GHGT-10
10th International Conference on Greenhouse Gas Control Technologies
Amsterdam, The Netherlands.
19-23 September 2010

ieaghg
Evaluating technology options to mitigate greenhouse gas emissions

Greenhouse Issues

March 2010 • Issue 97

IEAGHG New Website,

by Sian Twinning, IEAGHG

Following the launch of the new logo for IEAGHG, we have launched our new website www.ieaghg.org. This is a combination of both the www.ieagreen.org.uk site and the www.co2captureandstorage.info site, bringing together the best of both sites with a fresh new look. This site offers a great improvement, both in a more user friendly layout and improved site security.

The new-look IEAGHG website: www.ieaghg.org

We have also incorporated new facilities to the site; individual registration for each member, forums and a home page that will feature updates on the IEAGHG's activities on a regular basis.

The site will continue to grow, with additional features yet to come to include e-learning opportunities.

To make the most of this new site, please register an account at www.ieaghg.org/index.php?/Create-an-account.html

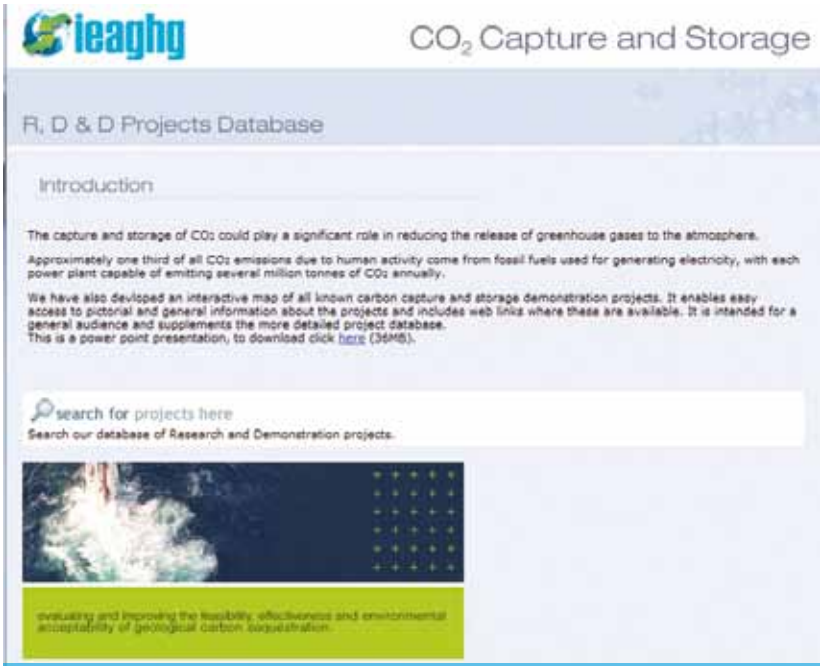
In this issue

IEAGHG R,D&D Database Update,

by Samantha Neades, IEAGHG

The IEAGHG R,D&D (Research, Development and Demonstration) project database (available at www.ieaghg.org) is currently being updated with new information and data that has been collected over the past 4 months.

The R,D&D database is a detailed, publicly-available information source containing in depth records on the Carbon Dioxide Capture and Storage (CCS) projects currently operational around the world. This is an important resource as the ever-expanding climate change industry means that capture and storage of CO_2 from fossil-fuel combustion is becoming a more common tool for mitigating greenhouse gas emissions.



The Welcome screen for the R, D & D Database on www.ieaghg.org

The update process began with a review of the database (current status, data gaps etc.) along with a comprehensive comparison of IEAGHG's database with others that are publicly available such as those from the Carbon Sequestration Leadership Forum (CSLF), CO2CRC, and the Global Carbon Capture and Storage Institute (GCCSI).

For the projects already existing on the database, various searches were done for the most in-depth and up-to-date information, and when necessary industry professionals were contacted in order to obtain accurate and recent information.

There are many new CCS projects, and one of the challenges of this database update was to identify new projects and studies that were not on the original database, and to add new entries if they satisfied the criteria for inclusion. To be applicable to the R,D&D project database, projects must be active (or in preparation to be operational in the foreseeable future) and of a practical rather than theoretical nature. Many of these projects were found whilst undertaking the comparison task, and others were discovered through personal contact with those involved or through related studies and articles published.

The main stage of the database update will be completed in early 2010, and an interactive map of R,D&D projects worldwide will be added to the www.ieaghg.org site shortly. As the update process is a continuous task, any contributions to the database are welcome. If you are aware of any projects or studies that may be relevant and should be added to IEAGHG's database, please contact Samantha.Neades@ieaghg.org ●

CCS in Copenhagen – The Future Work,

by Tim Dixon, IEAGHG

The last edition of Greenhouse Issues (No. 96) contained a brief article on the outcomes for CCS, and reported that CCS became again a hot topic, as attention on CCS erupted in four negotiation tracks. These were as follows: (i) Under SBSTA (the usual area for work on CCS in the CDM). (ii) Under CMP where the CDM Executive Board (EB) provided its summary on CCS in CDM. (iii) Under AWG-KP (for Kyoto Protocol Parties post 2012). (iv) Under AWG LCA (for UNFCCC Parties post 2012). This article will present and discuss the outcomes of the first three. LCA outcomes did not contain any text on CCS.

Experts Report

Despite CCS in the CDM being viewed as an 'old battleground', significant new input came from a report commissioned by the CDM Executive Board on "Implications of the Inclusion of Geological Carbon Dioxide Capture and Storage as CDM Project Activities", known as the 'Experts Report'. Under CMP Plenary the CDM EB provided its own summary on CCS in CDM, and heated exchanges resulted from the EB's own summary being shown to contain significant and unsubstantiated differences from the underlying 'Experts Report', including their table of positive and negative issues and their conclusion recommending that "the EB not to consider any CCS related baseline and monitoring methodologies until further guidance is given".

The 'Experts Report' provided many conclusions and recommendations on how CCS could work under the current CDM rules.

On Monitoring, the report said – "Verification and Certification in accordance with the CDM modalities and procedures can be performed provided that monitoring methodologies and plans are designed according to the recommendations in this report."

And on long-term monitoring the report said – "Impose a requirement that a country wishing to host a CCS CDM project activity must notify the UNFCCC that… it will commit to the post-crediting period responsibility for monitoring."

On long-term liability – "Unlike seepage occurring during a crediting period, which can be treated as project emissions, management of the risk of seepage from a storage reservoir occurring after the crediting is beyond the mandates provided by the CDM modalities and procedures. The risk of seepage after the crediting period demands effective management of liability in order to maintain the environmental integrity of the CDM. The CMP may wish to provide guidance regarding procedures according to which a country willing to commit to the post-crediting period responsibility and liability of a CO_2 storage project, and to compensate for any seepage amounts from the storage, may notify the UNFCCC of this."

On transborder issues, the report said "Additional legal implications for cross-border storage could be avoided by restricting any CCS project activities under the CDM in the first and second commitment period to take place within national boundaries and with no risk of migration across national boundaries."

The Experts report concluded that "Therefore, provided appropriate selection, operation and risk management with respect to storage sites, effective management of short- and long-term liability for CO_2 seepage, project boundaries, and monitoring and verification, and assessment of baseline, additionality and leakage issues according to standard procedures already applied in the CDM framework, CCS as CDM project activities can provide real, measurable and long-term emission reductions compatible with the Modalities and Procedures of the CDM [i.e. the existing rules]." Therefore the CDM should "Treat CCS projects as stable long-term emission reductions based on the collection of scientific data which supports assumptions regarding long-term permanent storage and zero-seepage (as in the IPCC Guidelines).This would treat CCS projects the same as other CDM project activities, and deliver fungible permanent CERs [credits]".

Thus the Experts Report describes how CCS can work under the CDM without needing the extensive work to create new rules (modalities and procedures). In light of this evidence, many view that the issue can only be resolved by a policy decision at the level of Ministers.

The work of the IEAGHG provided much input to the 'Experts Report'. The Experts Report is available at http://cdm.unfccc.int/EB/050/eb50annagan1.pdf and the EB's Summary at http://cdm.unfccc.int/EB/050/eb50_repan11.pdf

The SBSTA working text has been written, although not yet agreed, will be used as the starting point for further revisions. The concluding texts under CMP and AWG KP are also written, and they are similar to each other. The texts in full are available to view as an article on the IEAGHG website. Go to: www.ieaghg.org and click on the COP 15 article for the details.

As you can see, even though the whole is not agreed, there exist many square brackets with the text, there are some very positive aspects such as emphasising the main issue of long-term liability and recognising that other international conventions have dealt with the same issues for CCS. However, even having the uncertainty on when to report back (CMP6 or CMP7) shows the overall uncertainty on whether further progress will be achieved at SBSTA 32 in June in Bonn.

It is welcoming to that the importance of CCS is recognised, helped by the timely evidence such as the IEA CCS Roadmap. So it requests further submissions on these issues, a third synthesis report of these submissions, and SBSTA to work towards a decision being made by CMP 6 in Mexico.

So two options, in or out. Note the implication of the request for new modalities and procedures for CCS. These are the rules for operation of the CDM, and the current ones took much effort to develop and several years to be agreed, so if new ones are required for CCS this could introduce further delays before CCS can become operational in the CDM, and the 'Experts Report' shows how CCS can work within the current rules, thus requiring no new ones.

With all of these conclusions referring back to many of the same issues as have been considered before, it may be viewed as frustrating that these issues of concern continue, despite the evidence base available from bodies such as the IEAGHG, and the 'Experts Report' to the EB. New issues on this list are the 'perverse outcomes' - which means that a negative externality is created that isn't recognised within the CDM project approval process; international law- refers to for example compensation if CO_2 seepage causes an impact in another country; insurance provision - showing that the particular negotiators are possibly unaware of the commercial insurance products now available for CCS (although not for long-term liability). The work in these areas will continue at SBSTA32 in Bonn in June.

Overall, given that the evidence base exists but agreement on inclusion still cannot be reached, many consider that it will require Ministers to make the decision on inclusion of CCS in the CDM. IEAGHG will continue to provide

information and evidence on these issues to its members active in these negotiations, to try and ensure that misinformation does not arise. For example, a new argument against CCS raised in these Copenhagen negotiations was the possibility of "large-scale catastrophic release of CO_2" creating a Bhopal-like incident (when the mechanisms for such a release are not possible).

For the outcome texts and explanation of acronyms see http://unfccc.int/2860.php/ and for background information on the CCS work see http://cdm.unfccc.int/about/ccs/index.html.

Transboundary Transport of CO_2 Allowed For Offshore Storage, by Tim Dixon, IEAGHG

The London Convention and its Protocol, control dumping at sea, and in 2006 its prohibition on CO_2 geological storage in sub-seabed formations were removed. However this left in place its prohibition on export of material for dumping, which stopped CO_2 transport across national boundaries for geological storage. This was recognised as a barrier to CCS, and work was undertaken on how to resolve this. This culminated in April 2009 with Norway proposing an amendment to Article 6, the Export article.

At the annual meeting in October at the International Maritime Organisation in London (LP4), this issue was further considered in some detail by a working group. It was agreed by vote on the 30th October at LP4 to adopt an amendment to the London Protocol to permit the transboundary movement of CO_2 for the purposes of CCS.

We should acknowledge the role that the Norwegian Delegation played in driving this amendment through. The adoption of this amendment was relatively controversial with opposition being led by China and South Africa. In the end it proved not possible to reach consensus and a vote was taken on whether to adopt the amendment which proceeded as follows: For – 15; Against – 1; Abstentions - 6

Although in the end the amendment easily received the two thirds majority it required to be adopted, this was by no means a foregone conclusion and resulted in a fairly dramatic end to the week. In fact, this is only the second time that an amendment has ever had to go a vote (The first time was in 2006 when they were deciding whether to allow the sub-seabed storage of CO_2).

Offshore Storage Installation

The Resolution that accompanies the amendment also calls for some restraint in exporting long distances to developing countries. "Parties should ensure that the long distance export of carbon dioxide streams between UN regions is reduced to the minimum consistent with the protection and preservation of the marine environment from all sources of pollution, taking into account the special position of developing countries".

This means that responsibilities have to be clearly agreed, and the same control conditions need to be applied if the receiving country is not a party to the Protocol (which has requirements for permitting based on risk assessment and environmental impact, contained in the CO_2 Specific Guidelines).

Also, the working group concluded that the subsurface movement of CO_2 across national boundaries is not an export and the resolution states "the transboundary movement of carbon dioxide after injection (migration) is not export for dumping and therefore not prohibited by Article 6", but seeks further guidance from its Scientific Group on the CO_2 Specific Guidelines. This will be considered at the Scientific Group meeting in April in London.

For this amendment to come into force, two thirds of all Protocol Parties will have to ratify it, so this will still take some time.

IEAGHG was again an active participant to this meeting, answering questions and contributing information on CCS to the negotiations, including from its Monitoring

Research Network results and from the IEA CCS Roadmap (which as well as strongly making the case for CCS also calls for this London amendment).

All documents can be found at :

www.londonconvention.org

AMENDMENT TO ARTICLE 6 OF THE LONDON PROTOCOL

2 Notwithstanding paragraph 1, the export of carbon dioxide streams for disposal in accordance with Annex 1 may occur, provided that an agreement or arrangement has been entered into by the countries concerned. Such an agreement or arrangement shall include:

2.1 confirmation and allocation of permitting responsibilities between the exporting and receiving countries, consistent with the provisions of this Protocol and other applicable international law; and

2.2 in the case of export to non-Contracting Parties, provisions at a minimum equivalent to those contained in this Protocol, including those relating to the issuance of permits and permit conditions for complying with the provisions of Annex 2, to ensure that the agreement or arrangement does not derogate from the obligations of Contracting Parties under this Protocol to protect and preserve the marine environment.

A Contracting Party entering into such an agreement or arrangement shall notify it to the Organization.

Guideline for Storage Site Selection and Qualification - CO2QUALSTORE,

by Tim Dixon, IEAGHG (from material from the DNV Guidelines)

The project lead by DNV on "Selection and Qualification of sites and projects for subsurface geological storage of CO_2 - CO2QUALSTORE", is a joint industry project in which IEAGHG is one of the partners. The primary objective of this industry-consortium project is to develop a risk-based qualification procedure (the Guideline) to select storage sites and qualify them as suitable for project use. The project to develop this has nearly completed and the Guideline is about to be published.

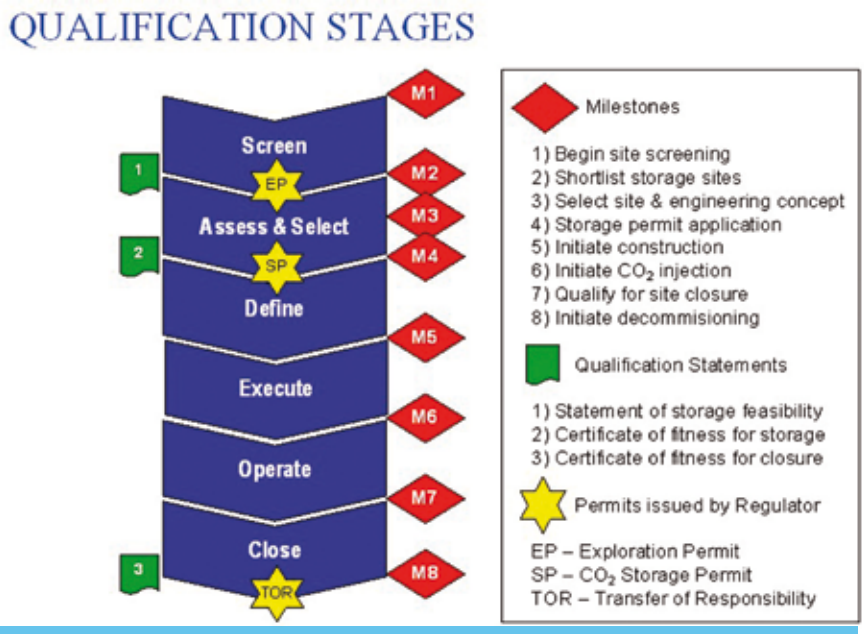


Figure 1: Generic Workflow for a CGS Project Development

Objective

The objective of this Guideline is to provide a systematic approach to selection and qualification of sites and projects for CO_2 Geological Storage (CGS). A key intention is to harmonise implementation of CGS in compliance with regulations, international standards and directives while avoiding additional documentation and reporting requirements that may incur project delays and additional expense. To this end, the Guideline introduces a generic workflow for CGS project development, relating activities and key project deliverables to associated milestones. To each of the stages Screen, Assess & Select, Operate and Close, a more detailed sub-workflow is presented with specific associated activities and deliverables. It is envisioned that these workflows, if followed, will contribute to enhanced traceability and streamlined implementation across projects, both regionally and internationally. Note that the Design and Construct stages are not covered in the guideline.

The proposed approach to site selection and qualification attempts to reflect the current understanding of best industry practice and drive towards a consensus, controlled and managed in compliance with applicable regulations, concurrent best engineering practice and best available technology (BAT).

DNV will issue and maintain an updated version of the guideline as a DNV Recommended Practice.

Users and Applicability

Table 1 shows the intended value of the guideline for a range of different users. The guideline serves primarily as a guide for project developers, but should also provide a basis for communication of project development and risk management with regulators and stakeholders, and contribute to a checklist for regulators and third party verification.

	Operator	Regulator	Third Party
Guide Implementation	•		
Inform of Industry Practice	•	•	•
Support Implementation of Regulations	•	•	
Reference for Verification	•	•	•
Support Stakeholder Communication	•	•	•

Table 1: Applicability matrix showing the intended values of the guidelines

The general public is not a direct user of the guideline, but implementation in compliance with this guideline should help provide assurance to the general public and other potential interested parties that a CGS site is selected based on a transparent and recognised process, will be safely and responsibly managed according to industry practice, and is in compliance with regulations and relevant directives.

Organisation and Guideline Development

The guideline has been developed in the CO2QUALSTORE joint public/industry project, which has consisted of the following partners (in alphabetical order): Arup, BG Group, BP Alternative Energy, Det Norske Veritas (DNV), DONG Energy, Gassco, Gassnova, IEAGHG R&D Programme, Petrobras, RWE Dea, Schlumberger, Shell, Statoil and Vattenfall. The project has been coordinated by DNV.

The strategy deployed to develop the current guideline comprise of the following four steps:

1. Development of a draft guideline (prior to start of the CO2QUALSTORE project). This project, which was performed by DNV in collaboration with Gassnova, the Norwegian state enterprise whose main task is to "manage governmental interest and support technology development within the area of CO_2-management (capture, transport, injection and storage of CO_2)." The deliverable from this project included an extensive literature review and input from a range of international CCS R&D and pilot projects.
2. Development of a draft qualification framework within the CO2QUALSTORE project based on current understanding of industry practice. In parallel with this work, a gap-analysis was carried out to identify the key areas where further work should be executed to enhance the completeness and applicability of the guideline.
3. The execution of eight sub-projects. Five of these projects aimed to test or evaluate components of the draft qualification framework, partly on real CCS projects, and the remaining three aimed to gather more knowledge on issues identified in the gap-analysis. A brief description of the purpose of these projects is provided below.

- **Sub-project 1: Site selection offshore Norway.**

  This project evaluated to what extent the steps in the draft qualification framework aligned with the process of screening and characterising potential offshore sites for storage of CO_2 from two gas-fired power plants located on the west coast of Norway.

- **Sub-project 2: Site screening criteria.**

  This project explored criteria that could be applied to accelerate the initial screening process aiming to identify the sites among a list of candidate sites that have the highest potential to serve as a cost-efficient option for CGS within a given region. This project relates to one of the steps in the qualification workflow for site screening. This was provided by IEAGHG using a study commissioned from ARC. [IEAGHG Report 2009/10]

- **Sub-project 3: Communication with regulators.**

  In this project the draft qualification framework was first benchmarked against the initial screening and characterisation activities performed by two prospective CCS developers in Germany. Next, two workshops were organised with representatives from German authorities positioned to regulate CCS in the relevant German states. The purpose of these workshops were to discuss how the draft qualification framework could help the regulators assess and evaluate projects in Germany, and how the process of specifying performance targets could be managed through an interactive dialogue between a regulator and a prospective project developer.

- **Sub-project 4: Monitoring and verification.**

  In this project representatives from a series of projects in the operation stage were asked to review and evaluate their monitoring and verification activities. The purpose was to evaluate how the design of the monitoring program was informed by risk analyses, and extract guidance from the lessons learnt to date in these projects regarding monitoring and verification.
- **Sub-project 5: Documentation of risk management and evolving risk profile.**

  The purpose of this project was to review and assess the risk assessment activities performed for the In Salah project in Algeria, and propose how the results of these assessments should be documented and communicated to regulators.
- **Sub-project 6: Caprock characterisation for data-poor sites.**

  This project reviewed and evaluated current state-of-the-art tools for assessing the integrity of the caprock for data-poor sites, typically saline aquifers in regions that have been subject to little or no oil and gas exploration activities. The aim was to provide guidance that could help regulators and project developers judge how much data that may need to be collected to assess suitability for CCS.
- **Sub-project 7: Geomodeling and uncertainty quantification.**

  The purpose of this project was to assess the capabilities and limitations associated with geomodeling and uncertainty quantification for CCS. This entails also the iterative feedback loop where static and dynamic models are calibrated to history match with observations from monitoring. The project also attempted to draw conclusions with regard to the implications of these limitations for site operation and permit review processes.
- **Sub-project 8: Performance targets.**

  The purpose of this project was to propose a framework that could help project developers and regulators agree on acceptable levels of risk, and also provide project developers with predictable conditions for site closure.

4. Finally, the current guideline was prepared based on the draft qualification framework and the input and lessons learnt in the sub-projects. Prior to publication of the guideline, it was distributed to CCS regulators and relevant authorities for comments, and to relevant experts for peer-review.

Also note that several meetings with authorities (Norway, Denmark, Germany and UK) have been organised during the project in order to get early feedback on the risk-based approach taken. These meetings have put particular emphasis on collecting the view of regulators on the points of interaction between a regulator and a project developer, including the proposed approach to specify performance targets.

It is hoped that this Guideline will assist the deployment of Carbon Capture and Storage (CCS) in a safe and sustainable way, as a recognised and publically available guideline that contributes to:

- Proper selection and qualification of well-suited sites according to recognised procedures.
- Efficient and harmonised implementation of legal and regulatory frameworks for CCS.
- Predictable technical, financial and regulatory operating conditions for operators, regulators and other stakeholders.
- A swift transition from R&D and demonstration scale projects to large scale CCS by acceptance for a learning-by-doing approach where data is gathered during operation to validate storage performance and uncertainties are controlled through a risk-based verification and qualification process.
- Use of concurrent best engineering practice, best available technology (BAT) and proper management of risks and uncertainties throughout the life of a CCS project.

This guideline is about to be published (as DNV Report No.: 2009-1425) and will be made available on IEAGHG and DNV web sites.

DNV MANAGING RISK

IEAGHG CO_2-EOR Study,

by Neil Wildgust, IEAGHG

Advanced Resources International (ARI), in association with Melzer Consulting, has undertaken a study of global CO_2 storage potential associated with enhanced oil recovery (CO_2-EOR). The main aim of the study was to reassess the likely future potential storage capacity for CO_2 in depleted oil fields as part of EOR operations across the world. The study also aimed to identify the key technical, economic and regulatory barriers that may be preventing widespread application of CO_2-EOR globally as a means of providing an early opportunity for CO_2 storage.

Previous IEAGHG studies estimated the global storage potential in depleted oil and gas fields as being up to 1,000Gt CO_2, 120Gt of which could be stored in association with CO_2-EOR operations. Although they provide a lower potential capacity than both deep saline formations and gas fields, depleted oil-fields still constitute a valuable storage resource with extensive repositories of data and knowledge.

The study found that despite a long and successful record of CO_2-EOR activity in the USA, with over 100 schemes currently in operation, implementation of this technology elsewhere in the world has been on a more limited scale and largely confined to Canada. Arguably, the main reason for the concentration of CO_2-EOR in North America has been the availability of reliable, affordable and largely natural CO_2 sources. With the anticipated increase of CCS implementation around the world, this situation may change in coming decades. However, regulatory and financial mechanisms for CCS will need to be established and in particular, requirements for the 'conversion' of CO_2-EOR schemes into CO_2 storage projects will need to be clear.

Using the USGS World Petroleum Assessment and additional information on US basins, screening criteria were developed and utilised by this study to convert the original oil in place (OOIP) in the top 54 hydrocarbon basins around the world, into technically recoverable OOIP using CO_2-EOR. These criteria were based on an empirical assessment of relationships between US reservoir characteristics and CO_2-EOR potential, and application of these statistics to other world basins. This clearly represents a major set of simplifying assumptions, made necessary by the global nature, timescale and resources of the study.

The study estimated global CO_2 storage capacity associated with CO_2-EOR as 140Gt, of which over 70% is within the world's 'top ten' basins. Source-sink matching considerations could significantly reduce this potential; for example by applying an 800km limiting distance between current industrial CO_2 sources and major fields, the CO_2 storage capacity associated with CO_2-EOR could be reduced to 65Gt. However, new anthropogenic sources are likely to be established in coming decades, including in the Middle East. Consequently, ARI concluded that the majority of the 140Gt storage potential could be economic, assuming a CO_2 cost of US$15 per tonne and a world oil price of US$70 per barrel. The CO_2 storage capacity associated with CO_2-EOR could be further increased if CO_2-EOR can be applied to 'undiscovered' oil resources and if other steps, such as the earlier deployment of CO_2-EOR in oil field production, are undertaken. ●

Building UK-Japan Collaborations,

by Ameena Camps, IEAGHG

As demonstration project developments progress, CO_2 storage environmental impact assessment increases on the agenda: sparking a UK-Japan workshop to build international collaborations.

Between the 12th and 14th of January this year the British Embassy in Tokyo, Japan, hosted a workshop to bring together British and Japanese experts to exchange information, explore complementary strengths, and to lay the foundations for future collaboration in the expanding area of CO_2 storage environmental impact assessment.

UK participants in front of the Golden Pavilion, Kyoto, Japan.

This workshop; organised by Japan NUS, the British Embassy and Ameena Camps in both her current role at IEAGHG and her previous role at CICCS, The University of Nottingham; discussed and exchanged information on a number of pivotal areas, including storage site monitoring, potential marine and terrestrial impacts, regulations and policy and, public communication. Key speakers included Dr Nick Riley from the British Geological Survey; Dr Makoto Akai from the National Institute of Advanced Industrial Science and Technology (AIST); Professor

Ian Wright from the National Oceanography Centre, and Mr Hirotaka Hamanaka from the Japanese Ministry of Environment. UK participants were also fortunate to be provided with a side trip to Kyoto, which included a tour of the Research Institute of Innovative Technology of the Earth (RITE) and an extended cultural programme.

Reciprocal visits to the UK have already taken place this February, and we look forward to seeing the results from collaborative projects initiated at this workshop.

Environmental Impacts of Amine Emission during Post-Combustion Capture Workshop,

by Mohammad Abu Zahra, IEAGHG

The expected emissions of amines, additives and their degradation products with flue gas stream and waste product streams is a continuing concern for the deployment of full scale CO_2 post combustion capture, using amine technologies. Therefore, a workshop on the environmental impact of amine emissions during post-combustion capture was held in Oslo, Norway, on 16th February, 2010, hosted by Gassnova and sponsored by Gassnova and Statoil.

Over 65 delegates from 15 countries joined the programme, which consisted of four oral presentation sessions, and covered the following topics:

- Amines emissions to air;
- Degradation of amines;
- Environmental impact assessment of emissions from post-combustion capture;
- Atmospheric chemistry and degradation of amines;
- Pilot plant emission measurements;
- Emission profiles and control technologies from different technology vendors and developers.

Delegates of the meeting pose for a group photo

Out of the presentations and discussions, it was clear that there are few on-going and planned projects and activities in this area. Moreover, it was concluded that there are number of areas that require special attention and focus.

These areas include among others:

- studying the effect of NO_x and O_2 in the flue gas on the amine degradation and emissions;
- measuring and quantifying the ammonia and Nitrosamines emissions;
- the development of post-combustion capture environmental related regulations;
- the evaluation of the expected capture emissions level of toxicity;
- evaluate the currently available technologies for chemicals deep removal and emissions measurement tools; and
- the focus on running pilot plants tests using real flue gas and online measurements for chemical emissions.

Overall, it is important not to send inapprpriate or unclear messages to the outside world regarding the levels of chemical and amine emissions.

More information on the details of the discussions that took place, the network report, presentations and the next meeting information are available on the network website www.ieaghg.org.

Workshop on 'What Makes a Good Seal for Geological Storage Projects?'

By Sam Krevor, & Sally Benson, Stanford University, and Robert Burruss & Leslie Rupport, United States Geological Survey

On January 12 to 15, 2010, U.S. Geological Survey (USGS) and the Global Climate and Energy Project, Stanford University, held a participatory workshop on "Seals and Caprocks in Geologic Sequestration" at the Asilomar Conference Grounds, Monterey, California, USA.

Sixty-five participants in academia, government agencies, and industry from six countries discussed topics that included depositional environments and petrology of caprocks, interfacial tension and capillary pressure in CO_2-H_2O-rock systems, basin-scale characterisation, and geomechanics and geochemistry of seals and caprocks. The program had a limited number of oral presentations with discussion sessions following each talk. Twenty-five posters were displayed during both days of the meeting. The program included extended afternoon breaks allowing participants time for in-depth discussions in the informal setting of the Asilomar State Park Grounds on the dramatic Monterey Bay coast. The conference was organised by Sally Benson and Sam Krevor from Stanford and Bob Burruss and Leslie Ruppert from USGS.

The goal of the workshop was to bring together scientists with expertise in petrophysical, geological, hydrological, and geochemical properties of caprocks and seals for water and petroleum retention with scientists studying carbon capture and storage (CCS) for CO_2 storage and retention in geologic strata. In the course of the workshop a number of important opportunities for further research were identified. These topics fall into the four broad categories identified below.

Delegates of the meeting at Monterey Bay, California

1. Developing Guidelines for Assessing the Suitability of Seals for Geological Storage of CO_2
   - What level of retention is needed below or within a seal?
   - What geological, hydrogeological, geochemical and geomechanical properties are required to assure safe and effective storage of the seal/reservoir system?
   - What operational requirements, such as injection well specifications and depths, pressure buildup and injection well spacing, are needed to ensure that the seal/reservoir system will deliver the needed storage security?
   - Are seals with 3-dimensional closure needed, or is it possible to trap CO_2 beneath flat or dipping structures?
   - To what extent are existing requirements on seal properties for natural gas storage applicable for CO_2 storage? What, if any, are the seal requirements for natural gas storage, and on which basis were they established?
   - What is the best approach to characterise and monitor whether or not abandoned and active wells have the potential to leak?
2. Improving and Increasing Measurements of the Transport Properties of Seals
   - How can we increase the amount of data available about permeability, relative permeability and capillary entry pressure of seals?
   - What new methods can be developed to shorten the amount of time needed to obtain accurate measurement of the transport properties of seals?
   - In which important ways does the transport properties of seals differ between CO_2 storage and hydrocarbon accumulations (from which most of our knowledge of seals is derived)?
3. Understanding Geochemical Controls on Transport Properties and Performance of Seals
   - How does the organic matter content of a seal affect the sealing properties of mudrocks?

- In the case of organic-rich shale, how could organic matter interactions with CO_2 change the mechanical and transport properties of the shale?
- What is the role of dissolution, precipitation, and surface reactions on the transport properties of seals?
- How do coupled geomechanical, geochemical, and transport processes affect the long term containment properties of seals?
- What is the role of surface absorption/desorption on caprock sealing?

4. Characterising the Transport and Geomechanical Properties of Seals Over the Spatial Extent of the Area Affected by a Storage Project (hundreds of km^2)
   - What tools (properties?) do we need to measure the heterogeneity of seals and model them on regional scales?
   - How does depositional heterogeneity affect the transport properties of seals?
   - How do you determine the area over which the prospective seal needs to be characterised?
   - What hydrogeological, geochemical and geomechanical techniques are most promising for characterising saline formation seals?
   - How do we optimise field testing to maximise knowledge of caprock properties?
   - How much information is needed to develop accurate models for predicting storage performance for large-scale projects?
   - What are the best approaches for reporting and dealing with uncertainty?
   - What can be learned from EOR and natural gas storage to inform characterisation of seals for geological storage?

The participants concurred that while there are many opportunities for research, ***increasing experience with commercial scale projects is urgently needed*** for moving forward. A productive research program in seal properties and characterisation is best carried out in parallel with these commercial scale projects.

The authors would like to thank all of the participants of the workshop for excellent talks and thoughtful discussions. We would also like to thank the Global Climate and Energy Project sponsors, ExxonMobil, GE, Toyota and Schlumberger and the United States Geological Survey for supporting this workshop. The speakers and agenda can be found at http://gcep.stanford.edu/events/workshops_caprocks.html.

Contact: Sam Krevor, Stanford University, skrevor@stanford.edu

Geothermal Energy & CO_2 Storage – Synergy or Competition?

by Ludmilla Basava-Reddi, IEAGHG

The international conference on Geothermal Energy and CO_2 Storage – Synergy or Competition, was held by the GFZ (German Research Centre for Geosciences) on 10th – 11th February 2010 in Potsdam, Germany. The meeting was attended by over 250 participants from around the world.

The conference examined the subject of whether CO_2 storage projects would be able to work with geothermal projects or if there would only be competition for use of the underground.

Several presentations outlined the difference between sites appropriate for geothermal projects compared to those appropriate for storage. For a geothermal project the optimum conditions are a high temperature gradient (≈ 30˚C/km) and a high flow rate, which mostly depends on the porosity and permeability of the target formation and to a lesser extent the viscosity of the formation fluid. The optimum depths are usually 3000-6000m.

For CO_2 storage, depths of at least 800m are necessary as that is the point where the pressure and temperature are such that the CO_2 remains supercritical. The optimum depth range is 1000-2500m, though some storage sites are deeper than this. The other main requirements are the possibility for long-term injectivity, a highly porous and permeable aquifer, with an overlying caprock and the ability to monitor the site for any possible leakage. A much lower temperature than that needed for geothermal energy is desirable.

So it can be seen that both require a porous and permeable formation, though with an enhanced geothermal system, this is not initially essential as the rocks can be fractured to cause fluid flow, but the other requirements are quite different. However, when comparing a map of potential geothermal areas and potential CO_2 storage areas, there is some overlap, but many places where there is none. It is the places where there is overlap that the possibility of competition may be a concern.

It was also noted that there are many areas where knowledge sharing may take place, including site survey data and knowledge of wellbore construction and integrity.

There were a couple of talks, which focussed on the possibility of CO_2 storage and geothermal activities being

able to take place at the same location. The first possibility, presented by Tore Torp, from Statoil, was that of using different strata for different uses, especially as each has a different optimum depth. This is a fairly new idea and so it would be necessary to work out what would happen under unintended circumstances, such as an induced earthquake; who would be responsible for what? The other possibility, in a talk given by Niels Peter Christensen, Vattenfall, was that of using the same formation. The suggestion was that CO_2 storage does not need to be in conflict with the extraction of geothermal water, as long as there is good forward planning to ensure that the two projects work in tandem. In the proposed location in Denmark, it should be possible to extract geothermal water from a formation, where CO_2 may be stored afterwards. This would mean that there would not be the issue of pressure increases during injection, the used geothermal waters would then need to be disposed of elsewhere, considerations for this could be injection into a different part of the formation (on the other side of the fault), or disposal into the sea.

The aim of both CO_2 storage and geothermal extraction is to reduce the amount of carbon dioxide emitted into the atmosphere. As they have many similarities and need much of the same initial data, then communication between projects is very important if they are to work in conjunction with each other. ●

The Impact of CCS Communication,

by Vassiliki Gemeni

The public acceptance of CCS is an important precondition for the large-scale deployment of these technologies. At present it can be assumed that the majority of the public is neither for nor against CCS, because the level of awareness among the public is very low or virtually nonexistent. Hence, the pivotal question is how information on CCS has to be communicated in order to increase the stability and consistency of public opinion to better predict future public support or opposition.

The project "Scrutinising the Impact of CCS Communication on the General and Local Public (Impact of communication)" is a collaborative project led by IEF-STE involving eleven partners from six countries: Germany, Greece, the Netherlands, Norway, Romania and the United Kingdom. It was initiated by the Fossil Energy Coalition's (FENCO ERA-NET) 1st joint call for proposals and is funded by the respective National Funding Agencies of the involved countries.

The aim of the project is to develop recommendations for the communication of CCS enabling the public to establish their own informed opinion on the technologies. To achieve this objective, two methods are used in all the involved countries:

1) Survey of a representative sample of citizens and
2) Comparison of the effectiveness of two CCS communication methods: focus groups and Information-Choice Questionnaire (ICQ). The collected data are compared to enable conclusions to be drawn concerning the question of how to communicate information on CCS technologies so that the resulting public attitudes could be understood as indicators of future public support.

At the moment, both methods are already examined. The results of the comparison of the effectiveness of the two CCS communication methods (focus groups and ICQ) are already drawn and some general recommendations have been developed. Representative nationwide surveys were carried out in all of the six countries involved in the project. The sample of each survey consists of over thousand respondents (i.e., N varied between 1000 and 1500) so that data of more than 6000 interviews are now available. In addition to the nationally representative surveys in each country, parallel surveys were conducted in each of the regions of interest so that samples of over 400 in each of the regions are available as well. The regions surveyed were Rogaland in Norway, Yorkshire and Humberside in the UK, Rheinschiene and Schleswig-Holstein in Germany and the three northernmost provinces in the Netherlands: Drenthe, Groningen and Friesland. All survey data were collected in the last quarter of 2009, so that analyses are still ongoing. They will reveal important aspects related to CCS public acceptance. For further details about the project, publications, reports and the newsletters of the project can be found in the website www.ccs-communications.gr. ●

New IEAGHG Research Network,

by Ludmilla Basava-Reddi, IEAGHG

The first meeting of the Social Research network was held in, Paris on 2nd – 3rd November 2009 and was hosted by CIRED. The meeting was attended by over 40 people from 13 countries.

The Research Network meeting was coordinated with the GCCSI's 'Communicating for CCS Projects' workshop, which was on 4 November 2009, Paris, organised by CSIRO. This was aimed at project companies and contained presentations from academics and industry and group exercises. The most valuable element came from the US DOE NETL Best Practice Manual. This Best Practices Manual, (Public Outreach and

Participants of the Social Research Network meeting

Education for Carbon Storage Projects) draws upon the very real experiences from the US Regional Partnership projects, and provides the following guideline activities for how and when to undertake public outreach so as to increase likelyhood of success:

1. Integrate public outreach with project management
2. Establish a strong outreach team
3. Identify key stakeholders
4. Conduct and apply social characterisation
5. Develop an outreach strategy and communication plan
6. Develop key messages
7. Develop outreach materials tailored to audiences
8. Actively oversee and manage outreach programme throughout project life
9. Monitor performance of outreach and changes in public
10. Be flexible – change programme as needed

For more detail, visit www.fossil.energy.gov/news

Before the adoption of this network, the researchers in this area already existed within the Carbon Capture and Storage Social Research Network (C2S2RN). The major aim of the C2S2RN was to foster the conduct and dissemination of social science research related to CCS in order to improve understanding of public concerns as well as improve the understanding of the processes required for deploying CCS projects. The members of C2S2RN agreed that it would be appropriate to continue research in this area within a new IEAGHG network. As this was the 1st meeting of the Social Research Network, one of the main desired outcomes was the formation of a list of aims and objectives for the network.

The first session involved group discussions on the objectives and scope of the network, before a pooling together of ideas. There were then 5 further sessions, with discussion at the end of each. The sessions included Current Research in Social Science, Measuring Public Awareness on CCS, Strength of Opinion, Application in the Real World and Identification of Gaps. The full program can be found on the website: www.ieaghg.org.

The aims of the network are summarised as:

- Ensure high quality social science research
- Promote a learning environment
- Build capacity within the social research network
- Translate studies into tools or applied lessons
- Create a database of social science research – clearing house of tools

The overall conclusions to the meeting involved finding ways to bridge basic and applied research, which would involve more sharing of information. This also leads to the challenge of getting social science research to be used by decision-makers. It has to be seen as an integral part of the process of setting up and project management of a storage site, as there have been some cases where this has not been done adequately, leading to detrimental effects. It was also agreed that it cannot be too early to start in public engagement for a potential site, and it could make sense for this to be carried out before site characterisation.

The recommendations for the Social Research Network from the meeting were as follows:

- Develop a research agenda
- Facilitate peer review and pre-review within the network
- Deepen international comparative research
- To promote greater evaluation of alternative methodologies
- To expand the exchange of information between researchers
- Learning to apply other social science experience to CCS
- To clearly identify the theoretical basis for applying insights from social science research to CCS
- To create a clearing house of easily accessible related information
- To bridge basic and applied research
- To share best practices.

The next meeting of the Social Research Network is anticipated to be held in Japan in November 2010. ●

Advocacy for CCS Could Arouse Public Distrust,

by Heleen de Coninck, ECN

On Thursday, January 21st, Nature published a "Letter to the Editor" by Heleen de Coninck (research international energy and climate policies of ECN) on ill-advised CCS advocacy in the CCS academic expert community. The editor shortened the original text considerably. The original text is available below.

Kramer and Haigh, in their opinion piece on low-carbon energy (Kramer, G.J. & Haigh, M. (2009) Nature **462**, 568-569), indicate CO_2 capture and storage (CCS) as an important mitigation technology, and indicate a role for governments to support the technology. I would however also like to appeal to the CCS expert community to play an important role: the role of independent CCS critics. Many supposedly independent CCS experts are currently actively promoting CCS. Although such advocacy may be typical of technological experts, it is problematic for CCS for three reasons.

Firstly, CCS is in desperate need of critical scrutiny. The technology has significant shortcomings, which can only be exposed and addressed by experts who know the ins and outs of the technology. Those experts, however, are increasingly advocates of the technology, and in many cases blind to drawbacks and selective listeners, dismissive of criticism. If CCS' weaknesses are not recognised, improvement may be hampered.

Secondly, CCS has sufficiently powerful supporters; it does not need independent academics to engage in advocacy. For the fossil-fuel industry that has to act in a carbon-constrained world CCS is a matter of survival. The industry has no choice: it has to stage an effective lobby for CCS, and it is resourceful enough. Valuable time of independent experts is best spent on research on the shortcomings of CCS, not on promotional activity.

Thirdly, the lay public, in order to make an informed assessment of CCS, needs reliable information on risks and benefits. Social science indicates that non-experts are more likely to trust independent experts than private sector or government representatives. If the public perceives the CCS expert community as CCS advocates who are largely oblivious to or out of touch with their concerns, severe public resistance and mistrust could emerge. This is already obvious in recently stalled CCS projects in the United States, Germany and the Netherlands.

Where have we seen this technological advocacy among experts before? Nuclear energy was once a promising technology, but the lack of an independent and critical expert community helped fuel controversy. The CCS community seems on track to make the same mistake. Peer pressure within the expert community to not be viewed as a CCS-sceptic is contributing to this development.

It is in the best interest of improving CCS technology and hence of mitigating climate change that an expert community is developed that leaves ample room for critical feedback and expresses the limitations of CCS, that leaves advocacy to industry, and that engages in an open and respectful debate on the technology with the general public. Only then will CCS be in a position to make a difference for climate change. ●

Commercial Application of University of Regina Carbon Capture Technology,

by Elsa Johnston

The University of Regina's patented carbon capture technology – developed through its International Test Centre for CO_2 Capture (ITC) – has been selected for use in a carbon capture project in the United States.

In December 2009, ITC's industry partners HTC Purenergy and Doosan Babcock Energy initiated a commercial carbon capture and storage project to be undertaken with Basin Electric Power Cooperative of North Dakota, US. Beginning with a front-end engineering and design (FEED) study valued at $6.24 million USD, the project could then see ITC's commercial post-combustion capture technologies installed at Basin Electric's Antelope Valley Station power plant in one of its two 450-megawatt coal-fired generation units. The FEED study will establish the design of the new capture plant, budget and construction plans.

Representatives of HTC Purenergy, Carbon Capital Management and the University of Regina at the agreement signing

Basin Electric supplies electricity to 2.8 million customers across nine states in the US. Following extensive research, Basin Electric selected the ITC's capture technology to move forward with development of a post-combustion capture plant to retrofit their Antelope Valley station for CO_2 capture.

The commercial demonstration plant could be one of the first fully-operational commercial post-

combustion capture plants to be constructed and, at 3,000 tonnes per day capacity, it would be the largest capture plant in operation (currently, the largest capture plants being planned are at 1,000 tonnes per day capacity or less). In addition, the capture plant could be utilized for further carbon capture technology development and integration.

The aim of the project is to use captured CO_2 for enhanced oil recovery (EOR) and associated geological storage. Basin Electric already has the CO_2 processing and pipeline infrastructure for EOR and geological storage. The cooperative currently supplies several thousand tonnes of CO_2 per day from its coal gasification plant at Beulah, ND – located near Antelope Valley – to Cenovus' (formerly EnCana Corporation) commercial CO_2-EOR and geological storage project at Weyburn, Saskatchewan. Basin Electric has additional capacity in its pipeline infrastructure and is looking to utilise that capacity by supplying the additional CO_2 from this plant to oil producers along the pipeline.

Potential funding sources for the commercial carbon capture plant at Antelope Valley include the United States Department of Energy and the US Rural Utilities Service.

For further information, please contact Elsa Johnston, Manager, Communications & Marketing, Office of Energy and Environment, University of Regina. elsa.johnston@uregina.ca ●

Potential of Carbon Neutral City with Masdar,

from ME NewsWire, UAE, Jan 18th 2010

Masdar, a wholly-owned subsidiary of the Mubadala Development Company focused on renewable energy and sustainability, and 1Malaysia Development Berhad ("1MDB") have signed a cooperation agreement to explore clean technology projects and investments, including the possibility of building Malaysia's first carbon-neutral city.

Masdar is Abu Dhabi's multi-faceted initiative advancing the development, commercialisation and deployment of renewable and alternative energy technologies and solutions. Masdar is driven by the Abu Dhabi Future Energy Company (ADFEC), a wholly owned company of the government of Abu Dhabi through the Mubadala Development Company.

Masdar and 1MDB intend to cooperate and invest in carbon reduction projects, under the Kyoto Protocol's Clean Development Mechanism ("CDM") and clean technology venture capital. If fully implemented the cooperation agreement would lead to the development of new catalytic projects, with an estimated value of USD100 million. The agreement with Masdar, which was signed during Malaysian Prime Minister, YAB Dato' Sri Mohd Najib Tun Haji Abdul Razak's visit to Abu Dhabi, will further boost Malaysia's ongoing efforts to embrace world-class sustainable practices and clean technology; it was among several strategic joint agreements signed between Malaysia and the UAE - Dato' Sri Mohd Najib and H.H. General Sheikh Mohammad Bin Zayed Al Nahyan, Crown Prince of Abu Dhabi and Deputy Supreme Commander of the UAE Armed Forces, witnessed the signing.

Approximate location of MASDAR city in UAE

Talking on the importance of the agreement, Masdar Chief Executive Officer, Dr. Sultan Ahmed Al Jaber, said: "Masdar is committed to building strategic partnerships and creating worldwide networks in the push for new low carbon energy technologies and clean, sustainable ways of living. We value this partnership with Malaysia and applaud their move to actively pursue and invest in new green technologies." 1MDB Chief Executive Officer Shahrol Halmi said: "Clean technology is an increasingly important sector for the future economic development of Malaysia. The partnership with Masdar will help expose Malaysia and 1MDB to world-class capabilities in sustainable development." Shahrol did not rule out the possibility of 1MDB building Malaysia's first carbon-neutral city, "It is our intent to explore and evaluate business opportunities relating to the development of an environmentally friendly carbon-neutral city in Malaysia," he concluded. Established by the Government of Abu Dhabi, the capital of the UAE, in 2006, Masdar is a wide ranging, multifaceted renewable energy initiative that integrates the full renewable and clean technology life-cycle -- from research to commercial deployment -- with the aim of creating commercially scalable renewable and clean energy solutions.

For further information visit www.energycentral.com/functional/news/news_detail.cfm?did=14252149#nextpart ●

The Economics of Transportation of CO_2 in Common Carrier Network Pipeline Systems,

by Arthur Lee, Chevron, and Team Member of CO_2 Capture Project (CCP)

Large-scale CO_2 capture and storage (CCS) will require large-scale infrastructure to move CO_2 from capture facility to storage formation. The CO_2 Capture Project, a partnership of seven oil & gas majors to advance CCS, has been looking at the issues surrounding the economics of transportation of CO_2 in common carrier network pipeline systems.

Significant resources will have to be dedicated in order to construct and operate a pipeline system. Many of the design considerations and technologies in large-scale systems are already used by the oil and gas sector in existing hydrocarbon pipeline applications. Because of this experience, the oil and gas industry can play a crucial role in determining a way forward for transporting CO_2 to make possible large-scale, commercial deployment of carbon capture and storage.

Establishing a widespread CO_2 transportation infrastructure requires a strategic approach that takes into account the magnitude of potential deployment scenarios for CCS with hundreds of megatonnes (Mt) of CO_2 transported every year through pipeline systems. Transporting CO_2 by pipeline is not a new technology; in the US almost 4,000 miles of CO_2 pipeline for enhanced oil recovery (EOR) are in operation. However, the infrastructure for mass CCS could be on the scale of the current gas transmission infrastructure for Europe or North America, and will require significant investment to construct and operate.

The CO_2 Capture Project has been looking at the issues surrounding the economics of transportation of CO_2 in common carrier network pipeline systems. The CCP commissioned a study to examine different approaches to infrastructure development. In the study two approaches have been evaluated. The first would see the development of a point-to-point system, the second the development of common carrier pipeline networks, including backbone pipeline systems. This study has helped our understanding of the challenges involved; shedding light on what would be the best scenario and how in practical terms CO_2 infrastructure might evolve. The results of this study were presented in a paper - Assessing issues of financing a CO_2 transportation pipeline infrastructure commissioned by the CCP, and completed by Environmental Resources Management (ERM).

Results of the Study

The study confirmed that an integrated backbone pipeline network is likely to be the most efficient long-term option. It offers the lowest average cost on a per tonne basis for operators over the life of the projects if sufficient capacity utilisation is achieved relatively early in the life of the pipeline. Crucially, integrated pipelines reduce the barriers to entry and are more likely to lead to the faster development and deployment of carbon capture and storage. Particularly in situations where government money is being used to finance CO_2 transportation it makes sense to pursue an integrated approach that provides equitable, open access to other large final emitters. This will reduce the barriers to entry and will encourage faster adoption of CCS. However, point-to-point pipelines offer lower costs for the first movers and do not have the same capacity utilisation risk.

It is clear that without government incentives for the development of optimised networks, project developers are likely to build point-to-point pipelines. Other forms of financial support may be needed which overcome commercial barriers and ensure optimised development of CO_2 pipeline networks

So what is the way forward? Guaranteed capacity utilisation is essential for integrated backbone pipeline networks to become economically viable. Public policy is needed that provides some guarantees as to capacity utilization. Government incentives or loan guarantees

Large-scale Pipeline Systems, such as would be used for CO_2 Transportation. Image courtesy of the IEA

are also needed to support a backbone infrastructure and encourage the development of optimised networks. Government support in the first years, when capacity is ramping up, will be essential for eventual commercial viability.

CCP is continuing its research into understanding the financial and policy mechanisms that can be applied to enable the large scale deployment of CCS at lowest cost. Additional work includes a detailed assessment of financing and incentives mechanisms.

For the complete paper, and to be kept up-to-date on all the latest developments, please visit:

www.co2captureproject.org ●

Highest Honour for Alberta's World-Expert on CO_2 Storage,

from Alberta Research Council, Media & Resources

One of Alberta's leading experts in greenhouse gas reduction technologies has been recognised as an Alberta Research Council (ARC) "Distinguished Scientist", the highest level that can be attained. On 21 December 2009, it was announced that internationally-renowned CO_2 storage expert, Stefan Bachu is only the fifth researcher in ARC's 88-year history to achieve a Distinguished Scientist designation.

Bachu's status was elevated to a Distinguished Scientist at ARC in recognition of his exceptional talents, achievement and on-going efforts. Bachu boasts decades of expertise in carbon capture and storage, a track record of successful Alberta projects, and outstanding national and international collaboration which has elevated Alberta's global influence. Bachu was one of the earliest scientific leaders in the area of CO_2 storage and has been a driving force in moving CCS technology from concept to reality. Working with other provincial, national and international organisations, he has helped position CO_2 storage as a key mechanism for delivering substantial global greenhouse gas emission reductions. For example, Bachu, as a Lead Author to the Intergovernmental Panel on Climate Change (IPCC) Special Report on CO_2 Capture and Storage, co-shared the 2007 Nobel Peace Prize which was awarded to the IPCC.

Bachu is a global leader in the area of CO_2 storage – one of the most important technologies for helping society respond to the risks of climate change. He continues to be highly sought-after as a collaborator in leading studies being undertaken by industry, governments and research organisations from around the world. Bachu has built strong and influential teams within Alberta, and is viewed by some as one of only a handful of international experts on geological carbon storage.

"I consider Stefan one of the three experts in the world on geological carbon storage," writes Howard Herzog, Senior Research Engineer

Stefan Bachu, Distinguished Scientist

at MIT (Massachusetts Institute of Technology) Energy Initiative. "If I need to get a straight answer about a complicated and or important issue relating to [geological storage], Stefan is one of three people in the world I call."

Bachu's research and development record is further proven by a running total of 167 publications and 250 presentations at conferences and symposia. He has been a key figure in developing CCS site characterisation methodology for use by governments, industry and organisations from around the world.

Employees awarded the Distinguished Scientist/Engineer designation have an extensive record of excellence and innovation. These individuals exercise significant influence over ARC's technical direction and help to shape the future direction of the organisation.

They must be nominated for the award, with extensive supporting documentation, achievement, awards and recommendations. In 1998 Dr. Alex Babchin, Dr. Bill Gunter and Dr. Peter Toma were awarded the Distinguished Scientist/Engineer designation, and in 2006 Mr. Terry Macyk was awarded the designation. These four highly-skilled individuals received this honour for their highly relevant and innovative scientific and technical accomplishments over many years.

For more information, please visit www.arc.ab.ca/media-resources/news--announcements/2009-news/highest-honour-for-albertas-world-expert-on-co2-storage/

Note that the Alberta Research Council is now known as 'Alberta Innovates - Technology Futures' ●

News for Members

This section is provided specifically for readers in member countries and sponsor organisations, (see list on www.ieaghg.org for full details of members and sponsors). Reports on IEAGHG studies are freely available to organisations in these member countries and sponsor organisations. Please contact IEAGHG for further details. For Non-Member countries, reports can be made available by purchase at the discretion of IEAGHG.

Reports recently issued include:

2009-7: 4th Meeting of the Risk Assessment Network

The fourth meeting of the Risk Assessment Network was held in Melbourne, Australia in April 2009. The meeting was organised by the IEAGHG and the CO2CRC, and included presentations and discussions of the latest research and practical R&D activities.

The discussion sessions were varied, and generated a set of agreed conclusions, incorporating the key learnings of the network and its participants, and the gaps requiring further research activities

2009-9: Techno-Economic Evaluation of Biomass Fired or Co-Fired Power Plant with Post-Combustion CO_2 Capture

The use of biomass in power generation is one of the important ways in reducing greenhouse gas emissions. Specifically, the co-firing of biomass with coal could be regarded as a common feature to any new build power plant if a sustainable supply of biomass fuel is readily accessible.

IEAGHG has undertaken a techno-economic evaluation of the use of biomass in biomass fired and co-fired power generation, using post-combustion capture technology. This report is the result of the study undertaken by Foster Wheeler Italiana.

2009-10: CCS Site Selection and Characterisation Criteria

IEA GHG recently commissioned the Alberta Research Council in Canada to conduct a review of storage site selection criteria and site characterisation methods in order to produce a synthesis report.

This report reviews the literature on the subject on site selection and characterisation since the publication of the IPCC Special Report on CCS, and provides a synthesis and classification of criteria.

2009-15: OPEC-IEAGHG CCS workshop for scientists and professionals in OPEC Member Countries

The summary report of OPEC-IEAGHG CCS workshop for scientists and professionals in OPEC member countries, which is the first dedicated activity for OPEC member countries, was held in Hassi Messaoud, Algeria in November 2009.

The workshop was organised by IEAGHG and OPEC and hosted by the Ministry of Energy and Mines and Sonatrach. The workshop invited speakers covering the whole chain of CCS, and also used breakout groups' activity to allow greater variety of discussion on CCS. At the end of the workshop a visit to the In Salah location was organised.

2010-1: Workshop on Operating Flexibility of Power Plants with CCS

This report is a summary of a workshop on the operating flexibility of power plants with CCS that was organised in November 2009 by IEAGHG in collaboration with Imperial College London. Operating flexibility is becoming recognised as an important issue for CCS plants but so far there has been relatively little discussion of the subject.

The workshop included presentations by invited speakers followed by discussions sessions. The presentations focussed on electricity systems and CCS operating requirements, and modelling and operating experience of the flexibility of the three main CO_2 capture techniques (pre-combustion, post combustion and oxy-combustion capture) and CO_2 transport and storage.

2009-TR6: What have we learned from CCS demonstrations?

IEAGHG has undertaken an assessment of the learning that is being provided by operational, large-scale, pilot, demonstration and commercial CCS projects around the world. This was undertaken by questionnaire and analysis of the responses.

From the analysis of the responses, key themes, learning points and areas for beneficial collaboration are identified. The extent of coverage of projects is summarised in terms of geological properties and monitoring techniques.

2009/TR7: A review of the international state of the art in risk assessment guidelines and proposed terminology for use in CO_2 geological storage

IEAGHG commissioned Imperial College London, to undertake a review of the international state of the art in risk assessment guidelines and proposed terminology for use in CO_2 geological storage.

The need for this study was identified during the 3rd meeting of the IEA GHG international storage research network on risk assessment, held at Imperial College. The study report provides an important reference document on risk management frameworks and risk terminology in the context of CO_2 geological storage.

Conferences & Meetings

This is a list of the key meetings IEAGHG are holding or contributing to throughout 2010. Full details will be posted on the networks and meetings pages of our website at www.ieaghg.org.

If you have an event you would like to see listed here, please email the dates, information and details to: toby.aiken@ieaghg.org.

Please note that inclusion of events in this section is at the discretion of IEAGHG.

Innovation for Sustainable Production
18-21 April 2010; Bruges, Belgium

6th Wellbore Integrity Network
28-29 April 2010; The Hague, The Netherlands

Carbon Capture and Storage: can anything be learned from 35 years experience in geological disposal of radioactive wastes?
27-30 April 2010; Meiringen, Bernese Alps, Switzerland
www.itc-school.org/index.php/Present-Courses/Carbon-Capture-and-Storage.html

6th Monitoring Network
6-8 May 2010; New Orleans, USA

9th Annual Conference on Carbon Capture & Sequestration
10-13 May 2010; Pittsburgh, Pennsylvania, USA

6th Monitoring Network
6-8 May 2010; New Orleans, USA

5th Risk Assessment Network
17-18 May 2010; Denver, Colorado, USA

IEAGHG International CCS Summer School
23-27 August 2010; Svalbard, Norway

High Temperature Solid Looping Network
15-17 September 2010; Alkmaar, The Netherlands

GHGT-10
19-23 September 2010; Amsterdam, The Netherlands

26th International Activated Carbon Conference & Courses
9-15 October 2010; Holiday Inn, Pittsburgh Pennsylvania, USA
www.pacslabs.com email: Henry@pacslabs.com

Greenhouse Issues
ISSN 0967 2710

Greenhouse Issues is the newsletter of the IEA Greenhouse Gas R&D Programme (IEAGHG). IEAGHG is funded by member contributions from IEA member countries as well as other developed and developing countries and industrial organisations that have an interest in implementing technical options for GHG mitigation. A list of this membership can be found on the website. Greenhouse Issues provides information on worldwide developments in the field of GHG abatement and mitigation. It is published four times a year and is free of charge. Mailing address changes and requests for copies of this newsletter should be sent to the address below. For further information about IEAGHG and suggestions for articles, please email or write to the :

IEAGHG ● Orchard Business Centre ● Stoke Orchard ● Cheltenham, Glos. GL52 7RZ ● United Kingdom.
Tel: +44 (0) 1242 680753 ● Fax: +44 (0) 1242 680758 ● mail@ieaghg.org ● www.ieaghg.org