agreement. The EU's Emission Trading System is strengthened with a tighter cap and a greater level of auctioning, putting a premium on low carbon technologies.

The measures include use of 300million EU ETS allowances, worth billions of Euros, to part-fund up to 12 Carbon Capture and Storage Demonstration plants which the EU have proposed.

The whole climate package will be voted on at the European Parliament the following week as the final part of the process. We will report more details in the next newsletter.

London Convention and Protocol Annual Meeting 2008

CO_2 Geological Storage
Transboundary Movement

Following the entry into force in 2007 of amendments to the London Protocol to allow (and regulate) CO_2 storage in sub-seabed geological formations, one issue was left unresolved. The London Protocol prohibits exports of wastes and other matter for dumping, and this includes CO_2. This means that it is currently illegal for London Protocol countries to export their CO_2 to another country for storage in sub-seabed formations. Following a working group on this issue in early 2008 hosted by the German Environment Ministry, the 2008 meeting of the 1972 London Convention and its 1996 Protocol (LC30/LP3), held at the International Maritime Organisation in London 27-31 October, considered this issue further, but without reaching a conclusion on the legal solution. However, Parties agreed a statement that the London Protocol should not constitute a barrier to the transborder movement of CO_2 streams, and agreed to progress this in a further working group, considering the option of developing an amendment to Article 6 of the Protocol, which prohibits the export of wastes for dumping purposes, or an interpretative resolution, or a combination of the two.

In addition, the 2008 meeting concluded on a reporting format for CO_2 geological storage activities under the London Protocol.

Ocean fertilisation

Ocean fertilisation activities, other than legitimate scientific research, should not be allowed, according to a resolution adopted by Parties to the London Convention and Protocol.

"Given the present state of knowledge, ocean fertilisation activities other than legitimate scientific research should not be allowed," says the (non-binding) resolution, adopted 1972 London Convention and the 1996 Protocol.

The resolution followed previous discussions by Parties to the two treaties on planned operations for large-scale fertilisation of the oceans using micro-nutrients – for example, iron – to sequester carbon dioxide (CO_2). The resolution states that ocean fertilisation activities other than legitimate scientific research, "should be considered as contrary to the aims of the Convention and Protocol and not currently qualify for any exemption from the definition of dumping".

In the resolution, Parties agreed that scientific research proposals should be assessed on a case-by-case basis using an assessment framework to be developed by the Scientific Groups under the London Convention and Protocol. Until specific guidance is available, Parties should be urged to use utmost caution and the best available guidance to evaluate scientific research proposals to ensure protection of the marine environment consistent with the Convention and Protocol. Parties agreed to consider further a potential legally binding resolution or amendment to the London Protocol at their next session in 2009.

The London Convention was one of the first global conventions to protect the marine environment from human activities and has been in force since 1975. Its objective is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. Currently, 85 States are Parties to this Convention. In 1996, the London Protocol was adopted, to further modernise the Convention and, eventually, replace it. The Protocol entered into force on 24 March 2006 and there are currently 36 Parties to it. IEA GHG contributes actively to their CO_2-related meetings and working groups as an observer.

Further information on the London Convention and Protocol can be found at http://www.londonconvention.org

ZEP Unveils Their Proposal for EU CCS Demonstration Programme

Founded in 2005, and initiated by the European Commission, the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP) is a broad coalition of stakeholders supporting CO_2 Capture and Storage (CCS) as a key technology for combating climate change. Its members come from European utilities, petroleum companies, equipment suppliers, scientists, geologists and environmental NGOs. ZEP is seeking to make CCS commercially viable by 2020 and kick-start its wide-scale deployment to tackle climate change.

During 2008, ZEP has carried out an in-depth investigation into precisely how a demonstration programme could work in practice, consulting an extensive range of experts and stakeholders. The aim was to establish the optimal portfolio of projects necessary to cover a full range of CCS technologies and fuel sources, geographies and geologies, Europe-wide. The conclusion was presented at the ZEP's annual meeting on 10 November in Brussels: a total of 10-12 demonstration projects is required in order to de-risk CCS for all players within the value chain and achieve commercialisation by 2020.

"It is widely accepted that CCS is one of the key solutions for combating climate change while building a bridge to a truly sustainable energy system," said Dr. Graeme Sweeney, Chairman, ZEP, and Executive Vice-President of Future Fuels & CO_2, Shell. "As a result, it is imperative that CCS receives the support and structure required to become a commercial reality and realise its potential of reducing CO_2 emissions in the EU by up to 400 million tonnes a year by 2030".

Experts within ZEP and the wider CCS community have identified the functional, operational and technical specifications for the technologies that require validation and integration across the entire CCS value chain. Known as Technology Blocks, these were a key driver in establishing all the technical and commercial criteria that needed to be fulfilled by the Programme – by both the portfolio as a whole and individual projects in particular.

They found that, in an ideal world, only 7 projects would be needed to satisfy these criteria. However, an ideal combination does not exist and the high-risk profile of some of these 'archetypal' projects means they are unlikely to materialise. When matched against the list of currently announced projects in the EU and EEA, they found that 8 projects will satisfy the vast majority of the criteria; while an additional 2-4 projects will cover the remainder that cannot yet be assessed (because the information is not available). This brought the total to 10-12 projects.

ZEP states that the cost of an EU Demonstration Programme will be high, but experience, technology development and economies of scale should drive the cost of CCS down. It is expected to fall from its current level of €60-€90 per tonne of CO_2 to €35-€50 per tonne of CO_2 in the early commercial phase (2020+) and to €30-€45 per tonne of CO_2 when total installed capacity increases to ~80 GW (giga watt) (Based on new-build coal-fired power plants: "Carbon Capture & Storage: Assessing the Economics", published by McKinsey and Company, September 2008). Nevertheless, the incremental costs of the first large-scale CCS demonstration projects will be exceptionally high – too high to be fully justifiable to shareholders. This is because all 'First Movers' will incur:

- Unrecoverable costs; from making accelerated investments in scaling up the technology
- Significant risk; because it is not yet known which CCS technologies will prove the most successful; the future CO_2 price is highly uncertain; and construction and operational costs are highly unpredictable.

In addition to the base cost of the power plants (€10 billion - €12 billion), ZEP's industry members are prepared to take on the commercial and technical risks associated with building the 10–12 integrated demonstration projects. However, ZEP concludes that a funding gap of €7 billion - €12 billion will remain to meet the costs of building and running the additional CCS installations and reduced plant efficiency.

However, ZEP concluded that these investment decisions must be taken now, but the incentive mechanism called for by the European Council in 2007 to "stimulate construction and operation by 2015 of up to 12 demonstration plants" is not yet available.

If such steps are taken and an EU funding mechanism is rapidly established, ZEP states that the outlook for CCS is highly favourable, with 80-120 commercial projects in Europe by 2030 avoiding ~ 400 million tonnes of CO_2 per year.

IEA GHG participates in ZEP, in the Task Force on Policy and Regulation.

The complete report, and detailed presentation, of ZEP's proposal for an EU Demonstration Programme presented on 10 November can be found online at: www.zero-emissionplatform.eu/ZEP_EU_Demo_Prog.zip

McKinsey Report on the Economics of CCS

CCS has potential to play a significant role in the European and global response to climate change by 2030. That is one of the findings in an independent report presented by the consultant firm McKinsey & Company on 22 September.

Over the last three years, McKinsey has worked with leading institutions to develop an understanding of the possibilities of reducing greenhouse gas emissions from all aspects, costs and profitability included.

The report in question, "Carbon Capture & Storage: Assessing the Economics", has been independently developed by McKinsey during 2008. The company says in its press release that the report was made "in response to a perceived need for a transparent and 'readily accessible' fact base for CCS", i.e. there is an information gap and low public awareness regarding CCS economics.

The report is based on input from over 50 companies, NGO's and CCS-experts and stakeholders. These are McKinsey's key findings, quoted from its report on CCS:

- CCS has potential to play a significant role in the European and global response to climate change by 2030 - as the only technology that can address emissions from stationary fossil fuel sources.
- McKinsey's reference cases have shown that the costs for integrated CCS projects could come down to 30-45 €/tonne of CO_2 abated for new coal-fired power by 2030, in the range of expected future carbon prices. Early demonstration projects will typically cost 60-90 €/tonne, representing an 'economic gap' of €500-1100 m per 300 MW project (in net present value, NPV, terms).

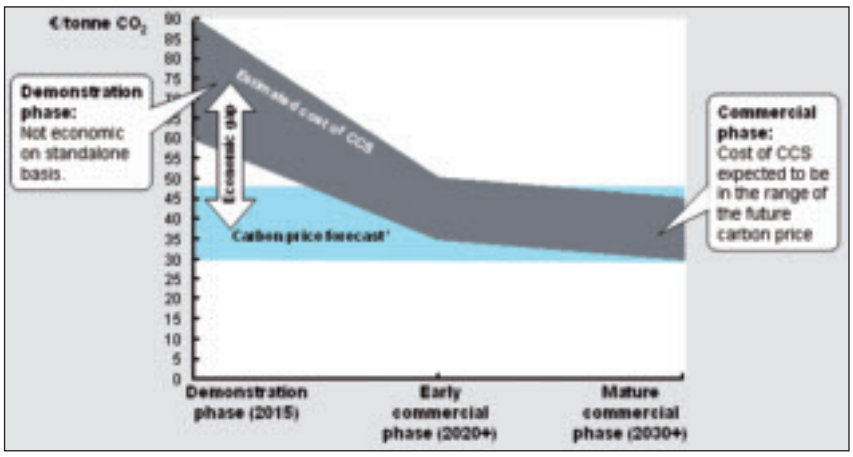


Figure - Likely development of CCS costs for new coal plant versus carbon price—reference case

A series of demonstration projects are an important first step, and three near term barriers remain to be addressed to facilitate them: Regulatory framework, funding mechanisms and public awareness and perception.

Beyond that, scale-up is key. Timing of demonstration plants, speed and approach to commercial roll-out and availability of regional storage are crucial to shaping the 2030 CCS landscape in Europe. Delays could lead to higher overall abatement costs or increased emissions.

The European Energy Commissioner, Andris Piebalgs, welcomed the report "CCS: Assessing the Economics" which was presented to him. "Early effective demonstration of technological viability of Carbon Capture and Storage (CCS) in power generation, both in Europe and internationally, is essential to move rapidly to economically viable, near free carbon electricity generation. This report is a valuable contribution to the discussions currently ongoing to find the best way to push this technology forward", said Commissioner Piebalgs on 22 September.

The report is available at: http://www.mckinsey.com/clientservice/ccsi/pdf/CCS_Assessing_the_Economics.pdf

Vattenfall's Oxyfuel Combustion Pilot Plant with CO_2 Capture

By Stina Rydberg, Vattenfall Power Consultants AB

Vattenfall's Oxyfuel pilot plant was officially inaugurated on the 9th of September 2008. The week before the inauguration, the first tonnes of CO_2 were produced in the plant, showing that the plant works and is able to produce the desired liquefied CO_2. Some work on stabilising and optimising operation is, however, still required.

Facing New Challenges

The Oxyfuel pilot plant is not a standard power plant and this means that other commissioning and control strategies are required. The main difference compared to a conventional power plant is the handling of pure oxygen and carbon dioxide. Large quantities of ammonia are also handled in the cooling loop of the CO_2 plant. Another very important difference, compared to the operation of a conventional power plant, is that three different operation modes are possible and necessary: the air-firing mode, the Oxyfuel mode with flue gas exhaust through the stack and the Oxyfuel mode with flue gas fed to the CO_2 compression plant.

The different firing modes imply different flue gas paths and bypass systems, a new boiler design, a new control system and many more novelties compared to conventional power plants. All this has been a great challenge to the equipment suppliers and the Vattenfall engineers in the design and construction phase, and these challenges continue into the operational phase.

As yet, the pilot plant is not running non-stop. It is regularly restarted, operated on an hourly or daily basis and constantly improved. The plan is for Vattenfall to begin test operations in the beginning of 2009, after a longer shutdown during the holidays.

Experience from the Commissioning

The Air Separation Unit (ASU) operates at low temperatures and the commissioning has shown that a cooling-down time of 60 hours is required to reach the operating temperature, if the ASU is started from ambient temperature. Liquid nitrogen, which is also produced in the ASU, can be used for cooling purposes and thus speed up this start-up period.

The first operational experience gained during the commissioning with the steam generator and its indirect firing system in the air-firing mode did not show any unexpected results. The pre-dried lignite ignited well and developed a stable flame.

Controlling the flue gas recirculation in the Oxyfuel mode has been both a challenging and time-consuming task, but absolutely necessary for safe Oxyfuel operation. To stabilise the flame and ensure safe ignition, adjustments to the swirl and the oxygen concentration at the burner were required. In both the air-firing and Oxyfuel modes all the required emission limits could be kept safely without any further optimization.

The operation of the CO_2 compression plant is also a rather

complex task for the control system, because of the dependence on what happens upstream. Stable pressure levels at specific places in the flue gas ducts have to be established and a minimum concentration of 50% by volume of CO_2 in the flue gas is required in order to start-up the CO_2 compression plant.

More details about the pilot plant and its first operation can be found in the paper by Strömberg et al., presented at GHGT-9 in Washington in November 2008. You will find it at: www.vattenfall.com/ccs

1st IEA GHG International Oxyfuel Combustion Conference

IEA GHG is pleased to announce the 1st International Oxyfuel Combustion Conference, which will be held in Cottbus, Germany from the 8th to the 11th of September, 2009. A visit to Vattenfall's Schwarze Pumpe 30MW Pilot Plant Facility will be part of the programme.

2008 sees a major milestone in the development of Oxyfuel combustion technologies; in November 2008 Vattenfall and Alstom successfully completed the commissioning of the world's first full chain Oxyfuel combustion boiler with CO_2 capture. To recognise this achievement and to mark the 1st anniversary of the pilot plant, we will be holding the 1st International Oxyfuel Combustion Conference in Cottbus, Germany. This event will provide a forum to continue to discuss the remaining issues relevant to the development of Oxyfuel combustion technologies and share what we have learnt from the experience of operating the 1st Oxyfuel combustion boiler.

The main topics for discussion at this conference will be on the following issues:

- Boiler and Burner Development
- Oxygen Production
- Flue Gas Processing
- CO_2 Processing Unit
- Process Control and Process Integration
- Novel Oxyfuel Processes
- Regulatory, Permitting, Policy Development (To follow up the Yokohama Discussion)
- Large Scale Pilot and Demonstration Projects

Sub categories of these topics can be found on the conference page on our website shown below.

IEA GHG have decided to keep the Network Workshop format, therefore we will only require you to submit an extended abstract and presentation (we will not require a full paper). It should be noted that we are opening slots for 35–45 presentations (30 minutes per presentation including Q&A) and 30–40 poster presentations. Thus, we encourage you to submit your abstracts according to the relevant topics listed.

Please note that submissions will not be limited to one paper per organisation but will be chosen based on the merits and interests of the audience. The organising committee will be appointing various experts to review and select the best and most promising abstracts.

If you are interested in presenting a paper during the conference, please submit an extended 2-3 pages abstract about your presentation before 1st March 2009 to the IEA GHG online registration page.

Please note that the submitted abstract should clearly demonstrate the scope of the proposed paper or poster. It should also contain enough information for the reviewers to make an informed decision.

Details of the conference will be posted in our website: http://www.co2captureandstorage.info/OCC1/OCC1.htm

For any queries with regard to the workshop, please contact Stanley Santos at Stanley.Santos@ieaghg.org.

New IEA GHG Study Report: 'Aquifer Storage – Development Issues'

Introduction

IEA GHG have recently undertaken a study of the current status of CO_2 storage in deep saline aquifers. The aim of this study was to review research since the IPCC Special Report on CO_2 Capture and Storage (IPCC SRCCS). Emphasis was placed on the identification of scientific knowledge gaps and priority areas for R&D activities.

The study also aimed to create a comprehensive summary of reservoir properties and injectivity data based on pilot and demonstration activities, both underway and planned, with comment on the range of reservoir properties encountered and whether these may be representative of global storage conditions. Finally, the study sought to establish knowledge targets necessary to achieve a level of confidence needed, to confirm deep saline aquifers as suitable, secure and safe options for CCS activities.

Storage Capacity Estimation

Methodologies for storage capacity estimation have been developed by both the Carbon Sequestration Leadership Forum (CSLF) and US Department of Energy (US DOE) in recent years. Estimates of regional

storage capacity should always be supported by clear statements defining the methodologies and nature of assumptions employed; this allows quoted capacities to be placed in the context of techno-economic resource classification schemes – for example, the CSLF 'pyramid'. Such an approach facilitates comparison of results from different regional studies.

Aquifer storage typically accounts for 90% or more of potential regional or global geological storage capacity according to many studies – so the underlying assumptions used for aquifer calculations have a fundamental effect on estimates of total capacity. Two factors were highlighted which can cause major discrepancy between different approaches:

Whether to limit capacity estimates in aquifers to structural traps (favoured by CSLF) or consider entire formations (favoured by US DoE), and how capacity is considered in terms of storage as free-phase or dissolved-phase CO_2. The CSLF methodology includes calculation of dissolved-phase capacity, whilst the US DoE methodology recognises the long term significance of dissolution but without any method for calculation.

IEA GHG has recently commissioned a study on storage capacity coefficients, building on the work of the CSLF. The results of the project are due in the spring of 2009 and are anticipated to make a significant contribution to regional storage capacity estimation, with the key issues of pressurisation and brine displacement being considered.

Geochemistry and Trapping

The rates at which geochemical trapping mechanisms occur are dependent on thermodynamics, kinetics and physical properties of the storage formation. Predicting potential timescales over which these processes take effect, is crucial to understanding the relative importance of geochemical trapping in relation to the security and viability of a storage site. Where predictive modelling fails to account for geochemical trapping, the amount of CO_2 stored as an immiscible phase and the potential risks associated with leakage could be overestimated.

The ability to simulate CO_2 dissolution into formation water has been demonstrated to match experimental data, although more data is needed at pressure and temperature conditions analogous to storage scenarios. Similarly, modelling codes have been developed to allow calculation of saturation indices for complex solutions and mineral phases. However, more experimental and field data for both single and multi-mineral phase systems is required to verify models. Continued modelling of experimental, field and analogue data allows further progress in incorporating kinetics of reactions into codes.

Specific knowledge gaps still remain, including thermodynamic properties and kinetic rate parameters of mixed mineral phases, reactive surface area and associated reaction mechanisms, and upscaling of reaction kinetics. The report emphasises the need for additional experimental and natural analogue data.

Predictive Modelling

The report provides an informative overview of all significant factors affecting the current state of the art in CO_2 storage modelling; current codes can incorporate hydrodynamic, geomechanical and geochemical processes. Effects of heterogeneity, relative permeability hysteresis, convective mixing and brine co-injection have all been recently researched. Leakage scenarios have been investigated, including assessment of self-enhancing and self-limiting geochemical and geomechanical processes.

Injected CO_2 can be stored as: a gas phase, either beneath a seal or in residual form within the pore space; dissolved in formation water; or precipitated in a mineral phase. The relative importance of these trapping mechanisms will have a major bearing on the optimal injection strategies for sites, and modelling processes should be sufficiently robust to inform these strategies. Adequate characterisation of the storage formation is also important; for example, the presence of shale barriers within a storage formation.

Specific issues that still require research include coupling (e.g. geomechanics, geochemistry) and quantification of leakage scenarios. The forthcoming IEA GHG workshop on geological modelling of CO_2 storage, scheduled for February 2009 in Orleans, France will address these issues.

Risks associated with Wellbores

The 2008 aquifer study describes leakage through abandoned wells as significant, particularly at onshore locations with high concentrations of wells. Wellbore leakage raises the potential problem of CO_2 interactions with standard cements, a topic of much research effort as reported by the IEA GHG wellbore network.

Research effort is also being focussed on the coupling of migration through cement and reactions within the matrix. A key knowledge gap is characterisation of pre-existing fractures, since diffusive transport of CO_2 through cement is considered too slow to affect integrity. A further challenge is for reactive transport modelling simulations to match laboratory experiments and field data.

Site Characterisation

'Site characterisation' is the collection and analysis of geological information to confidently predict the safe and effective injection of CO_2 into an accurately constrained storage capacity. Key relevant documents issued in recent years are the 2007 Best Practice Manual from the SACS/CO2STORE project, and a separate 2008 CO2CRC report on storage capacity estimation, site selection and characterisation.

Site characterisation may be the most time-consuming aspect of site selection. The report describes the key steps involved: structural and stratigraphic interpretation; construction of geological models; and numerical modelling to predict plume migration. IEA GHG is funding a site characterization study by DNV that aims to develop qualitative 'best practice' procedures, whilst a second study by ARC will consider quantitative criteria.

Risk Assessment

To date, no consistent RA methodology for CCS projects and CO_2 storage exists. The IEA GHG risk assessment network has facilitated much debate and sharing of experience on the application of risk assessment techniques to CO_2 storage. Whilst a fully quantitative RA process for CCS may be desirable, current limitations and uncertainties in CO_2 storage modelling and impact assessment restrict meaningful RA techniques to qualitative or semi-quantitative methods.

Monitoring Technologies

At Sleipner, 4D seismic has been successfully deployed but this technique is relatively expensive; 4D gravity has also been shown as a useful tool for qualitative assessment. At the Frio and Nagaoka pilot sites, 4D vertical seismic profiling and cross-well electromagnetics allowed quantitative tracking of the CO_2 plume.

Monitoring technologies for shallow groundwater, soil and atmosphere have been researched and developed, but still require successful demonstration. Development of cost-effective monitoring strategies, and additional monitoring and verification data from injection projects are needed. Natural analogues provide important opportunities for ongoing testing of near-surface CO_2 leakage. The work of the IEA GHG monitoring network continues to focus on the development of CO_2 storage monitoring technologies.

Potential Storage Costs

Available cost data is sparse, quoted in different currencies from different years, and based on widely differing storage scenarios and methods. The current widespread absence of regulatory regimes also means that the requirements for the major cost elements of site characterisation, monitoring, abandonment and remediation are uncertain. IEA GHG aims to commission an updated study of CO_2 storage costs in 2009/10, pending completion of studies on site characterization, injectivity and efficient use of storage capacity, and further development of regulatory regimes.

Regulatory and Liability Framework

Key issues that need to be addressed by regulatory regimes are: long term liability and stewardship of storage sites; definition of monitoring and verification requirements; and emission trading scheme implications. These issues are being addressed rapidly in many regions and the IEA regulators network is providing an important contribution.

Overall Conclusions of the Study

The study has demonstrated considerable progress being made in addressing knowledge gaps for CO_2 storage in saline aquifers, although further research is required. Nevertheless, the scientific knowledge gaps are not considered barriers to injection projects. Further development of 'Best Practice' manuals for aquifer storage needs to focus on an increasing number of case study injection sites across different geographic regions.

The report concludes that geological storage of CO_2 in saline aquifers can be regarded as a proven technological option, in part due to the success of large scale demonstration projects at Sleipner and In-Salah. Wider commercial uptake of aquifer storage now requires regulatory frameworks, such as those being urgently developed in Europe, Canada, USA and Australia. Ultimate storage capacity available on a global scale will also depend on economic and technical factors, including limits imposed by pressurisation and brine displacement.

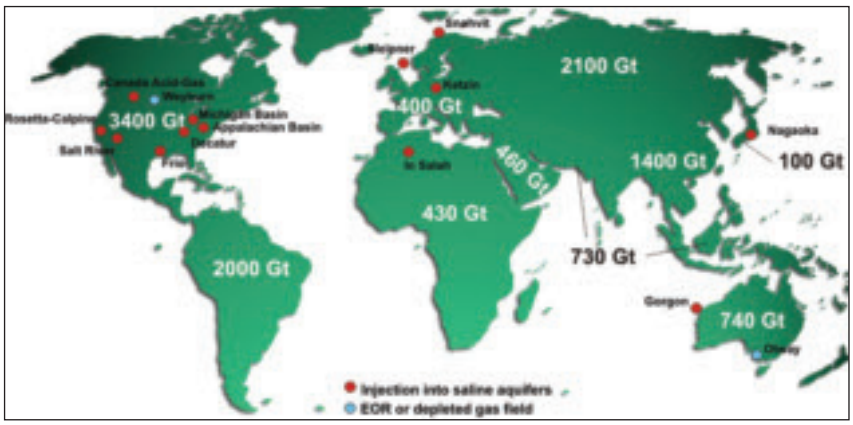


Figure 1: Map showing projects injecting or having injected CO2 into deep saline aquifers. Also shown are projects in an advanced planning stage, as well as the Weyburn and Otway pilot projects. Regional theoretical storage capacity estimates are shown in Gigatonnes of CO2

CO2QualStore Joint Industry Project

In November 2008 Det Norske Veritas (DNV) launched the CO2QualStore Joint Industry Project (JIP) to develop guidelines for the selection and qualification of sites and projects for subsurface geological storage of CO_2. The IEA GHG recognises the importance of such an activity and accordingly became a founding partner to the project. In addition to DNV and IEA GHG, the project includes BG Group, BP, Dong Energy,

Gassco, Gassnova, Petrobras. RWE, Schlumberger, Shell, StatoilHydro, and Vattenfall.

Background

A barrier to effective large scale deployment of CCS is a lack of recognised and publicly available guidelines and standards for CO_2 capture, transport and storage. Legal and regulatory frameworks are necessary, but not sufficient means for defining effective frameworks for implementing CCS. Traceable guidance in a risk based approach to CCS is needed. Best practice guidelines with specific recommendations can contribute to transparent, predictable, consistent and cost-effective deployment of CCS by:

- Guiding in managing and minimising risks (and uncertainties);
- Guiding in deploying concurrent best engineering practice with links to decision gates in field development projects;
- Providing open references for confidence and trust among stakeholders and the public;
- Simplifying demonstration of compliance with legal and regulatory requirements in acts, directives, conventions, etc., and harmonising implementation;
- Explaining how to obtain credits under CDM, JI, ETS, etc.

A large base of knowledge gained in R&D and demo projects is available (partly in best practice reports) that can be transferred and translated into guidelines. Writing such guidelines will identify knowledge gaps and help prioritise further R&D work to close gaps.

Objectives

The primary objective of the CO2QualStore JIP is to develop a risk-based qualification guideline suited to the decision process of;

- Identifying, characterising and selecting the best-suited sites and projects among a list of candidates;
- Defining qualification criteria, and providing the evidence that the site and project will function reliably according to these qualification criteria;
- Verifying that the selected site and its planned management procedures comply with given standards and regulations, and that the available data and management procedures as well as the contingency (remediation) plans provide sufficient confidence that the site will serve as a secure repository for long-term storage of CO_2.

In particular, the procedure should provide a step by step protocol to assist operators, authorities, verifiers and other stakeholders to do the following;

- Define the storage site attributes they should seek to demonstrate;
- Determine data and analysis requirements necessary to provide confidence that the storage site has the required attributes;
- Define guidelines for how to assign and rank risks to different attributes based on the available (and missing) data;
- Define a checklist to help operators implement an environmentally and economically acceptable procedure for the storage site operation, including compliance with codes, standards, legislation, and applicable directives;
- Define requirements for a monitoring, measuring and validation programme for the operational and post-operational phases;
- Define requirements for mitigation and remediation plans as part of developing a multi-barrier risk management concept;
- Manage storage sites following a transparent, consistent and cost-effective process that meets the expectations of authorities, stakeholders and the general public.

Based on the site specific characteristics, and the risks and uncertainties identified, the procedure will include requirements to pre-operation, operation and post-operation phases. This includes selection of appropriate risk mitigation measures, remediation plans, and implementation of adequate data acquisition and monitoring programs.

Intended users of the guidelines are operators, authorities, third parties and other stakeholders involved in site characterisation and selection, project planning, project/site approval, and independent verification. As appropriate, the guideline shall be suited for issuing certified statements meeting the needs of users and stakeholders at various decision milestones in the development process.

The guideline will be developed based on proven procedures for technology qualification. Modifications and deviations will be made as and when deemed appropriate based on guidance, results and best practices from relevant completed and on-going research, development and demonstration projects accessible to the JIP partners.

For further information about the CO2QualStore JIP and IEA GHG's involvement contact Brendan.beck@ieaghg.org.

IEA GHG Storage Modelling Workshop

IEA GHG are pleased to announce the opening of registration for its 1st workshop on geological storage modelling. The proposal for a CO_2 geological storage modelling network was approved recently by the IEA GHG executive committee and subsequently debated at the recent joint meeting of the existing research networks (monitoring, risk and wellbore) in New York. At that meeting, there was broad support for the formation of a modelling network, but concern was expressed by some members of the risk assessment network that a modelling network might duplicate their efforts. Therefore, a decision was made to hold an initial workshop, to gauge support for the formation of

a modelling network. The meeting will be held at the BRGM offices in Orleans, in France.

Workshop Scope

The aim of the workshop is to bring together specialist modelling practitioners from industrial and research organisations across the world, to consider the following questions:

- Is there significant divergence in approaches to modelling adopted by different organisations?
- What software tools are available for modelling?
- How much confidence can be placed in current approaches and resulting models?
- Do current models provide the necessary results to adequately inform risk assessments?
- Can modelling technologies be developed to fulfil likely regulatory requirements?
- What are the current knowledge gaps, and what should be the future focus for research?

The workshop will first consider the fundamental aspects of modelling, and then go on to consider some of the more advanced topics on which current research efforts are focussed. Some of the challenges facing researchers in this field include: the scale effects of various processes, including solubility, residual gas trapping, convective mixing; parameterisation; and incorporation of leakage pathways to overburden into reservoir models.

Delegates will also be invited to debate the possible formation of a modelling research network, which has been proposed to, and approved in principle by, the Executive Committee of the IEA GHG. There is already firm support from several organisations for such a network to be formed and run in parallel to the existing IEA GHG international research networks on monitoring, risk assessment and wellbore integrity. However, careful consideration needs to be given to this proposal, and any network objectives and terms of reference agreed to avoid unnecessary duplication of effort with related activities in the existing networks.

This IEA GHG workshop is being hosted by BRGM and co-organised with Schlumberger and CO2GeoNet. For more information, including a draft agenda and details on how to register, please go to: http://www.co2captureandstorage.info/networks/1stmodelling.htm

Environmental Impacts Workshop

In September, IEA GHG held a workshop to help to define the R&D needs necessary to assess the potential environmental impacts of CO_2 storage. In particular, the workshop looked at potential impacts of leaks in scenarios both onshore and offshore. The workshop was held at the offices of the British Geological Survey who co-organised the workshop.

The workshop attracted over 30 delegates from Europe and the USA, and presented regulatory views from these arenas before looking at lessons learned from natural analogues as well as data from purposeful release experiments. The main focus of the workshop was to discuss and define the needs that R&D activities need to address in order to demonstrate the safety of CCS and allow quantification of risks as well as likely impacts of any leaks.

The report from the workshop will be available shortly, but the discussions sessions first focussed on the needs for industry, regulators, the general public and research before progressing these needs into key messages. These key messages can be summarised as follows:

- We need to learn from natural analogues,
- We need R&D and demonstration projects and experiments to develop understanding,
- Definitions and terminology need clarifying,
- Progress towards monitoring for verification purposes must be made.

The workshop was a success, and it is envisaged that another may be held in 18 months or 2 years, when sufficient new data and research material is available to justify another exercise defining the future needs at that point.

Delegates of the IEA GHG / BGS EIA Workshop

MOVECBM & CarboSulcis ECBM Projects

The EC funded research project MOVECBM has completed its 2 year duration, and was concluded with the general assembly and final dissemination meetings held in Sardinia in September 2008. The project investigated Enhanced Coal Bed Methane in Poland, following on from the RECOPOL project which completed in 2005.

The general assembly meeting was followed by an open dissemination workshop, outlining the results of the project. This event was kindly hosted by CarboSulcis, a coal mining company in Sardinia, and was also used as an opportunity to outline plans that CarboSulcis have for an ECBM pilot project at their coal mine concession on Sardinia.

The meeting was open to members of the public and academic bodies from Sardinia, with CarboSulcis extending invitations to key representatives from these organisations. Toby Aiken of IEA GHG opened the meeting before handing over to Frank van

Bergen of TNO for an overview of the MOVECBM project and its activities, as well as the basic concepts involved in CO_2 Capture and Storage and more specifically CO2ECBM. Each work package leader from the MOVECBM project also gave an outline presentation of the activities carried out under each work package.

CarboSulcis

The presentations given by the representatives of CarboSulcis were given in a combination of English and Italian ensuring that the invited delegates from the local public bodies and academic institutions could understand and follow the presentations.

The representatives gave an overview of the geological formations and the mining activities, and explaining the processes that created it 53 million years ago. The Sulcis coal basin has 6 main geological regions, formed in layers, and 3 hydro-geological bodies which are not linked, and only 1 of which is in contact with the producing formation.

CarboSulcis have a well-planned research project, and this was backed up with an overview of the companies history, activities and professional experience. The Sulcis concession is a 55km^2 area with reserves of 60 million tonnes of coal, currently being produced at a rate of 1.5Mt a year.

The R&D activities are aiming to integrate commercial activities with emerging markets and CCS/ECBM applications in the unminable coal seams, deeper than 700m. There are also activities looking into underground coal gasification (UCG), and coal to liquid (CTL) applications. CarboSulcis CCS research is looking into ECBM and aquifer storage amongst other options, although the primary focus is ECBM.

Investigations have been carried out to determine the limitations applicable, and this includes permeability, coal seam depth and spatial availability issues. Analysis of the available sources of CO_2 have been compared to the potential injection rates, and this has determined that there is a good source-sink match in the area, meaning that there is enough readily available CO_2 to allow the project to maximise its storage capacity on an ongoing basis.

The motivation for the proposed pilot project was born of a number of reasons, but a key factor was that only 1/10th of the mine area is currently being utilised for coal production purposes, so there is an ample opportunity to develop the remaining 9/10th through CCS, CTL and UCG. There is also an aim to dedicate resources to active research, rather than on demonstrating commercial viability of ECBM in the Sulcis region.

CO2SINK Update

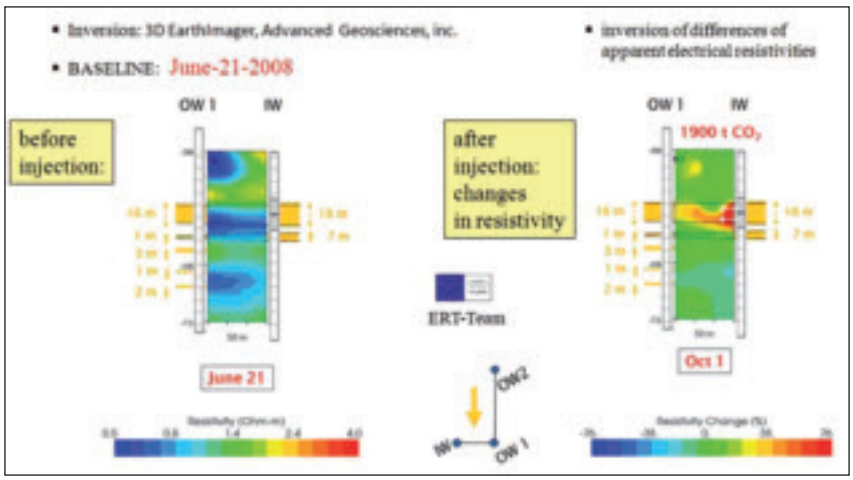
Having completed all baseline measurements, CO_2 injection into the reservoir finally started on 30th June within the CO2SINK project in Ketzin, near Potsdam Germany. The event was royally celebrated on site and was the culmination more than 5 years of preparation and fundraising.

Start of injection was delayed due to the fact that the injection tests showed significant loss of injectivity in the selected injection well. With the massive N2-lifts for stimulation of the well it became clear that the reason for the observed well impairment was the formation of iron sulphides produced by bacteria which were metabolising remnants of the organic components of the drilling mud. A genetic fingerprinting method was applied to determine the responsible bacteria. With the N2-lift the injectivity of the well was restored.

Injection started with 30m^3 of a KCl slug (6 % KCl) to avoid halite scaling, followed by 7m^3 of a krypton tracer and 130m^3 of nitrogen. Finally injection commenced with CO_2 supplied by Linde GmbH and delivered to site by trucks where it is stored in two pressurised storage tanks. Injection is conducted with a suite of pumps (5 pumps 0-1000 kg/h, 1 pump 0-500 kg/h) to enable any injection rate between 0 kg/h and 3600 kg/h precisely.

Arrival of nitrogen, krypton and CO_2 at the first observation well was detected using a down hole gas membrane sensor. At the time of breakthrough an amount of 531 tons of CO_2 had been injected over a period of 16 days.

Before start of injection a competition was announced within the consortium. Every member was asked to estimate the time of arrival of the CO_2 within the first observation well. Six bottles of champagne, sponsored by Schlumberger, were on stake (3 for the winner, 2 for the runner up and 1 for the third place, 1 extra bottle for Martin Zimmer controlling the GMS sensor). Eleven estimates were received from the specialists in the consortium until the 15th of June of which 3 were based on numerical modelling. The best estimate was based on the modelling done by Peter Frykman who therefore



won the competition. With the third rank being also a modeller it was demonstrated that it is indeed possible to accurately predict the spreading of a CO_2 plume in a saline aquifer. During injection several repeats of resistivity tomography before and after the CO_2 reached the first well were successful in monitoring migration.The figure shows the first results of interpretation of the electric resistance tomography clearly showing the evolution of the CO_2 plume. Researchers are now working on combining cross well seismic and electric resistance information to further improve the imaging of the plume.

By the end of November a total of over 4800 tons of CO_2 had been injected. Breakthrough to the second observation well is awaited any day but hydraulic tests have shown that there may be some flow boundary between this well and the injection point possibly delaying the arrival of CO_2. Further, correlation of the stratigraphy between the wells indicate that parts of the reservoir sandstone in which CO_2 is injected might not exist in the second observation well what could also be a reason that it has not been detected until now. Further details of the experiment at Ketzin can be found at the CO2SINK website or by reading the several papers and posters which were presented at the recent GHGT-9 conference in Washington. These are available at the conference website. http://www.co2sink.org/publications/publications.htm, https://www4.eventsinteractive.com/iea/rs.esp?id=270005&scriptid=sppp1

Study on Sub-Seabed Carbon Dioxide Storage, published by the German Federal Environment Agency

By Dr. Harald Ginzky, Dr. Edda Hahlbeck, Ulrich Claussen, German Federal Environment Agency

The storage of CO_2 is generally seen as a serious instrument to mitigate climate change. The German Federal Environment Agency, however, postulates that in Europe the instruments - energy saving, energy efficiency and the use of renewables - should be primarily applied and strengthened. With regard to the storage of CO_2 in sub-seabed geological formations the German Federal Environment Agency demands that each storage project is efficient to mitigate climate change and that risks to the marine environment have to be avoided. Proposals on how to meet these requirements are provided in a study recently published on behalf of the German Federal Environment Agency.

The research project focuses on necessary requirements with regard to the storage of CO_2 in sub-seabed geological formations by which an efficient outcome for the mitigation of climate change can be safeguarded and by which any risk to the marine environment can be avoided.

The scientific aspects are explored by a team led by Prof. Klaus Wallmann (Leibniz-Institute for Marine Science at the Christian-Albrechts University in Kiel – IFM-GEOMAR), and the legal issues are examined by the team led by Prof. Peter-Tobias Stoll (Institute for International and European Law at the University of Göttingen).

Some of the scientific and legal results should be stressed. In order to protect the climate, storage for some thousands of years is required. There is still no proof whether this is technically feasible. Old drill holes present the greatest risks of leakage.

In order to guarantee a positive effect for the climate a permissible maximum annual leakage rate of 0.01 % is needed.

Benthic and pelagic ecosystems may be disturbed by acidification through CO_2 leakage via pore and seawater if the natural CO_2 fluxes at the seafloor are significantly enhanced by leakage from man-made submarine storage sites. Considering the range of natural benthic CO_2 fluxes, the maximum permissible leakage flux from submarine storage sites may be defined as 10 t of CO_2 km-2 yr-1 for marginal sea and shelf areas.

The lawyers examine the outcomes of the latest changes of the London Protocol and the OSPAR Convention by which the storage of CO_2 is regulated. They stress that the placement of CO_2 in the water column is prohibited according to both international instruments. Moreover, the lawyers highlight that additional substances in the CO_2 stream which derive from the production process or which may be needed for the capture, transport or storage, should in general be minimized according to the international provisions.

The report is written in German and contains an English executive summary. Both can be downloaded from: http://www.umweltbundesamt.de/wasser/themen/gewschr/fue-in4.htm

Information about the international workshop "How to store CO_2 safely for the marine environment - from planning to eternity –" in Berlin in June 2008 at which the proposals of the report were discussed may be seen from: http://www.umweltbundesamt.de/wasser-und-gewaesserschutz/veranstaltungen.htm

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IEA GHG Summer School on CCS

Earlier this year the IEA Greenhouse Gas Programme in conjunction with the University of Regina held the second IEA GHG Summer School on CCS. The event was held at Tigh-na-mara Seaside resort, on Vancouver Island, Canada between the 24th and 30th August. The meeting was sponsored by Natural Resources Canada and a number of local sponsors including ConocoPhilips, Suncor, Golder Associates and the Alberta and Saskatchewan Governments. The summer school series is supported by a number of IEA GHG members including; The Research Council of Norway, BP, Gassnova, Schlumberger, StatoilHydro, E.On, and Alstom.

The summer school covered every aspect of CCS including technical information on capture, transport and storage of CO_2, and non-technical issues such as economics, regulation and public acceptance. The programme for the school included morning lectures followed each day by group work. The presentations included one by Gary Lunn, the Minister of Natural Resources Canada, who came in for the final day of the event to speak and field questions about what Canada is doing with CCS. His inclusion in the programme was a highlight of the week and even managed to make the local papers. The group work involved groups of ten students who were each given a question relating to the application of CCS and over the course of the week each group had to prepare a presentation which they gave to the rest of the attendees.

Sixty students from twenty-five countries were selected to attend the event from over one hundred and twenty applicants. Students were selected from various backgrounds including engineering, science, economics and politics. All students were either in PhD or Post Doc studies and most were working on topics relevant to CCS. In addition to the sixty students, five students who attended the summer school last year were invited to attend again as student mentors. Included in the student mentors were the three student award winners from last year including Patricia Seevam who not only mentored but also gave an excellent presentation on CO_2 Transport to the group.

Twenty-five experts from the international CCS industry also attended the summer school to give the presentations and to act as mentors for the students to provide support during the group work and assist them with the direction of their discussions and the sourcing of information. Without the support of the experts the summer school could not have been the success it was.

On the final day of the event the experts were called upon to select the outstanding students of the week. The best student award was given to the students whose contribution to the event was seen to be outstanding. This assessment was made across every aspect of the week, including input to the lectures, the group work and during the social programme. The students selected will return to the 2009 summer school as student mentors with all their costs covered by the school. The best students selected this year were, Gareth Johnson from the University of Calgary and Mairi-Jane Fox from the University of Edinburgh.

The 2009 summer school will be held in August just outside of Melbourne, Australia in conjunction with the CO2CRC. Registration of applicants for the summer school is now open, for more information about how to apply please see the next article.

Announcing the 2009 Summer School; Applications Now Open

Following the success of the first two IEA GHG Summer Schools in Kloster Seeon, Germany and in Tigh-na,mara, Canada, we are pleased to announce the 2009 Summer School to be held at the Mantra Erskine Beach Resort in Lorne, Australia. The school will be held from the 23rd to the 28th August and is hosted by the CO2CRC with support from Alstom, BP, E.On, Gassnova, the Norwegian Research Council, RWE, Schlumberger and StatoilHydro.

Similar to last year, the summer school will cover the whole field of CCS and will aim to presents the most recent results on:

- Capture of CO_2
- Transport of CO_2
- Underground geological storage
- Safety
- Costs and economic potential of CCS
- Regulatory regimes
- Implications of CCS for GHG inventories and accounting.

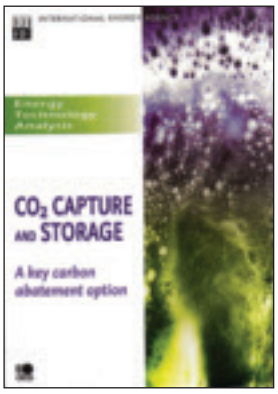
This year the summer school will also include a field trip to the CO2CRC Otway project.

The target group for the summer school is young scientists, e.g. PhD students and Post Docs with background in engineering, science, geo-technologies, and socio-economics. The goal is to provide students with diverse backgrounds a broad understanding of the issues surrounding CCS and encourage their active participation in this area. Some 50 students from both developed and developing countries will be invited to participate at the summer school from all those who apply.

Applications are now open, further details on how to apply, and details of previous summer schools are available on the summer school website: www.co2captureandstorage.info/SummerSchool/SummerSchoolIndex.html, or contact Brendan at Brendan.Beck@ieaghg.org

Book Review: CO_2 Capture and Storage: a Key Carbon Abatement Option

By Deborah Adams



At the Gleneagles summit in 2005, the G8 leaders asked the IEA to advise on alternative energy scenarios and strategies aimed at a 'clean clever and competitive energy future' and to work on accelerating the development and commercialisation of CCS. This book 'CO_2 capture and storage: a key carbon abatement option' responds to the request of the G8. The study documents progress toward the development of CCS:

- capture, transportation and storage technologies and their costs;
- storage capacity estimates;
- regional assessment of CCS potential;
- legal and regulatory frameworks;
- public awareness and outreach strategies; and
- financial and international mechanisms.

The book finds that given appropriate emission reduction incentives, CCS offers a viable and competitive route to mitigate CO_2 emissions. In a scenario that aims at emissions stabilisation based on options with costs up to US\$50/tCO_2, 5.1 $GtCO_2$/y would be captured and stored by 2050, which is 14% of the total needed for global temperature stabilisation. In a second scenario, where CO_2 emissions are cut in half and abatement options are considered up to US$_2$00/tCO_2, CCS accounts for 19% of total emissions reductions in 2050, and 10.4 $GtCO_2$/y would be captured and stored in 2050.

Overall on the basis of current economics, the financial consequences of CCS range from a potential benefit of US\$50/tCO_2 mitigated, through the use of CO_2 for enhanced oil recovery, to a potential cost of US\$100/tCO_2 mitigated.

The next 10 years will be critical for CCS development. By 2020, the implementation of at least 20 full-scale CCS projects will reduce the uncertainties related to the cost and reliability of CCS technologies. If these demonstration projects do not materialise in the near future, it will be impossible for CCS to make a meaningful contribution to GHG mitigation efforts by 2030.

Investment in CCS will occur only is there are suitable financial incentives and/or regulatory mandates. Various financial and regulatory options exist for encouraging CCS. Market-based solutions alone will be insufficient to finance critical early demonstration projects. Governments must lead by providing sufficient direct financing or financial incentives for CCS. Private sector finance is also critical. The longer term viability of CCS will be enhanced by its inclusion in the Clean Development Mechanism.

Governments are making progress toward the establishment of legal and regulatory frameworks governing CCS, but much additional work is needed to fill the gaps.

Given the scale of investment required for CCS RD&D, and the projected growth of fossil-fuel usage in non-OECD countries, international co-operation is needed to accelerate CCS deployment. International co-operation can be enhanced through the development and implementation of a global CCS roadmap. The roadmap developed for this publication outlines one potential way forward to further enhance dialogue amongst government and industry stakeholders which would aim to lead to the implementation of a more co-ordinated global strategy on CCS.

CO_2 capture and storage: a key carbon abatement option. IEA/OECD Paris, France, 266 pp 2008

CCT 2009 Conference

By Geoff Morrison, IEA CleanCoal Centre

Preparations are continuing for the fourth in this popular series of conferences on clean coal technologies. CCT2009, will be held at the Maritim Hotel and International Congress Center, Dresden, Germany on 18-21 May 2009, in conjunction with the Third International Freiberg Conference on IGCC and XtL Technologies. The conference is being organised by IEA CCC, Forschungszentrum Jülich and the University of Freiberg. The first three conferences in this series were held in Sardinia, Italy. The most recent, in May last year attracted more than 200 delegates from more than 32 countries confirming this as one of the world's foremost events for those interested in clean coal technologies. IEA CCC will hold an Executive Committee meeting in Dresden ahead of the conference on 16-17 May.

A thank you to all delegates who have submitted abstracts for papers to be presented at CCT2009. There has been an excellent response. Prospective authors will be notified by 15 January 2009 as to whether their paper has been accepted. Full papers are required by 1 March 2009. Further details of this major event are available from the conference website www.cct2009.org

EAGE Workshop on CO_2 Geological Storage, Budapest

By Gyorgy Falus, Eötvös Loránd Geophysical Institute of Hungary

On 29-30 September 2008, the European Association of Geoscientists and Engineers (EAGE) held its first workshop on Carbon Dioxide Geological Storage (CGS), sponsored by Vattenfall and StatoilHydro, at the Hungarian Academy of Science, Budapest. The goal of the meeting was to assess recent progress in geological storage, recognising the increased interest in Europe since the announced intention of 10-12 EU-financed demonstration projects.

Following an introduction by Tore Torp of StatoilHydro, who stressed the vital importance of CO_2 geological storage as a mechanism to mitigate greenhouse gas emissions and combat climate change, the workshop was honored with a presentation by Dr. P. Dechamps from the Bureau of Advisers to the President of the European Commission on Energy and Climate Change, who set out the role CCS has to play in Europe's energy strategy and described current efforts to put the right framework in place to allow deployment. The workshop was then organized into five thematic sessions, each introduced by invited keynote speakers.

Capacity Estimation, the first thematic session was chaired by N.P. Christensen of Vattenfall, who gave a keynote on 'Methods and Pitfalls in Capacity Estimation'. The session summarised geological storage options and related capacity estimations in Europe's new member and associated states, representing mainly the results of the EU GeoCapacity project. Results of PICOREF, a French research project aimed at developing a methodology for the characterisation of deep saline aquifers suitable for CO_2 storage, were also presented.

The *CO_2 Storage Monitoring* session was chaired by A. Chadwick (BGS) and included presentations summarising recent monitoring projects in Denmark, Australia and Norway. The session introduced new methodologies, allowed discussion of the weak points of some previous investigtions and emphasised the complex and site-specific nature of monitoring.

The session on *CO_2 Storage Modelling* chaired by I. Czernichowski-Lauriol (BRGM) and G. Falus included results of models in different storage mediums (e.g. coal, brine) and demonstrated that modelling tools, including those available commercially, have developed considerably in recent years to allow for the behavior of CO_2 and incorporate coupling of various mechanisms, for example geochemistry and geomechanics.

The *Risk Assessment and Field Laboratories* session was chaired and keynoted by S. Lombardi (University of Rome) dealing with 'The Study of CO_2 Natural Reservoirs to Develop Criteria for Risk Assessment and Safety Strategy'. The session focused mainly on three major categories: wells, faults, and seal integrity. Novel microbiological studies were also presented.

The *Case Histories* session was keynoted by T. Torp (StatoilHydro), who addressed 'CO_2 Storage in Practice'. Detailed case histories, monitoring results and arising problems where shown from the Weyburn, In Salah and Sleipner large scale injection projects.

The workshop was attended by 100 participants, with lively 'question and answer' style discussions following each presentation. The success of the meeting as expressed by participants may lead to future CO_2 geological storage meetings being organised by EAGE.

Greenhouse Cuttings

UCS Calls for CCS

The Union of Concerned Scientists has called for the USA to halt the construction of new coal-fired power plants without CCS technology. It has also proposed that the US government should invest in 5-10 full-scale demonstration plants to test CCS technology properly.
http://www.ucsusa.org/assets/documents/clean_energy/Coal-power-in-a-warming-world.pdf

Indonesia Considering CCS

Indonesia is considering implementing CCS technology to cut emissions. There are currently abut 70 oil and gas companies operating in Indonesia, and it is estimated that CCS could cut energy sector emissions by 40%. A recent study by Lemigas shows that East Kalimantan and South Sumatra could be suitable for CCS projects as many depleted oil and gas reservoirs are located there.
http://old.thejakartapost.com/detailnews.asp?fileid=20081031.I02&irec=1

Australian Coal Industry and CCS

Major R&D investment and a few ambitious CCS demonstration projects have begun Australia's journey towards commercial CCS. Australia's government is investing $500m into a low-emissions coal programme and up to another $100m/y into helping establish an institute to promote large-scale CCS projects. The Australian coal industry is spending about $1 billion on technology to cut emissions from burning coal.
http://www.climatechangecorp.com/content.asp?contentid=5743

Clean Coal May Need $15bn Investment

Low-emissions coal-fired power technology probably needs a further $15 billion of investment and 10 more years of R&D to be ready for commercial use, according to the Credit Suisse Group. Spending on CCS is not sufficient to achieve the G8 goal of developing 20 large plants by 2010, said the IEA.
http://www.bloomberg.com/apps/news?pid=20601072&sid=al3dbrRfHMu4&refer=energy

Blue Source and Och-Ziff Partnership

Blue Source LLC has announced a strategic investment partnership with affiliate funds of Och-Ziff Capital Management Group LLC to fund the development of carbon infrastructure projects. Och-Ziff's investment funds have committed up to $500m for new GHG reduction projects to be managed in partnership with Blue Source. The investment will support Blue Source's ongoing development of a 'carbon highway' of pipeline infrastructure projects across North America as well as other GHG mitigation projects.
Source: Blue Source LLC

Global Rise in CO_2 Emissions

Annual CO_2 emissions from burning fossil fuels and manufacturing worldwide have grown 38% since 1992, according to analysis by the CO_2 Information Analysis Center (CDIAC) at Oak Ridge, Tennessee. Emissions increased from 6.1 billion tonnes in 1992 to 8.5 billion tonnes in 2007.
http://www.energycentral.com/centers/news/daily/article.cfm?aid=11148194

World Bank and CCS

The World Bank's new $6.1bn climate change funds will finance coal projects, but only those that advance the deployment of CCS. According to Katherine Sierra, vice president of the World Bank's sustainable development network: 'What we are looking at are technologies in the upper end that get countries ready for CCS'.
Source: Cornwall Energy

Australia Passes Law to Regulate CCS

The Offshore Petroleum Amendment Bill has been passed in Australia. It establishes access and property rights in Australia's offshore waters for the burial of CO_2.

Global Carbon Capture and Storage Institute

The GSSI has been launched. The Institute will be based in Canberra, Australia and the Australian government will contribute up to $100m/y towards its operation. Founding members include Anglo American.
http://www.pm.gov.au/media/release/2008/media_release_0484.cfm

Victorian Government Funding

The Victorian Government has announced AUS$182 million in funding to encourage the development of large-scale energy technology demonstration projects, across both sustainable energy and CCS.
Victoria has also become the first state to pass CCS legislation. Due to take effect from the start of 2010, the law will allow companies to collect large amounts of CO_2 and store them below ground.

EU Energy Security and Solidarity Action Plan

The European Commission has proposed a new Energy Security and Solidarity Action Plan which sets out five areas where more action is needed to secure sustainable energy supplies. There is a new policy to stimulate investment in more efficient, low-carbon energy networks. It includes a package of energy efficiency proposals.
http://europe.eu

Australian Coal Association Website

The ACA has launched a comprehensive website explaining the new generation of low emissions coal technologies and their role in addressing climate change. It will cover CCS.
www.newgencoal.com.au

Scottish Reports

Three reports about energy and climate change have been published in Scotland. They are:

- Mitigating against climate change in Scotland: identification and initial assessment of policy options (AEA report);
- Scottish energy study – volume 5: Energy and CO_2 projections for Scotland (AEA report); and
- Grid issues arising from changes to the generation background in Scotland (SKM report). The reports show that clean energy generation is essential to achieving the targets set out in the Climate Change Bill for Scotland.

http://www.scotland.gov.uk/News/Releases/2008/11/12111123

Illinois Senate Legislation

The Illinois Senate has passed the Clean Coal Portfolio Standard legislation, which will enable development of coal gasification with CCS projects in Illinois. The legislation provides a framework for the development of clean coal projects and requires project developers to capture and store more than 50% of the CO_2.

Abu Dhabi $3bn Carbon Project Set for 2013

Abu Dhabi's $3 billion Masdar CCS project will be operational by early 2013, allowing for enhanced oil recovery (EOR) and providing

alternative energy for power and transport, according to the project developer Hydrogen Energy, a joint venture between BP and Rio Tinto. The project is currently in the Feed (Front end engineering and design) stage, which is being undertaken by Foster Wheeler. Under the project, CO_2 will be captured from industries with major emissions across the UAE, and then transported via pipelines to storage sites near oilfields, for EOR. About 50mt CO_2 will be captured during the project's life of about 25 years.
www.tradearabia.com

ADA-ES Begins Work to Develop Clean Coal Technology

ADA-ES has started work on a US Department of Energy (DOE) project to develop technology to capture CO_2 from coal-fired power plant. ADA-ES will be the prime contractor for a $3.2m project with the DOE's National Energy Technology Laboratory. Co-funders include AEP, Southern Company, Luminant, Xcel Energy and others. The project will advance capture technology based on re-generable solid sorbents and equipment. Solid sorbents have the potential advantages of lower costs and requiring less energy than competing technologies.
Source: ADA-ES

Battelle CO_2 Project Back Online in Wallula

Boise Inc has announced that it will allow Battelle scientists to conduct research and drill and inject CO_2 on its land in Wallula. The project will explore the possibility of storing CO_2 permanently in basalt rock. Lab studies have shown that basalt can help mineralise CO_2 into CaCO3. The project was opposed by some members of the community as they feared the project may lead to a coal-fired power plant in the area. The new agreement addresses that concern, and a coal-fired plant will not be built at the end of the study. The Battelle project is part of the Big Sky Carbon Sequestration Partnership, led by Montana State University. The project will begin with mapping of the basalt formations. The most appropriate layers lie about 3000-4000 ft deep. Battelle would need a state permit from the Department of Ecology for a field-scale test to store CO_2 permanently in the basalt.
See: http://www.energycentral.com/centers/news/daily/article.cfm?aid=11356985

Aker Investing in CO_2 Capture

Aker has announced plans for a new CO_2 capture plant, with a budget of NOK 875 million. The purpose of the new facility is to develop construction methods and effective execution models that make carbon storage cheaper. The facility will be built in 2009. It will have a capacity to remove 100,000t CO_2/y from exhaust gases. Facility investments are estimated are estimated at about NOK 725 million and operating costs are estimated at NOK 150 million over a 3 year period. Aker Clean Carbon hopes to build the facility near the natural-gas fired power plant and gas processing facilities at Kårstø, Norway.
www.akercleancarbon.com

Japan and China Co-Operate in CO_2 Project

Japan and China will co-operate in a $300 million project to reduce CO_2 emissions from a thermal power plant. The captured CO_2 will be used for EOR in a major Chinese oil field. The companies involve include Toyota Motor Corp, JGC Corp, China National Petroleum Corp and China Huadian Corp. The cost is estimated to be about 20-30 billion yen ($190-285 million). CO_2 from a coal-fired plant in Harbin, northeast China, will be transported to the Daqing oil field, about 100 km west of the plant. The plant emits more than 1 mtCO_2/y. Daqing produces about 40 mt/y of crude oil. Using the CO_2 for EOR will increase output by about 1.5-2 mt/y.
http://uk.reuters.com/article/environmentNews/idUKT6916020080503?pageNum

EPCOR and Siemens to Design Near-Zero Emission Coal-Fired Power Facility

EPCOR, with support from the Canadian Clean Power Coalition, the Alberta Energy Research Institute and Natural Resources Canada has entered into an agreement with Siemens Energy Sector to review and design a gasification island, leading to detailed plans and a cost estimate. EPCOR is conducting FEED work on an IGCC power plant with CO_2 capture as a critical element of the project. The work is taking place at Genesee, near Edmonton, Alberta. Siemens will license its SFG-500 coal gasifier technology to the FEED project. If later decisions go as planned, a 270 MW generating station using the new technology would be targeted to commence operations in 2015. The project has the potential to capture more than 1.25 mtCO_2/y.
Source: EPCOR Utilities Inc

Alberta to Fund CCS Projects

The Alberta provincial government plans to create a CAN$2 billion fund to advance CCS projects. Funds will be allocated to encourage construction of Alberta's first large scale CCS projects.
Source: Power Engineering, August 2008

Gassnova CCS Project in Norway

Mitsubishi Heave Industries Ltd (MHI) has signed a contract to carry out the technical pre-studies for the planned CO_2 capture plant from Gassnova SF in Norway. If the FEED study is passed, MHI will compete to construct the CO_2 capture facility, which will capture about 3000 tCO_2 from the flue gas from an existing 420 MW gas-fired power generation plant in Kårstø, Norway.
http://www.mhi.co.jp/en/index.html

Praxair Seeking DOE Funding for Oxy-Coal Project

Praxair Inc, working with the Jamestown Oxy-Coal Alliance and others, is to submit a proposal to the US DOE for funding to demonstrate technology designed to capture CO_2 from both new and existing coal-fired power plants. The primary site for the demonstration project is the Jamestown Board of Public Utilities in Jamestown, New York. It would involve construction of a new 50 MW circulating fluidised bed (CFB) plant. The proposed project would integrate Praxair's oxy-coal technology with a CFB boiler generating system to be supplied by Foster Wheeler. Praxair would provide oxygen supply facilities, oxygen mixing and injection technology, the downstream CO_2 capture and gas-processing equipment, and overall integration of the control systems with the power systems.
Source: Praxair Inc

Duke Energy IGCC Plant May Capture CO_2

The Duke Energy 630 MW IGCC power plant under construction in Edwardsport, Indiana could also be the test site for a new technology to capture CO_2 emissions. The Governor of Indiana, Mitch Daniels is trying to position the state as a leader in CCS technology.
http://www.energycentral.com/centers/news/daily/article.cfm?aid=11008820

FirstEnergy Experiment Go-Ahead

The Ohio Environmental Protection Agency has said that Akron-based FirstEnergy Corp. may test the feasibility of storing CO_2 underground at one of its coal-burning power plants in eastern Ohio. The pilot project will proceed at the R E Burger power plant in Shadyside on the Ohio River in Belmont County. The utility will use an experimental well drilled in 2007 and the CO_2 will be pumped into 3 underground saline formations as much as 8200 feet (2500 m) below ground. About 3000 tCO_2 will be used. The gas will be heated and under pressure and so will act more like a liquid. Battelle is working with FirstEnergy.
http://www.energycentral.com/centers/news/daily/aricle.cfm?aid=11024709

Bow City Power Project Plans to Move Forward with CCS

The Bow City power project is a proposed 1000 MW coal-fired power plant, about 185 km east of Calgary. The project will use an advanced super-critical combustion technology, and it proposes to incorporate an amine scrubbing system capable of removing an additional 80-90% of the project's CO_2 emissions. The scrubbed CO_2 may be stored in nearby oil fields for EOR. The project is being developed by Bow City Power Ltd.

Norway Group to Spend $59m on Carbon Capture

A Norwegian group has announced plans to spend NOK 317m ($59m) on research on carbon capture. The 8 year project, called SOLVit, is led by Aker Clean Carbon, with SINTEF and the Norwegian University of Science and technology participating. Gassnova will contribute to the first phase of the project. Amines will be tested in the first phase. A new laboratory will be built near Trondheim.
http://www.akercleancarbon.com

RWE Npower to Test CO_2 Capture at Didcot

RWE Npower is completing new facilities at the Didcot power station in the UK to test CO_2 capture. The test facility will enable evaluation of CO_2 capture from gases released from coal combustion and from oxyfuel firing.
http://www.energycentral.com/centers/news/daily/article.cfm?aid=11115613

CSIRO and Chinese Partnership

CSIRO and its Chinese partners have launched a post-combustion capture (PCC) pilot plant in Beijing. The PCC research pilot plant at the Huaneng Beijing co-generation power plant is designed to capture 3000 tCO_2/y. The Chinese partners are the Huaneng Group and the Thermal Power Research Institute. The PCC project will focus on assessing the performance of an amine-based pilot plant under Chinese conditions.
Source: Cleaner coal essentials, 3, Jul-Sep 2008

Italy's First CCS Project

Italy's Eni SPA and electric power utility ENEL will integrate their CCS projects to construct a pilot plant in Brindisi. At the Brindisi thermal power station, Enel is working on a pilot plant that will be able to remove 2.5t/h of gas and transport it to the Cortemaggiore site in late 2009. Eni has started an injection project that could offload 8000 tCO_2/y into the depleted, exhausted Stogit field at Cortemaggiore in 2010. Both companies have committed to laying a CO_2 transport line at the Brindisi site.
Source: Oil and Gas Journal, Oct 2008

Greenearth Energy Looking to Store CO_2 in Latrobe Valley

Geothermal energy company Greenearth Energy has confirmed that hot sedimentary aquifers exist deep below the Latrobe Valley, Australia. The company is applying to the Federal Government for funding to continue looking for storage sites.
http://latrobevalley.yourguide.com.au/news/local/news/general/burial-ground/1343927.aspx

Initial Oxy-Firing CO_2 Capture Test Completed

Babcock and Wilcox have concluded initial tests of its oxy-firing process

and are analysing the results. Preliminary findings have been issued. The tests were conducted in Ohio by B&W and Air Liquide. The oxy-fuel testing used an ESP followed by wet FGD with moisture control. Oxygen was injected at the burner and in both primary and secondary recycle streams and amounts were varied. Conversion to oxy-fuel began in 2007, and full oxy mode was achieved in October 2007. The tests were run with three different kinds of coal, and varied oxygen distribution, recycle flows and moisture removal. Early results have shown a significant reduction in NOx generation in the oxy mode, and the ability to achieve essentially the same ESP and wet FGD performance as obtained with air firing. B&W and Air Liquide are working towards a 100 MW net demonstration plant.

ECO2 Technology

Powerspan Corp is preparing to begin the first demonstration of its ECO2 technology, a system that attaches to coal-fired power plant stacks and traps CO_2. A 1 MW pilot-scale unit has been installed at the R E Burger plant in Ohio and will trap 20 tCO_2/day. The company is conducting studies for $200 m demonstrations of ECO2 at Antelope Valley Station in North Dakota.

Coal Innovation Centre at Niederaussem

RWE Power will invest some €90 million in the coming years at Niederaussem in R&D for CO_2 reduction and conversion technologies. As well as specific projects that go from the lab to the workbench, the Coal Innovation Centre is designed to give international experts a platform for exchanging ideas. At the power plant, technologies and processes can be tested on a commercial scale to increase the efficiency of coal-fired power generation. Four major projects are already underway. For example, RWE Power is testing its proprietary technology for pre-drying lignite using the fluidised-bed method.
http://www.rwe.com/generator.aspx/presse/language=en/id=76864?%24=0i%

Alstom to Build CCS Facility in Poland

Alstom has signed a memorandum of understanding with PGE Elektronia Belchatow to develop and build CCS technology at the Belchatow power plant in Poland. In the first phase, Alstom will design and construct a pilot CCS plant at one of the old units at Belchatow. It will capture about 100,000t CO_2/y and is expected to be operational by 2011.
http://www.pointcarbon.com/news/1.1017465

International CO_2 Storage Assessment Centre

The Government of Saskatchewan, Royal Dutch Shell and the University of Regina have announced the launch of a new centre, to be known as the International Performance Assessment Centre for Geologic Storage of CO_2 (IPAC-CO_2). It has been created through founding investments of $5 million each from the Govt of Saskatchewan and Shell. It will be located at the University of Regina and will focus on key elements of the geological storage of CO_2.
http://www.uregina.ca/news/newsreleases.php

EPCOR CCS Projects

EPCOR Utilities Inc. is proceeding to the next stage of the Alberta Government's $2 billion CCS funding programme. It is preparing more detailed proposals for 2 projects: an IGCC project at Geneesee with CO_2 capture, and an amine scrubbing pilot project. EPCOR is also involved with the Alberta Saline Aquifer Project, the Integrates CO_2 network plan, the Heartland Area Redwater Project and the Wabamun Area Storage Project.
www.epcor.ca

Clean Coal in the USA

Two new coal-fired plants have been given the go-ahead in the USA. American Electric Power Co will build a 600 MW plant in Hempstead County, Arkansas. The John W Turk Jr plant will be an ultra-supercritical facility. Southwestern Electric Power Company is setting aside part of the site for carbon capture equipment in case this is required by future legislation. The second plant, planned for Schuyllkill County, Pennsylvania, is being developed by Future Fuels. It will use advanced IGCC technology.
http://www.energyefficiencynews.com/i/1557/

IPS Wins Contract with US DOE

Invensys Process Systems has been selected by the US DOE's National Energy Technology Laboratory (NETL) to provide a dynamic process simulator for an IGCC plant with carbon capture. It will be located at Morgantown, West Virginia.
http://www.redorbit.com/news/business/1599413/ips_wins_contract_with_us_department_of_energy/index.html

Big Sky Carbon Sequestration Partnership Award

The US DOE has awarded $66.9 million to the Big Sky Carbon Sequestration Partnership (BSCSP). BSCSP, headed by Montana State University-Bozeman, plans to conduct a large-scale test in the Nugget Sandstone formation at the Riley Ridge Unit in SW Wyoming. The test will demonstrate the ability of a geological formation to store more than 2 $mtCO_2$, examine the CO_2 injection process, and provide the groundwork for future CCS opportunities in the region. BSCSP plans to drill a CO_2 injection well and inject up to 1 $mtCO_2$/y into the Nugget Sandstone formation at a depth of about 11,000 ft (3300 m). The CO_2 will be supplied by Cimarex Energy Company's planned helium

and natural gas processing plant at Riley Ridge.
http://www.bigskyco2.org/

US DOE Second Carbon Sequestration Atlas

The US DOE has released its second Carbon Sequestration Atlas of the US and Canada. It documents more than 3,500 $GtCO_2$ storage potential in oil and gas reservoirs, coal seams, and saline formations.
http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasII/

GE Energy and University of Wyoming Agreement

GE Energy and the University of Wyoming have reached an agreement for work to begin on a proposed development plan for the High Plains gasification Advanced Technology Center. The centre will enable researchers to develop advanced gasification and clean coal solutions for Powder River Basin and other coals.
http://www.uwyo.edu/ge/default.asp

Essent and Shell Development

Essent and Shell have agreed to study the feasibility of a 1000 MW low-CO_2 power plant. Most of the CO_2 produced will be captured and stored underground. Shell and Essent will evaluate the feasibility of combining a high-efficiency gasifier, a power generation plant and equipment to capture and store CO_2. Coal and solid biomass would be gasified to produce synthesis gas which in turn is used to make hydrogen. The hydrogen is then used to generate electricity in turbines. The study will consider both onshore and offshore fields for storage. Possible sites for the plant are being evaluated in the SW Netherlands.
http://www.essent.eu

Consortium for Clean Coal Utilisation

Washington University in St Louis has established the Consortium for Clean Coal Utilisation. It will foster work to explore co-combustion of coal with biomass or combustion of coal in pure oxygen, both of which can lead to reductions in carbon emissions. The Consortium will receive $5 million each from Arch Coal and Peabody Energy and $2 million from Ameren, to be paid over 5 years.
http://www.greencarcongress.com//2008/12/wustl-establsig.html

Carbon Assessment Software

Researchers at MIT have designed new software that will help developers of clean coal technology to accurately measure how much CO_2 they can store underground. The software model takes into account how CO_2 will migrate from the original injection well and also incorporates capillary trapping, whereby liquefied CO_2 eventually dissolves to form harmless carbonate minerals.
Source: The Irish Times

Air Products and AERI study

Air Products is collaborating with the Alberta Energy Research Institute on a study of an advanced CO_2 capture technology for use with gasification. The technology could reduce the cost of CO_2 capture by up to 25%. The study 'Advanced hydrogen and CO_2 capture technology for sour syngas' is expected to be completed by October 2010.
www.airproducts.com/co2_capture

TransAlta Plan

TransAlta Utilities has said that it could have a CCS system operating at one of its coal-fired power plants within four years. Advanced engineering is underway on 'Project Pioneer', a unit at Sundance or Keephills, south of Lake Wabamun will be retrofitted with new technology from Alstom. The pilot unit will use the chilled ammonia process to recover about 1 $mtCO_2/y$.
www.edmontonjournal.com

£2bn Plan for Clean Fuel for Scotland

A plan has been announced for a 1600 MW plant for Scotland to be powered by clean coal technologies and up to 15% biomass. The plant would be built in Hunterston. The first of two 800 MW plants could be operating by 2014, but a more realistic timetable is for 10 years ahead. Dong is behind the proposal, with partners Peel Energy.

Pilot Algae Plant Launched in Germany

An algae growing plant for CO_2 conversion has been commissioned in Neideraussem,Germany.RWEentered into agreements with a number of partners, including Jacobs University, Bremen, the Juelich Research Centre and the Phytosolutions company, for the planning, research and implementation of the project. The aim is to optimise the entire process chain from algae production to the final product. In a trial plant measuring some 600 m^2, the algae are 'fed' with flue gas from the power plant. Possible use of the resulting algal waste as a biofuel is to be investigated. Micro-algae have a growth rate 7-10 times higher than land plants.
Source: RWE press release 06/11/08

Lime May be Used to Capture CO_2

New research suggests that technology using calcium oxide (lime) has potential as an inexpensive carbon capture technology. The method uses the 'carbonation-calcination' cycle, where CO_2 is removed from the flue gas via a chemical reaction with CaO. This produces CaCO3. The CaCO3 is then heated to a high temperature to create a further reaction which

separates out the CaO and CO_2. The CO_2 is concentrated and available for storage. The researchers calculate that the proposed technology would reduce CO_2 emissions from 0.781 $kgCO_2$/net kWh to 0.122 $kgCO_2$/net kWh, at a cost of capture of about €16/tCO_2. The technology requires further development and pilot study. Source: Energy Conversion and Management 49 (10), 2809-2814

News for IEA GHG Members

- **2nd Expert Meeting on Financing CCS Projects (Report No. 2008/4)**
  The 2nd Expert Workshop on Financing Carbon Capture and Storage provided an opportunity for discussion on the issues that are affecting the development of commercial carbon capture and storage in North America from a financial perspective, and of possible options to overcome these issues. It was clear that there are still several unresolved issues and potential difficulties in the deployment of CCS, such as insurance, viable financial incentives and the need for the establishment of a robust policy and regulatory framework, however the general consensus was that these difficulties and issues surrounding CCS can be resolved.

- **3rd Meeting of the Oxy-Combustion Network (Report No. 2008/5)**
  The IEA Greenhouse Gas R&D Programme (IEA GHG) has developed an international research network on oxy-fuel combustion to provide a forum to various key industry players and stakeholders to discuss developments in oxy-fuel combustion for power generation with CO_2 capture.
  This report covers the third workshop in the series which was held at the Yokohama Conference Centre, Yokohama, Japan on the 5th and 6th of March, 2008. The workshop was hosted by IHI, JCoal and JPower.

- **International Network for CO_2 Capture: Report on 11th Workshop (Report No. 2008/7)**
  The 11th Workshop of the International Network for Post Combustion CO_2 Capture met in Vienna in May 2008. Presentations covered fundamental laboratory investigations, progress reports on activities in various countries, updates on pilot plant work, the need for and meaning of "capture ready", developments by several technology suppliers and there was a panel session which considered what might be the next generation of post combustion capture technologies.

Conferences & Meetings

World Future Energy Summit, Abu Dhabi, 19th-21st January 2009. Contact: Ivan Youd, Tel: +44 (0)20 72158161, Email: ivan.youd@ukti.gsi.gov.uk or visit: www.worldfutureenergysummit.com

Platts 9th Annual Caribbean Energy, 29th-30th January 2009. Santo Domingo, Dominican Republic. Contact: Cynthia Rugg, email: cynthia_rugg@platts.com

European Conference on CCS Research, Development and Demonstration, 10th-11th February, 2009, Oslo, Norway. Information about the conference and the registration form can be found at www.ccs-conference.com

STRACO2 International Regulatory Conference, 18th-19th February 2009. Centre Albert Borschette, rue Froissart, 36 1040, Brussels, Belgium. More information is available at: www.euchina-ccs.org

Coal UK 2009 Conference and Awards Dinner, February 26th 2009, Lords Crocket Ground, London, UK. For more information, please contact Susie Hansford on: Tel: +44 (0)1730 265095, Fax: (0)1730 260044 or email: susie.hansford@mccloskeycoal.com

3rd Annual European Carbon Capture and Storage Conference, 26th-27th February 2009, Brussels, Belgium. To register call +44 (0)20 7176 6212 or visit http://www.platts.com/Events/2009/pc965/

The IARU International Scientific Congress on Climate Change, 10th-12th March 2009, Copenhagen, Denmark. For more information, please visit: www.climatecongress.ku.dk

US DOE / NETL 2009 CO2 Capture Technology Conference, 24th-26th March 2009. Sheraton Station Square Hotel, Pittsburgh, Pennsylvania, USA. For further information please visit: www.netl.doe.gov/events/09conferences/co2capture/index.html

European Geoscience Union General Assembly 2009, 19th-24th April 2009. Vienna, Austria. Contact: Michael Kühn, Environmental Geotechnique, GFZ – German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, Germany. Tel: +49 331 288 1594, Email: mkuehn@gfz-potsdam.de

8th Annual Conference on Carbon Capture & Sequestration, 4th-7th May 2009, Sheraton at Station Square, Pittsburgh, Pennsylvania, USA. For details contact the Forums office at: +01 1800 877 303 7367 or email: forums@exchangemonitor.com

10th International Conference on CO2 Utilisation, 17th-21st May 2009. For more details, please visit: http://fuel.tju.edu.cn

Advanced Membranes; Membranes for Clean and Sustainable Processes 7th – 12th June 2009, Trondheim, Norway. Contact: May-Britt Hägg, Department of Chemical Engineering, Norwegian Univ. of Science and Technology, NO-7491, Trondheim, Norway. Tel: +47 73 595867 email: may-britt.hagg@chemeng.ntnu.no

5th Trondheim Conference on CO2 Capture and Storage: TCCS-5, 16th – 17th June 2009, Trondheim, Norway. For more details, please visit: www.ntnu.no/tccs5.no

3rd International Symposium 'CO2 Capture and Geological Storage', 5th-6th November 2009, Paris France. For more information, please contact Hervé Quinquis on +33 1 47 52 65 57 or email: herve.quinquis@ifp.fr

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