Greenhouse News

• the official newsletter of IEAGHG and its members •

December 2011 • Issue 104

IEAGHG Celebrates 20 Year Anniversary,

by Toby Aiken, IEAGHG

This year sees a milestone for the IEAGHG, with the celebration of the 20th Anniversary of the programmes' inception back in 1991. In that time, the company has evolved from a staff of 3, all engineers drawn from the Coal Research arm of British Coal, to a company of some 16 employees specialising in all areas of the CCS chain, as well as the supporting admin staff.

The intervening years have seen CCS grow from a theoretical possibility to a demonstration scale climate change mitigation technology. During its' 20 year history, IEAGHG research has helped to forge the way, identifying research gaps and further needs, and initiating and supporting the research needed to overcome these gaps and build the knowledge base needed to take theory to reality.

The 20th Anniversary celebration was timed to coincide with the 40th ExCo, held in London in the Church House Conference Centre. Within Church House, the ExCo was held in the impressive Assembly Hall, a Grade II listed room built in 1939 and designed by the celebrated architect Sir Herbert Baker.

IEAGHG logo evolution, 1991-2011

The circular room was surrounded by a quote from the Salisbury Diurnal by GH Palmer: *"Holy is the light and passing wonderful, lending radiance to them that endured in the heat of the conflict: from Christ they inherit a home of unfading splendour, wherein they rejoice with gladness evermore."*

The views from the balcony of the adjoining Bishop Partridge Hall of Westminster Abbey made for a beautiful vista for the lunch and coffee breaks, ensuring that this 40th ExCo will be remembered as a significant milestone in the history of IEAGHG.

The ExCo meeting itself was well attended, with only 9 members not represented. The result of such a turnout meant that the discussions were both in-depth and detailed, lending invaluable insights to the proposed work plan, and ensuring that the completed work that was presented was thoroughly reviewed.

In this issue

For the anniversary celebration itself, guests were invited to a gala dinner in the Darwin Centre of the Natural History Museum in London, with a tour of the Darwin Centre itself. Guests included IEAGHG staff past and present, current and long-serving ExCo members and other noted contributors from the past 20 years. The surroundings were magnificent, and the celebration dinner will doubtless be discussed for years to come. The dinner concluded with an award ceremony, where awards were presented to Jim Harrison, who was instrumental in establishing the IEAGHG in 1991, Bob Durie for his long service managing the Australian Consortium of the IEAGHG, Peter Versteegh and Johannes Heithoff to celebrate their retirement after long service, and a Special Award was presented by Kelly Thambimuthu on behalf of the entire ExCo to John Gale for his contributions to the programme, both since taking over as General Manager, and before in his previous role. John Gale has been a key member of the team for many years, and his input has been felt by many different projects and activities over the years, underlining his value and far-reaching capacity to the IEAGHG, and the award was in recognition of these contributions over the years.

To mark the 20th Anniversary, IEAGHG have prepared a booklet to commemorate the occasion. The booklet contains stories from noted members and contributors to the programme, as well as pieces written by staff members. The booklet describes the work undertaken by the programme over the years, as well as containing articles written by key players in the CCS environment. The booklet is available to download from the IEAGHG website, and selected extracts are included as articles in this newsletter. They can be found from page 20 onwards.

Images: Opposite page, clockwise; Bob Durie receives his award for long service, Church House Assembly Room ExCo venue, Kelly Thambimuthu, ExCo Chairman relaxing after presenting the awards, John Gale, General Manager, caught off-guard by his surprise award. Above: John Gale receives his Special Award, Jim Harrison receives his award for establishing the programme in 1991, and Peter Versteegh (The Netherlands) receives his award for long service on his retirement

GHGT-11 Update, by Toby Aiken, IEAGHG

Following the opening of abstract submission for GHGT-11, abstracts have begun to be received, and initial analysis appears to suggest that it will again be a marathon task to assess and review all abstracts received; GHGT-11 appears to continue the trend of popularity as the conference of choice at which to submit and present the latest research.

With less than a year to go until the conference, organisation is picking up pace with the formation and establishment of the Technical Programme Committee, which has now been joined by Chris Hendriks of Ecofys, The Netherlands. Sponsorship has also started to gain pace, with the first confirmed sponsors having signed the sponsorship agreements.

There is still a requirement for further sponsorship, and indeed there are still events and 'add-ons' available for sponsors to sign up for. If you or your company would be interested in sponsorship opportunities, please contact me (Toby Aiken) in the first instance either by email toby.aiken@ieaghg.org or by telephone +44 (0)1242 680753 extension 209, and I will be happy to discuss options and arrangements with you.

We are inviting key companies and organisations in CCS to join in sponsoring the conference. As well as providing exposure at the conference for your organisation, supporting this international conference will help in advancing the understanding, development and deployment of CCS.

Funding for the GHGT-11 meeting will come from 3 major sources: sponsors (gold, silver and bronze), supporters, and delegate fees. For gold and silver sponsors, we offer the option of 'add-ons' so they can sponsor individual items or events related to the conference. Further sponsored items will be identified throughout the planning for the conference, but examples of sponsored items are: badge lanyards, registration desks, the GHGT-Times daily newspaper, travel cards, lunches (which will include the opportunity for a keynote talk at the sponsored lunch), and dinner sponsorship. The individual costs for these items are negotiable, and should be discussed on an individual basis with the conference organisers.

The Call for Papers and Sponsorship Prospectus are both available from the GHGT website (www.ghgt.info) and this website also contains some information on the travel options for getting to and from Kyoto, along with some suggested hotels in the vicinity of the conference venue.

ISGS-led Consortium Begins Injection of CO_2 for Storage at the Illinois Basin – Decatur Project

First U.S. large demonstration-scale injection of CO_2 from a biofuel production facility begins

The Midwest Geological Sequestration Consortium (MGSC) has begun injecting carbon dioxide (CO_2) for the first million-tonne demonstration of carbon sequestration in the U.S. The CO_2 will be stored permanently in the Mt. Simon Sandstone more than a mile beneath the Illinois surface at Decatur. The MGSC is led by the Illinois State Geological Survey (ISGS), part of the Prairie Research Institute at the University of Illinois.

"Establishing long-term, environmentally safe and secure underground CO_2 storage is a critical component in achieving successful commercial deployment of carbon capture, utilisation and storage (CCUS) technology," said Chuck McConnell, Chief Operating Officer for the U.S. Department of Energy (DOE) Office of Fossil Energy (FE). "This injection test project by MGSC, as well as those undertaken by other FE regional partnerships, are helping confirm the great potential and viability of permanent geologic storage as an important option in climate change mitigation strategies."

MGSC is one of 7 regional partnerships created by the DOE to advance technologies nationwide for capturing and permanently storing greenhouse gases that contribute to global climate change.

"I want to congratulate the MGSC, the Prairie Research Institute, ADM, and the other partners on this leading-edge demonstration project that has brought the future of clean energy research and technology to the state of Illinois today," said Illinois Governor Pat Quinn. "We are poised to reap the economic and environmental benefits that this public-private partnership has produced. This successful project gives Illinois a competitive advantage to attract green businesses and address our climate change responsibilities."

"We are enthusiastic as we reach the operational stage of our project. The analysis of data collected beginning in 2003 indicates that the lower Mt. Simon Sandstone has the necessary geological characteristics to be an excellent injection target for safe and effective storage of CO_2," said Robert J. Finley, PhD, director and leader of ISGS's sequestration team. The $96 million Illinois Basin – Decatur Project was funded in 2007 and now marks the beginning of the injection of 1 million metric tonnes of CO_2 over the next 3 years.

"Reaching the injection phase of this project is a major milestone in sequestration technology world-wide and for the State of Illinois," said Prairie Research Institute Executive Director, William W. Shilts, PhD. "Four years of effort are coming to fruition at a site with unique capabilities, some of them first-in-the-world with respect to the extensive subsurface monitoring system. It's a strategic investment in Illinois' future." Visitors from Australia, China, Norway, Spain, and Japan have already visited the Illinois Basin – Decatur Project and they expect to welcome more of the international sequestration research community over the next several years, Shilts noted.

The CO_2 is being captured from the fermentation process used to produce ethanol at Archer Daniels Midland Company's (ADM) corn processing complex. It is compressed into a dense-liquid to facilitate the injection process and permanent storage at a depth of 7,000 feet, according to Finley. The Mt. Simon Sandstone is the thickest and most widespread saline reservoir in the Illinois Basin, which covers two-thirds of Illinois and reaches into western Indiana and western Kentucky. The estimated CO_2 storage capacity of the Mt. Simon is 11 to 151 billion metric tonnes, and it is below several layers of shale that serve as an impermeable cap rock to hold the CO_2 in place, Finley added.

This demonstration project is part of the Development Phase of the Regional Carbon Sequestration Partnerships program, a DOE Office of Fossil Energy initiative launched in 2003 to determine the best approaches for capturing and permanently storing greenhouse gases that can contribute to global climate change.

The Illinois State Geological Survey manages the MGSC project. ISGS characterised the regional geology that led to selection of the Decatur site and is investigating the characteristics of the Mt. Simon reservoir and the overlying shale seal that retains the CO_2. The Survey is conducting one of the most extensive environmental monitoring programs of any sequestration site in the world. The project is permitted under requirements of both the Illinois and the U.S. Environmental Protection Agencies as the first large demonstration-scale injection of CO_2 from a biofuel production facility anywhere in the U.S.

Schlumberger Carbon Services is providing full project management for the design and construction of all wells associated with the storage and deep monitoring parts of the project. Drilling of the injection well in 2009 confirmed suitability of the site and was followed by a seismic survey, a geophysical monitoring well, and a pressure and fluid sampling (verification) well, all in 2010. Completion of the verification well was followed by two rounds of initial fluid sampling to thoroughly document pre-injection reservoir conditions.

About the Illinois State Geological Survey (ISGS)

The Illinois State Geological Survey, part of the Prairie Research Institute at the University of Illinois, is a global leader in carbon capture and storage research technology and education through the Survey-based MGSC and the Sequestration Training and Education Program (STEP). ISGS has been investigating the geology and resources of Illinois for more than 100 years and carbon sequestration in Illinois since 2000. The MGSC is the largest externally supported program of the Prairie Research Institute. For more information, visit www.sequestration.org and **www.isgs.illinois.edu**

About the Prairie Research Institute

The Prairie Research Institute at the University of Illinois at Urbana-Champaign, formerly the Institute of Natural Resource Sustainability, is the home of the Illinois State Scientific Surveys: Illinois Natural History Survey, Illinois State Archaeological Survey, Illinois State Geological Survey, Illinois State Water Survey, and Illinois Sustainable Technology Center. It was established by state statute in 2008 and builds on the Surveys' reputations for basic and applied research and service. With 1000 employees and a budget of more than $78 million, it is the largest institute within the University. Prairie Research Institute scientists work to support economic development and natural and cultural resource sustainability for Illinois and beyond. For more information, visit **www.prairie.illinois.edu**

About Schlumberger Carbon Services

Schlumberger Carbon Services provides technologies and services for the long-term geological storage of CO_2. Experience and a detailed understanding of the varied challenges posed by CO_2 storage, gained by participation in many carbon capture and storage projects worldwide, is backed up by a corporate history of over 80 years in the oil & gas industry. For more information, visit **www.SLB.com/carbonservices**

About Archer Daniels Midland (ADM) Company

For more than a century, the people of Archer Daniels Midland Company (NYSE: ADM) have transformed crops into products that serve vital needs. Today, 30,000 ADM employees around the globe convert oilseeds, corn, wheat and cocoa into products for food, animal feed, chemical and energy uses. With more than 265 processing plants, 400 crop procurement facilities, and the world's premier crop transportation network, ADM helps connect the harvest to the home in more than 160 countries. For more information about ADM and its products, visit **www.adm.com**

New Project Officers at IEA GHG, by Toby Aiken, IEAGHG

New Project Officers Jasmin Kemper and Prachi Singh

To meet the increasing demands and workload, and to fill the vacancies caused by the retirement of Mike Haines, and resignation of Mohammad Abu Zahra earlier in the year, IEAGHG has recruited 2 new Project Officers to support its operations.

Jasmin Kemper and Prachi Singh have joined the Programme Team and will join the CO_2 capture team. We would like to take this opportunity to welcome them to the team.

OCC2 – Oxyfuel Combustion Technology; Working Toward Demonstration and Commercialisation,

by Stanley Santos and Siân Twinning, IEAGHG

One of Three Groups on Callide Site Visit

The 2nd Oxyfuel Combustion Conference was held at Capricorn Resort in Yeppoon, Australia from 12th to 16th September 2011. This conference was attended by 210 delegates from 23 countries worldwide and despite the remote location of the meeting, 80% of the participants attending were from outside Australia.

Over the three days, 6 keynote presentations were given and 3 plenary sessions were held with a total of 11 presentations; all were very well attended and received. Due to the high demand to present results and projects 3 parallel sessions per day were required for the 90 oral presentations selected by the Committee. A 2 hour dedicated poster session complimented the oral sessions with 27 posters presented. The meeting was concluded by closing remarks from five stakeholders.

The full programme is listed on the OCC2 pages on the IEAGHG website at: **www.ieaghg.org/index.php?/20110525251/occ2-programme-overview.html**

The oxyfuel combustion conference has gone from strength to strength. The event covered four basic themes that shaped the technical content of the meeting;

- Updates to the large scale pilot plants and announced demonstration projects worldwide,
- Updates in the development of oxyfuel combustion boilers and burners,
- Updates in the development of oxygen production, and
- Updates to the development of the CO_2 processing unit.

Most of the presentations were focused toward the demonstration of the oxyfuel technology, and several gaps in information have been filled since OCC1 in 2009. This has helped to provide clarity in terms of technology development and the associated costs.

The 16th saw the conference conclude with a visit to the Callide A Power Station. Of the 210 conference delegates, 145 made the 6 hour round trip to the facility. The trip was organised and hosted by the Callide Oxyfuel Project and despite the heat, the opportunity to visit the world's largest Oxyfuel Combustion Demonstration plant was much appreciated and valued by all who participated in the day.

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The important messages coming out from this meeting can be summarised as:

- Oxyfuel Combustion is ready for Demonstration.
- It has reached maturity as an option for capturing CO_2 from coal fired power plants.
- The industry needs the demonstration projects to go ahead to sustain the RD&D investment in this technology.
- We now need to build on the progress achieved over the last 10 years.

The success of this event would not have been possible without the support of our conference partners – Callide Oxyfuel Projects Ltd. and Xstrata Coal, our major sponsors - Air Liquide, Hitachi Power, and Vattenfall; and our supporters – Alstom, ANLEC R&D, CIUDEN, and Newcastle University.

With four sponsored dinners and the welcome dinner attended by the Regional Mayor, Brad Carter, who took the opportunity to welcome delegates to the region, there was also much networking associated with the event. Old acquaintances were renewed, new friendships and contacts were made, to the accompaniment of a glass of wine and crocodile skewer.

The pictures taken during the event can be viewed at: **www.flickr.com/photos/45448680@N06/sets/72157627790334837/**

In conjunction with OCC2, the 3rd APP Oxyfuel Combustion Working Group – Capacity Building Course was held on the 11th September, this was lead by Terry Wall and Rohan Stanger from the University of Newcastle and attended by 50 students and young professionals. The course made good use of the experts attending the OCC2 with several key individuals giving presentations during the day.

Finally, we are pleased to announce that the 3rd Oxyfuel Combustion Conference will be hosted by Fundacion Ciudad de la Energia (CIUDEN) and will be held in Leon, Spain in September 2013. We hope that you will join us there, and further announcements will be made in due course in this newsletter and on our website www.ieaghg.org.

Challenges and Opportunities of CO_2 Capture and Storage in Iron and Steel Industry, by Stanley Santos,IEAGHG

The 1st Industry CCS Workshop – "Challenges and Opportunities of CCS in Iron and Steel Industry" was held at the Auditorium of Stahl Institute VDEh at Dusseldorf, Germany on the 8th and 9th November 2011. The meeting was chaired by Prof. Dr. Ing. Gunnar Still of ThyssenKrupp and was attended by 72 delegates over 2 days.

The objectives of the workshop:

1. To address and discuss the difficulties for the implementation of the CO_2 Capture and Storage in the iron and steel industry; and
2. To discuss and understand the various issues and factors in the evaluation of the cost of CO_2 capture in an integrated steel mill.

The programme consisted of 20 different presentations covering the CCS technologies relevant to the steel industry, CO_2 transport and storage specific to steel industry needs.

The meeting highlighted some of the challenges that steel industry faced in implementing any CCS projects – on a commercial basis:

- CCS would be one of the important solutions to mitigate CO_2 emissions from the steel industry sector
- It should be noted that unlike the power generation industry, CO_2 emissions particularly from integrated steel mills come from numerous point sources per site.
- Work is still on-going toward validation of new CO_2 capture technologies that would allow large scale implementation of CCS within the steel industry.
- Demonstration of Oxy-Blast Furnace Technology (i.e. AM Florange) for retrofit cases is essential in order to validate technology and cost; and most importantly to reduce risk.
- Handling an annual 10 – 30 millions tonnes of CO_2 should be expected per integrated steel mill site. The challenge of handling this huge volume should require demonstration to reduce risk and to increase confidence that it works.
- Market competitiveness is an equally important consideration to any implementation of CCS in the steel industry. This includes a level playing field on a global scale – an essential element for CCS in steel industry to succeed.

The full programme is listed on our website:
http://www.ieaghg.org/index.php?/20110609257/ccs-in-the-iron-and-steel-industry.html

Finally, we would like to thank the host and partners of the meeting – Stahl Institute VDEh and Swerea MEFOS.

The 1st EAGE Sustainable Earth Sciences Conference, by Millie Basava-Reddi, IEAGHG

The 1st Sustainable Earth Sciences Conference was held in Valencia, Spain from 8th – 10th November 2011. The meeting was organised by the European Association of Geoscientists and Engineers (EAGE).

The aim of this meeting was to bring together learnings from technologies for sustainable use of the deep sub-surface. This was divided into three main topics; geothermal energy, geological storage of CO_2 and deep earth storage. For each, there were posters and presentations given. There were plenary sessions and the start of the first 2 days and a concluding plenary session at the end of the last day. The rest of the days were taken with 3 parallel sessions covering the main topics.

The plenary session on the first day had talks on the IEA analysis and roadmaps for CCS and geothermal activities and highlighted the importance of all technologies in achieving climate change targets in the

coming years. The potential role of enhanced geothermal systems (EGS) was considered, which would allow exploitation of deep geothermal resources in drier rocks by hydraulic fracturing. This technology, while still in the development phase, has seen success in some areas and could potentially be used in locations not previously considered for geothermal use. The final talk was on underground gas storage in the European gas infrastructure. The issue of competition for resources was brought up in the discussion and it was considered that while maps may show resource overlap each activity is looking for slightly different parameters, for example gas storage sites are much smaller than sites needed for CO_2 storage.

The plenary session on the second day considered some of the challenges associated with the technologies being discussed. Topics considered included the difficulty of accurate capacity measurements for geological storage and uncertainties related to EGS.

The final session was based on learnings from different projects. Talks on geothermal activities at the Basel and Hague projects were given. EGS activities at the Basel project highlighted the importance of understanding induced seismicity, for which research into the data is still taking place and may be useful for other projects. A talk on the US regional partnerships programme showed a different approach taken in the US based on exploiting opportunities for CO_2 enhanced oil recovery while advancing knowledge and experience in CO_2 storage as well as capture technologies. Talks were also given on learnings from the CO_2 storage projects at In Salah and Lacq/ Rousse.

Overall conclusions from the meeting are that there are many places where learning and technological advances in each of these areas can be shared; an example of this is geomechanical interpretation and modelling of the subsurface. There is plenty of scope for knowledge sharing, particularly in areas where there is or expected to be multiple use of the subsurface.

Phase 1b of the What Have We Learnt Study,

by Samantha Neades, IEAGHG

The 'What Have We Learnt From Operational CCS Demonstrations – Phase 1b' report was supported by the Global CCS Institute (GCCSI) and was published by IEAGHG in October 2011. This report was intended to be a follow-up to the original IEAGHG technical review, What Have We Learnt From CCS Demonstrations, published in 2009.

The original assessment of the learning provided by operational CCS projects (2009 report) identified twenty eight eligible projects. This initial report looked at the extent of coverage of CCS demonstrations and the learnings from these capture and storage projects.

Phase 1b intended to add additional information to the original report on well injectivity, regulation and public communication. IEAGHG received twelve responses from operational, large-scale CCS demonstration projects in this phase – four from capture projects and eight from storage.

The well injectivity section in Phase 1b looked at injection conditions, predicting injectivity, injectivity in practice and improving injectivity. The results show that the projects cover a wide range of injection depths – varying from 600 metres to approximately 3300 metres, and reservoir thicknesses – which ranged from 5 to 90 metres. The formation water salinity was also reported and these results ranged from 4000 parts per million (ppm) at the Pembina Cardium project to 350,000ppm at the Midwest Regional Carbon Sequestration Partnership's Michigan Basin Project. Most projects experienced higher injection rates than anticipated, with the average rate ranging from approximately 30 to 500 tonnes per day and, as expected, injection pressures vary with depth and hydrostatic gradient. Despite the generally favourable injectivity found in practice compared to design predictions, operators had collectively tried a range of techniques to improve or maintain inflows. These methods included acid injection, re-perforation, horizontal drilling, pre-injection fracking and pre-injection back-flushing. CO_2 injection has been successfully demonstrated in a wide range of settings.

In terms of regulations, Phase 1b looked at interaction with regulations and regulators, possible gaps in the regulatory framework and underground CO_2 inventories. The results show that most project experienced positive interaction with regulators. There were some issues with Mining Safety Laws and Regulations where projects were located in an active hydrocarbon field and some issues on permitting the observation wells were raised at the phase III early test at the Cranfield project (Southeast Regional Carbon Sequestration Partnership) – this was overcome by permitting them as observation wells. All projects questioned had not yet attempted to register for CO_2 credits and a key learning here

was the better understanding of the range of characterisation activities and supporting MVA (monitoring, verification and accounting) documentation that may be required in the presence of a carbon credit market. Regulations and standards, when coupled with proactive community policies, led to a positive relationship within the community. The first demonstration projects are too small to have come up against many significant issues in terms of regulations – at best, authorities have been alerted to the potential issues that could arise at full-scale.

The public communication section in Phase 1b reported on communication methods employed, novel communication methods and lessons learned. Several projects emphasised the effectiveness of an informal approach and the establishment of situations where conversations can be held as equals, between operators, stakeholders and the public. Most projects had encouraged visitors to the site of operations, organised meetings with interested parties and all projects set up websites with project-specific information. This report shows that the existence of identifiable benefits of some sort is present at most sites and objections to a project are unlikely if there are benefits for the local community.

A copy of the 'What Have We Learnt From Operational CCS Demonstrations – Phase 1b' (IEAGHG, 2011) can be obtained from IEAGHG by quoting the report number 2011-09.

Storage Gap Analysis Study Report, by Neil Wildgust, PTRC

IEAGHG has published, on behalf of the Global Carbon Capture and Storage Institute (GCCSI), a study reviewing the current global portfolio of operational and announced CO_2 geological storage projects, in the context of key CCS deployment targets for 2020: 20 operational sites stipulated by the G8; and 100 operational sites as described in the 2009 IEA CCS Roadmap 'Blue' scenario (limiting atmospheric CO_2 concentrations to 450ppm).

The study, undertaken by Geogreen of France, included detailed modelling of the timescales and resources required for storage sites to achieve bankable status, whereby final investment decisions can be made in advance of site construction, commissioning and operations. Building on this analysis, the study showed that the current CCS project portfolio could allow the G8 target to be reached provided that adequate resources are made available for a large proportion of the proposed projects, and that storage associated with CO_2-EOR can be included.

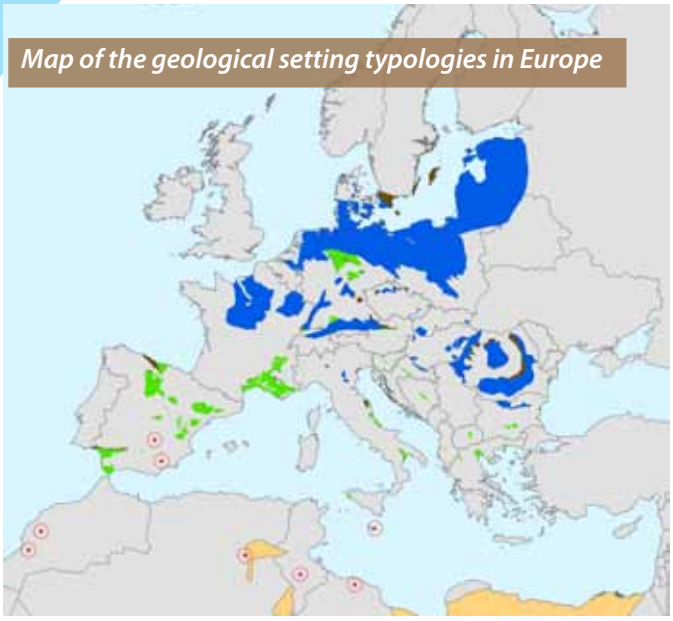
However, the analysis also showed that the IEA Roadmap target for 2020 is effectively unattainable. Storage project lead times are long – up to 15 years for deep saline formation storage sites, accompanied by significant risks of project failure due to both technical (e.g. geological) and non-technical (e.g. financing, public acceptance) issues. Based on current projections and assuming adequate funding, Geogreen estimated that approximately 50 sites could be operational by 2025 or, with the inclusion of CO_2-EOR projects, 100 sites by 2028. The latter could require up to 6 billion Euros of total investment to achieve the requisite number of storage bankability assessments, not including site construction and operational costs.

Hence the gap between the current global portfolio of CCS projects and roadmap deployment targets to mitigate greenhouse gas emissions is wide, being especially stark in non-OECD countries where only a small fraction of required project numbers have been announced. In the absence of adequate funding to resource storage site exploration and incentivise CCS, the report concludes that this gap will continue to widen as CCS falls further behind climate science – driven targets.

Potential Impacts of CO_2 Geological Storage on Groundwater Resources, by Millie Basava-Reddi, IEAGHG

IEAGHG has published a study reviewing the potential impacts on groundwater resources of CO_2 geological storage. The study, undertaken by CO_2GeoNet and lead by BRGM in France. The aim of study was to produce a 'high level' overview of potential impacts on groundwater resources from storage operations, concentrating on deep saline formations (DSF) across a range of typical regional settings. The study also highlights the current state of knowledge and/or gaps, recommending further research priorities where appropriate.

Areas of geographical overlap between potential DSF CO_2 storage and overlying fresh water aquifers have been identified by combining available datasets to map the global and regional juxtaposition of groundwater resources and potential CO_2 storage sites. A classification scheme has been developed for the various geological settings in which overlap may occur. A map of these typologies for Europe can be


Map of the geological setting typologies in Europe

seen in the figure above. This was then tested for Europe where groundwater resources and potential CO_2 storage sites are relatively well documented and understood. In central Europe, potential storage areas coincide with areas of large, uniform potable aquifers and this could lead to potential conflicts in instances where potable aquifers extend to considerable depth, or low permeability caprock layers are scarce. In southern Europe, more complex aquifer systems (e.g. limestone karst) tend to coincide with potential storage resources. In North America it is the reversed situation, with the majority of geographical overlap occurring between complex aquifer systems and DSF and in Australia, there is overlap with deep freshwater aquifers. The situation in Australia is interesting to note as deep freshwater may coincide with potential DSF.

Two approaches have been used to address potential impact mechanisms of CO_2 storage projects on the hydrodynamics and chemistry of shallow groundwater. The first approach classifies and synthesises observations of water quality changes obtained in natural or industrial analogues, and in laboratory experiments. The second approach reviews hydrodynamic and geochemical models, including coupled multiphase flow and reactive transport, with the aim of linking leakage scenarios to possible impacts on groundwater resources.

The findings of the study emphasise the current state-of-the-art regarding potential groundwater resource impacts to be based largely on theoretical considerations. Selection of appropriately characterised and risked storage sites should negate concerns over potential impacts on groundwater resources. Nevertheless, further research is required to better characterise potential leakage mechanisms and impacts, to inform the risk assessments required by regulators.

Possible mitigation options to stop or control CO_2 leakage have been discussed. In particular, the effect of CO_2 pressure in the host DSF and potential effects on shallow fresh water aquifers have been examined. In the literature, such options are mainly addressed through modelling approaches. Techniques for proper and effective mitigation of the impact of stored CO_2 on fresh water resources have been identified. These include: interception and extraction of CO_2 from the plume or brine from the storage reservoir; increase in pressure in formations above the leak; isolation or shut-off of leaks in accessible locations; creation of hydraulic barriers within the reservoir; and treatment of contamination caused by leakage, either in-situ or by 'pump and treat' technologies. Increased monitoring and investigation can also be regarded as an effective mitigation option in some instances.

Formulation of a credible mitigation strategy may form an important element of regulatory requirements for commercial scale storage sites. Also to be noted is that there is currently limited practical experience of CO_2 storage on the industrial scale and knowledge of managing potential impacts is largely theoretical based on modelling studies.

CO_2ReMoVe Closing Conference

29th February 2012 – IFP Energies Nouvelles Rueil-Malmaison, France

CO2 REMOVE
research monitoring verification

The CO_2ReMoVe project has been researching predictive performance assessment and monitoring and verification techniques for CO_2 storage. The project started in March 2006 and is carried out by a consortium of research, industrial and service organisations, all with extensive experience in the geological storage of CO_2. Over the last five years the consortium has had the opportunity to integrate their experience at both industrial- and pilot-scale geological storage sites aimed at testing specific technologies and methodologies.

The project is now in its 6th and final year and the consortium is pleased to invite you to the final conference where the results will be presented. The conference will give you new and in many cases unpublished insights into the performance of actual CO_2 storage projects, give results of new monitoring and performance assessment techniques, and explain how the results are used in the European regulatory processes.

Storage sites studied by the CO_2ReMoVe project

The CO_2ReMoVe research partners have had direct access to actual data from all the world's large-scale storage sites plus a number of pilot-scale projects.

In Salah is the world's first onshore industrial-scale CO_2 storage site. CO_2 injection started in 2004, at a rate of about 0.9 Mt per year. Key performance issues relate to pressure evolution, fracture enhanced fluid flow and topseal integrity.

Sleipner is the world's first CO_2 injection project aimed at emissions mitigation. The Sleipner CO_2 storage operation commenced in 1996, and remains the world's most mature large-scale demonstration of storage technology with around 13 Mt of CO_2 currently stored. Key performance issues relate to plume migration and detailed reservoir flow processes.

Snøhvit injection commenced in 2008 into a deep saline aquifer beneath the Snøhvit gasfield. Key performance issues are pressure control and reservoir heterogeneity.

Ketzin is a pilot-scale project injecting into a relatively shallow saline aquifer (around 600 m depth). Ketzin has a very comprehensive monitoring programme and the key issue is performance prediction and reservoir heterogeneity.

K12-B is a pilot-scale project, injecting into a depleted gasfield at great depth (>3500 m), beneath a secure salt seal. Well integrity and injection performance are the key issues.

Kaniow is a pilot site for CO_2 storage in coal seams. The site now provides a valuable opportunity to monitor the post-injection phase of storage evolution.

Weyburn, Canada; A large-scale EOR project in an oilfield near Weyburn, Saskatchewan, using CO_2 captured from a coal gasification power plant. Injection started in 2000 with more than 16 Mt of CO_2 now stored. Surface monitoring for leakage integrity is a key issue.

The scope of CO_2ReMoVe is immense with its wide range of site geology, injection strategies and settings giving unrivalled opportunity to compare and test different performance prediction and MMV technologies.

Who should attend?
As a researcher, policymaker or industry representative, you should attend this conference if you would like access to the cutting-edge in geological CO_2 storage research results, storage demonstrations and regulatory development on CO_2 storage in Europe and abroad. You should attend this conference if you would like the opportunity to network with the researchers who develop and test monitoring techniques and performance and risk assessment tools for CO_2 storage and if you are interested in learning what the CO_2ReMoVe research project can do for you.


In Salah - the world's first onshore industrial-scale CO_2 storage site


K12-B pilot-scale project

CO_2ReMoVe is funded by the EC 6th Framework Programme and by industry partners Statoil, BP, Schlumberger, ConocoPhillips, ExxonMobil, Total, DNV, Vector, Vattenfall and Wintershall. R&D partners are BGR, BGS, BRGM, CMI, DNV, ECN, GFZ, GEUS, IEAGHG, IFP, Imperial College, MEERIPAS, OGS, TNO, URS, Quintessa, Schlumberger SINTEF, Total and Vattenfall R&D. Three R&D institutes outside Europe participate in CO_2ReMoVe: CSIR from South Africa, UNDLP from Argentine and ISM from India. For more information please go to the website (http://www.co2remove.eu/) where you can read our new blog page or contact the project coordinator Ton Wildenborg (e-mail ton.wildenborg@tno.nl tel. + 31 30 256 4636).

For further information about the closing conference please contact Karen Kirk, Tel: +44 (0)115 936 3013,
Email: klsh@bgs.ac.uk ●

Suppliers Chosen for Technology Qualif

Courtesy of Helle Brit Mostad and Statoil, initially publish

Gassnova and Statoil have chosen suppliers of CO_2 capture technology to participate in a technology qualification program for full-scale CO_2 capture at Mongstad (CCM).

In late Spring, the CCM project announced a technology qualification program for all companies which have technology that could be used to capture CO_2 from the existing combined heat and power plant at Mongstad.

This was an open international process where the goal was to select companies for technology qualification for full scale capture of CO_2.

The following companies have been selected to participate in the technology qualification program: Mitsubishi Heavy Industries, LTD., ALSTOM Carbon Capture GmbH, Siemens AG, Aker Clean Carbon and Huaneng-CERI Powerspan Joint Venture. The purpose of the technology qualification program is to qualify at least one technology and demonstrate that it can be scaled up and used at the combined heat and power plant at Mongstad, and that it will meet all HSE requirements.

"CO_2 capture, transportation and storage is unquestionably required to combat climate change. Norway has undertaken an important role, and succeeding with the Mongstad project and the technology qualification program is vital in this context. We are therefore very pleased with the participation from internationally leading technology suppliers representing different capture technologies. We are looking forward to work together with them", says Bjørn-Erik Haugan, CEO of Gassnova SF.

The technology qualification program is divided into three phases:

- Feasibility study to show that the technology can be used at Mongstad. Companies must demonstrate that technologies can be scaled up; that they have the necessary operational regularity; and that high capture ratios are possible to achieve in relation to energy use and costs, for example.
- Demonstrate that the process will work and that the emissions will be within the specified criteria. This shall include vendors' test of chemical and process technology so that real emission data can be analysed and evaluated based on the limit set for release at Mongstad.
- Concept Phase for design of full scale CO_2 capture at Mongstad.

"CCM is a very large industrial and technological development project, and a plant of similar size has never been built before. For Statoil, it is very important that the system works as intended and does not represent any danger to people or the environment. For CO_2 capture technology in general, it is also important that the project shows that CCS can be accomplished elsewhere: therefore

ication at Mongstad CO_2 Capture Project

ed 8th November on www.statoil.com,

it is of great importance that there is a responsible project implementation that takes care of uncertainties in the best possible way, ensuring the best technical solutions at the lowest possible cost. We are very pleased to announce several leading technology vendors, as well as a thorough technology qualification program," says Kurt Georgsen, vice president in Renewable Energy and responsible for CCM.

Successful results in the technology qualification program should allow for a concept selection including selection of technology in first half of 2014.

Participation in the technology qualification program will provide technology suppliers with an opportunity to demonstrate its technology for a full-scale plant at Mongstad.

Multiple vendors can bid on a FEED (Front End Engineering and Design) based on the concept selected, and the final investment decision will be put forth to the Parliament in 2016.

UK Government Reaffirms Commitment to CCS,

Department of Energy & Climate Change (DECC), UK Government

Press Notice: 11/084
19th October 2011

The Government today announced the next steps on the Carbon Capture and Storage (CCS) demonstration programme, after the conclusion of negotiations for a CCS demonstration project at Longannet in Scotland.

A decision has been made not to proceed with Longannet but to pursue other projects with the £1 billion pounds funding made available by the Government. The decision balances the UK's low carbon ambition with the need to ensure taxpayer's money is invested in the most effective way. £1bn will be available for a new process and we are expecting a number of promising bids from both Scotland and England.

Chris Huhne, Secretary of State for Energy and Climate Change said: "CCS is a key technology for the UK's long term energy strategy. A billion pounds is enough to demonstrate this vital new technology in the UK, but it's got to be spent in the most effective way. Despite everyone working extremely hard, we've not been able to reach a satisfactory deal for a project at Longannet at this time, so we've taken the decision to pursue alternative projects."

DEPARTMENT OF ENERGY & CLIMATE CHANGE
Office of Carbon Capture and Storage

The Government's long term vision for CCS deployment together with an industry action plan will be set out when the selection process for further CCS projects is published. Ministers will meet with industry leaders to discuss next steps and lessons learned at the Carbon Capture and Storage Development Forum on Wednesday 2nd November.

Learning to Live with Fossil Fuels,

by, Carmen Dybwad, IPAC-CO2

The Institute for Sustainable Energy, Environment and Economy (ISEEE) held its first Conference on the Assessment of Future Energy Systems (CAFÉS) in Calgary last week.

It was an excellent, thought provoking, and exceedingly relevant conference that convened many of the world's leading thinkers on energy systems and how they transform.

One theme that seemed to surface in many of the presentations on transitioning to a sustainable energy system was the need to shift our focus on energy away from supply source (the fuel) toward the services that energy provides. In other words, the demand side. As one presenter stated, people want the energy, they do not "want" per se the fuel. But "wanting" a fuel is different than accepting that you need it.

Such is the case with fossil fuels. Due to the length of time it takes to complete and energy system transformation, we will continue to "need" fossil fuels for some time to come.

The results of our Saskatchewan Survey appear to support this view. Concentrating on responses from the Southeast region of the province where the generating stations are located, and knowledge of CCS (the Weyburn-Midale Project is situated here) is greatest, it is not surprising that the majority of residents know that most of the province's electricity comes from coal.

What is surprising is that, like respondents from the other parts of the province, they rank solar (95%), wind (95%), hydro (90%), and natural gas (87%) over coal (66%) when asked what energy source they favour. However, when asked if they believe that fossil fuels will still be used after 2050 for electricity production the majority (77%) agreed.


Carmen Dybwad, IPAC-CO2

What is of important for the CCS community to know is that residents in Southeast Saskatchewan agreed (72%) that capturing and storing CO_2 should be compulsory when building a new coal-fired power plant.

We may still need fossil fuels well into the future, but it is clear that we will need to be responsible in their use; this from some of the world's most fossil fuel/CCS savvy residents.

IEAGHG to Establish CCS Themed Blog,
by Toby Aiken, IEAGHG

In order to keep up with the 21st century, IEAGHG have been developing their social media presence for some time now, with a Facebook page, Twitter feed and monitoring discussions on LinkedIn.

The next stage in this process is to establish a blog on the IEAGHG website. Planning for this has been ongoing for some time now, and we are now in a position to launch this activity. We will shortly be adding the blog to the www.ieaghg.org website, and it will feature blogs from IEAGHG staff, researchers from around the world, and will cover subjects as diverse as the activities we take part in, from research networks to technical studies, international conferences to small workshops. Any topic that deserves attention and discussion can be included, and we would like to hear from anyone who would like to suggest possible topics, or who would like to contribute. All blog entries will be moderated by the Communications Team at IEAGHG for content, and appropriateness, but we would strongly encourage participation and discussion of the topics covered.

The blog will hopefully be up and running within the next month or so, and anyone wishing to contribute or suggest ideas should contact Toby Aiken, Communications & Dissemination Manager on **toby.aiken@ieaghg.org** or +44 (0)1242 680753 extension 209.

Battelle, Midwest Regional Carbon Sequestration Partnership Release Phase II Reports

U.S. Dep't of Energy-funded projects yield critical data in development of technologies to reduce carbon dioxide emissions

The Midwest Regional Carbon Sequestration Partnership (MRCSP), led by Battelle, has completed its Phase II projects to evaluate storage of carbon dioxide (CO_2) in its 9-state region. In addition to the Phase II Final Report, which summarises more than 5 years of research activities, 16 other detailed reports on geologic sequestration field tests, terrestrial sequestration field tests and regional geologic characterization efforts are now available at www.mrcsp.org. Funding for the Phase II effort came primarily from the U.S. DOE. The 2nd largest contributor was the Ohio Coal Development Office and the remainder of funding came from private contributions from some of the other 35-plus members of the MRCSP.

Such validation-scale projects are important because they will assist the development of site-specific monitoring and assessment programs that meet regulatory and public expectations. The Phase II work helped identify both the opportunities and challenges for carbon sequestration and provided direction for future efforts. For example, the geologic mapping and field tests confirmed technical feasibility of geologic carbon sequestration and monitoring in the deep subsurface. The next steps include additional detailed mapping, site characterisation, and testing, as well as larger-scale projects to establish performance certainty needed for long-term operations.

The focus of the overall MRCSP program is to develop a class of technologies called carbon sequestration, which includes capture and storage of carbon dioxide in deep geologic structures such as saline formations, active and depleted oil and gas fields, organic rich shales, and unmineable coal seams. It also includes increasing the storage of carbon in terrestrial ecosystems such as forests, agricultural lands, and wetlands. Carbon sequestration is an important element in an overall strategy to reduce the impact of carbon dioxide from human activities. Other methods used to reduce carbon emissions include increased energy conservation, increasing the efficiency of our energy conversion processes, and deriving more of our energy needs from sustainable or non-carbon sources such as solar, wind, biomass, and nuclear fuels.

The program is being implemented in three phases: Phase I (Characterisation Phase), Phase II (Validation Phase) and Phase III (Development Phase). Phase I began in October 2003 and focused on developing a comprehensive assessment of regional CO_2 sources and potential geological sequestration opportunities within the Midwest region. Building on this foundation, a series of small-scale field validation tests were conducted in the Phase II portion of the program (late 2005 – early 2011). The ongoing Phase III of the program builds on the Phase II successes, with major goals of conducting a larger volume CO_2 injection and monitoring test into a geologic reservoir and continued assessment of CO_2 storage and utilization opportunities in the MRCSP region.

Key achievements and findings of Phase II are summarised below:

- The MRCSP Phase II project exceeded its original goal for validation field tests by successfully completing 3 geologic field tests, one in each of the 3 major geologic provinces of the region, and completing four terrestrial field tests on land types of regional significance.
- The Phase II project involved a significant refinement and increase understanding of the region's geologic storage potential through the collective efforts of the team of geologic experts from each of the region's nine states.
- Refinement of earlier estimates of regional storage capacity in the MRCSP's deep geologic formations further confirmed the potential for storing at least a century's worth of CO_2 emissions from all the region's major CO_2 sources.
- Validation scale field testing conducted at the Phase II Cincinnati Arch site (Duke Energy's East Bend power station in northern Kentucky) demonstrated good injectivity into the Mount Simon Sandstone at a depth of about 3,500 feet. The Mount Simon reservoir has the largest storage capacity in the region and one of the largest potential storage reservoirs in the U.S. This was the first known injection test into the Mount Simon for purposes of qualifying storage potential.
- Validation scale testing into the Bass Islands Formation in Michigan demonstrated the efficacy of carbonates rocks as a potential storage target in the MRCSP region. Previously, such formations were not included in the MRCSP's estimates of regional storage capacity. As a result, carbonates like the Bass Islands, Copper Ridge/Knox Dolomite along Ohio Valley and others are now considered as potential additions

to the MRCSP's estimated storage potential. However, such formations require detailed exploration and geologic framework development due to their heterogeneous nature.

- Validation scale testing into the complex and heterogeneous geological regions like the northern Appalachian Basin (FirstEnergy's R. E. Burger Plant) helped establish familiarity with CO_2 sequestration technologies in the region. It provided important deep well data points in a strategically valuable portion of the MRCSP region that may hold promise for geologic storage, but requires more characterization for mapping and quantification of storage potential.
- The field tests provided opportunities for U.S. EPA Region 4, U.S. EPA Region 5, and Ohio EPA to review and process three permit applications for CO_2 injection and to start building experience for future permit applications. The permit requirements were successfully met and all wells at all three sites have been closed as required.
- The oil and gas industry provides a wealth of experience and sophisticated technologies that can be used for modeling, implementing and monitoring of geologic carbon sequestration facilities. Continued development and testing of monitoring approaches under various field settings is essential to adapt those techniques to the unique needs of long-term carbon storage.
- The Phase II geologic characterisation work further underscored opportunities for enhanced oil recovery and storage in the region. Further study would provide a greater understanding of how to optimize production and storage operations, as well as staging of CO_2 sources. In the near-term, monitoring and assessment of enhanced oil recovery projects in depleted oil fields can serve as a cost-effective bridge towards carbon dioxide storage in deep saline formations.
- Terrestrial sequestration was confirmed as a valuable sequestration resource for the MRCSP region with the biophysical potential to sequester approximately 15% of the region's annual CO_2 emissions from large-point sources for a period of time, if deployed at full-scale.
- It is critical to engage the public, legislature, regulators, and industry in project implementation and in sharing the results of the research. These audiences areconcerned about the safety, reliability, and cost effectiveness of this technology. The MRCSP team found that it was important to develop relationships with community leaders and to work with local groups both to assess concerns and develop productive outreach efforts. Much of this work was achieved in collaboration with the companies hosting the research projects on their property.

The MRCSP program leadership and validation-scale geologic field tests were conducted by Battelle's Carbon Management team in Columbus with support from team members from Pacific Northwest National Laboratory, which is managed by Battelle for the DOE. The field tests were made possible through facilities and site support provided by FirstEnergy, Duke Energy, DTE Energy, and Core Energy, LLC. The terrestrial sequestration field tests were carried out by research partners Ohio State University, West Virginia University, University of Maryland, and the New Jersey Department of Environmental Protection with Rutgers University. The regional mapping and delineation of geologic sequestration potential was led by Ohio Division Geological Survey and a team of geological experts from each of the nine MRCSP states including Kentucky Geological Survey-University of Kentucky, Indiana Geological Survey, Maryland Geological Survey, New Jersey Geological Survey, New York State Museum Institute, Pennsylvania Geological Survey, Rutgers University, West Virginia Geological Survey, and Michigan Geological Survey - Western Michigan University. Collective evidence from these characterization, injection, and monitoring efforts substantiates previous assessments that this nine state region has significant storage potential. The field tests provide confidence that larger scale applications can also be implemented successfully.

About MRSCP

Battelle led efforts to evaluate carbon sequestration in a nine-state region of the Midwestern United States as part of the U.S. DOE's Regional Carbon Sequestration Partnership Program. Member states include: Indiana, Kentucky, Maryland, Michigan, New Jersey, New York, Ohio, Pennsylvania, and West Virginia. With nearly 40 government industry, and university partners, the MRCSP is a public-private collaboration that has become the premier source for knowledge on sequestration technologies within the region.

About Battelle

As the world's largest independent research and development organisation, Battelle provides innovative solutions to the world's most pressing needs through its four global businesses: Laboratory Management; National Security; Health and Life Sciences; and Energy, Environment and Material Sciences. It advances scientific discovery and application by conducting $6.5 billion in global R&D annually through contract research, laboratory management and technology commercialisation. Headquarteredin Columbus, Ohio, Battelle oversees 22,000 employees in more than 130 locations worldwide, including seven national laboratories which

Battelle manages or co-manages for the U.S. Department of Energy and the U.S. Department of Homeland Security and a nuclear energy lab in the United Kingdom.

Battelle also is one of the nation's leading charitable trusts focusing on societal and economic impact and actively supporting and promoting science, technology, engineering and mathematics (STEM) education.

For more information contact Katy Delaney at (614) 424-7208 or delaneyk@battelle.org, or T.R. Massey at (614) 424-5544 or masseytr@battelle.org

Perceptions from a Kiwi, Steve Goldthorpe, IEAGHG

Steve Goldthorpe, IEAGHG

I had been working on Greenhouse Gas R&D for British Coal for about 15 years when I emigrated to New Zealand in 1995. I am grateful for the opportunity to return to the UK for six months this year to join the staff of IEAGHG and once again to play a part in exploring ideas about greenhouse gas emission control and geoengineering, after my experience in other arenas.

It is interesting to see how the body of knowledge has evolved since the early days of the programmme and how the details of CCS concepts are much better defined. However, the basic messages are broadly the same as they were back then, giving me a sense of déjà-vu.

I remember in the early days there was an emphasis on Full Fuel Cycle (FFC) analysis, in which the emissions from fuel processing activities were assessed and added to the fuel combustion emissions. The "backpack" of greenhouse consequences carried by consumer fuels was then considered an important element of looking at the bigger picture issues. I would have thought that, as the production of fossil fuels gets ever more difficult and the backpack accordingly gets heavier, the focus on FFC analysis would have been greater, but it appears to be lessening. Perhaps some of my inputs to the body of knowledge might help to redress that balance.

It was great to be a part of the celebration of 20 years of the IEAGHG programme and I look forward to continuing to contribute to the work of IEAGHG.

News from the IEACCC, Debo Adams, IEACCC

The IEA CCC is currently organising two workshops. The call for papers is now open for both.

The 2nd International Workshop on Cofiring Biomass with Coal

This will be held in Copenhagen, Denmark on 27th-28th March 2012. The two-day event includes a tour of Avedøre power plant. It follows on from the extremely successful 1st Workshop, held at Drax, UK in January 2011.

Increasing the amount of biomass cofired with coal at power plants seems to be a relatively simple way to reduce emissions of CO_2 from power generation. However, cofiring does raise a number of issues, which will be discussed at Copenhagen:

- What happens if higher percentages of biomass are cofired?
- How can the quality of biomass be improved and standardised, by processes such as torrefaction?
- How does increasing the rate of cofiring influence the composition and use of ash?
- What cofiring is actually happening at power plants?
- How is the biomass sourced and certified - what are the sustainability issues?
- What is the future for biomass cofiring?

More information can be found at http://cofiring2.coalconferences.org

IEA CLEAN COAL CENTRE 2nd WORKSHOP

Cofiring biomass with coal

27-28 March 2012

The IEA CCC Workshop on Upgrading and Efficiency Improvement in Coal Fired Plant

This will be held in Melbourne, Australia on 19th - 20th April 2012 immediately following the Second International Industry Symposium on the Sustainable Use of Low Rank Coal, (Melbourne, 16 -18 April 2012). The workshop will bring together the world's experts to identify and share expertise on:

- technical opportunities to improve the thermal efficiency of existing coal-fired plants
- barriers and challenges to these opportunities
- specific initiatives that can increase efficiency substantially.

More information can be found at http://upgrading.coalconferences.org. Three reports have been published recently by the IEA Clean Coal Centre and can be found at our website www.iea-coal.org. The reports cover a range of subjects:

Efficiency and Emissions Monitoring and Reporting, CCC/188, by Lesley Sloss

As concern about emissions and the environmental footprint of energy production grows, it is increasingly evident that more accurate information on emissions of CO_2, SO_2, NO_x and trace pollutants from fossil fuel power plants will be needed. Since the determining factors for these emissions are coal characteristics and power plant efficiency, it is also necessary to be able to assess the performance of a coal plant. Power plant efficiency data are calculated at most plants in developed countries but are often considered commercially sensitive. Accurate information for plants in developing countries is not systematically obtained. There are several different methods available to estimate power plant efficiency and this lack of standardisation is proving a barrier to allowing direct comparison between plants.

This report summarises the techniques and equipment used to determine efficiency and pollutant emissions at coal-fired plants and discusses how the data from these systems are used to comply with the various permits, legislation and action plans that apply to coal-fired power plants in different countries.

Expert Systems and Coal Quality in Power Generation, CCC/186, by Hermine Nalbandian

Coal quality, that is the properties of coal, has an impact on many parts of a power plant including the coal handling facilities, pulverising mills, boiler, air heater, ESP, ash disposal as well as stack emissions. The behaviour of a coal in a boiler is strongly influenced by its rank and by the mineral matter and other impurities associated with it. Coal properties can affect the efficiency, reliability and availability of both the boiler and the emissions control units. Therefore they affect the economics as well as the short- and long-term operation of the plant. Expert systems are used today in many aspects of power generation. Online analysers can show variations in coal quality as they are occurring. However, online analysers can be expensive and their cost-effectiveness depends on the site and application. Despite questions about the accuracy of online analysers being raised, their use in coal mines as well as power plants continues to increase.

Opportunities for fine coal utilisation, CCC/185, by Mark Lewitt

Coal is prepared to meet end-user requirements such as limits on the proportion of fine coal and ash forming minerals in the product. Preparation methods leave residues of fine material which can have a wide range of compositions from a good coal product to very high ash, surface moisture and sulphur contents. Regardless of composition, at the time of generation of these residues no market for them existed and so large amounts (estimated as about 58 Gt) have been deposited around the world in heaps or in slurry impoundments. Changes to the value of coal and developments in coal preparation and utilisation technologies have enabled increasing amounts of these materials to be recovered and used. The report pro-vides an overview of the resource and opportunities for utilisation.

For more information about the workshops and reports visit www.iea-coal.org

IEA CLEAN COAL CENTRE

IEAGHG: 1991-2011, by Kelly Thambimuthu, ExCo Chairman

All those years ago, back in 1991, the Earth Summit was a seminal event organised by the UN which effectively came up with an agenda for the future, simply known as Agenda 21. The premise behind Agenda 21 was that of sustainability for the development of the planet and how the human race should tackle challenges in order to best achieve this. The summit was fairly comprehensive, addressing topics as diverse as protection of the Earth's flora and fauna, global warming and climate change; it was the precursor that started people thinking about the tone of developments around the world, and how these need to change in order to preserve this planet. The IEAGHG was established as a consequence of the lead up to and what happened at that summit, and as such this was the first key milestone in the development of what IEAGHG is today.

IEAGHG was established in 1991 by Jim Harrison, the Director of CRE in British Coal, as a way of responding to the challenges emerging from the Earth Summit for the mitigation of greenhouse gas emissions from the use of fossil fuels. Partnerships were formed under the umbrella of the IEA, with John Topper, also from CRE, being integral to bringing together these partnerships for the formation of IEAGHG as an Implementing Agreement under the International Energy Agency. The foundation members of the programme were 12 countries. These 12 Contracting Parties were joined soon after by RWE and DMT from Germany as sponsor members.

The early years of work, provided a better definition of the CO_2 capture technologies, pulling together the data and knowledge on appropriate capture technologies, storage methods and early opportunities, and life-cycle analyses as well as maintaining parallel work on non-CO_2 greenhouse gases. In the course of carrying out these tasks and in defining processes, the programme coined a lot of terminology that was eventually adopted by the wider international CCS community, such as post-combustion, pre-combustion and Oxyfuel combustion; CO_2 Storage as opposed to disposal, and the use of the term saline reservoirs where storage is mainly targeted rather than aquifers, which avoided the unfounded links with sources of drinking water that most people commonly associate as being sourced from non saline aquifers. Harry Audus who later became the General Manager was largely involved in this process, and these terminologies remained important in setting the standards for adoption by all in the years to come.

In terms of practical R&D and early engagement in R&D, IEAGHG was among the first supporters of the SACCS project in 1995, operated by Statoil at Sleipner, and the programme also provided a collaborative agreement for cooperation in CANMET Energy, Canada's Oxyfuel Combustion Pilot Project. IEAGHG then went on to participate and support in 1998 the Weyburn Project in Canada. The following years were to see the programme became increasingly engaged as events unfolded under the UNFCCC, more involvement with the IEA in Paris, and with the UNFCCC's own activities.

The dawn of 1998 also saw the programme organise a conference on 'Activities Implemented Jointly' in Vancouver, which addressed cooperation among nations on greenhouse gas mitigation

Kelly Thambimuthu, ExCo Chariman

technologies in the lead up to COP-3 held in Kyoto. The outcomes from this Kyoto meeting were to prove seminal in countries taking on commitments to mitigate their emissions, and there was more interest in CCS as a technology option from this point.

This was followed by our participation in the establishment of the Zero Emission Technology Platform at COP-8 in Delhi, and I was part of the IEA delegation that launched this activity. The lead up to this event was instrumental in gaining the attention of the convention and of the Intergovernmental Panel on Climate Change (IPCC) which led to an invitation for myself and the project director of the time, Paul Freund, to organise a fact-finding workshop to determine whether an in depth evaluation of CCS was warranted. The workshop was organised in conjunction with the Government of Canada in Regina with the assistance of Malcolm Wilson. The workshop proved successful in convincing the IPCC that an in depth report was required, and many IEAGHG members and staff were subsequently engaged in the writing of the IPCC Special Report on CCS that was published in 2005. Paul Freund, John Gale and myself played leading roles as Contributing Lead Authors in the writing of 3 chapters of this report and John

Davison, Olav Karstad, Malcolm Wilson and many others from our membership contributing as lead authors. All were subsequently recognised for their contributions in winning the IPCC's Nobel Peace Prize in 2007. The IPCC Special Report on CCS led to the adoption of CCS as a recognised climate change mitigation technology at COP-11 in Montreal.

The IPCC report highlighted the apparent lack of published data world-wide on CCS, most of that which was available originated from IEAGHG, and so this led to the establishment of the International Journal of Greenhouse Gas Control (IJGGC) by Elsevier, with our current General Manager John Gale serving as both the founding and current Editor-in-Chief.

From the early days of inception we also started our own conference series which subsequently merged with another ongoing conference series that preceded us to form the GHGT conference series that continues under our stewardship. Together with the IJGGC journal the conference series now provides a very credible and premier global source of information on technologies for GHG mitigation.

In the midst of these activities and interests as the world increasingly embraced CCS, we more recently extended our activities covering our establishment of several international research networks, two new conference series on post combustion and oxyfuel combustion capture, participation in the activities of the G8 Clean Energy Initiative, capacity building in the form of an International CCS Summer School series, and participation in a number of workshops throughout Africa just to name a few.

IEAGHG: 20 Years of Evolution, by John Gale, IEAGHG

Twenty years is not a long timeframe in the cycle of evolution, but 20 years has seen considerable change in IEAGHG for instance in terms of the membership and the way it operates. It is probably correct to say that when the IEAGHG was started in 1991 nobody envisaged it would be still operating after 20 years. The first Executive Committee meeting was held in January 1992 and comprised 26 people. Now the Executive Committee meetings often comprises of 70 or more delegates.

As membership has grown so has the work programme to meet member's needs. In the beginning, IEAGHG had 3 staff, all engineers drawn from the coal Research of British Coal. Now we have 16 staff on board, with a range of scientific disciplines that reflect the interdisciplinary nature of CCS, such as chemical engineers, geologists, geophysicists etc.,

Techno-economic evaluations and Practical R,D&D activities have long been a large part of our work, as described by Kelly Thambimuthu above, but our work on facilitating implementation started in mid 2000 mostly looking at barriers to technology development and ways to overcome them. Mostly now we concentrate on providing "evidence based" information to groups like the UNFCCC, IMO, OSPAR, and this is an area where we have been putting in considerable effort in the last few years to ensure CCS was included in the major international treaties and helping to support the development of regulations on CCS in regions like Europe by providing technical information to underpin the regulations. In 2002 it was recognised that there would likely be a human capacity shortage if CCS were to be deployed at the scales suggested by the IEA CCS roadmap. To help offset that perceived shortage we set up the summer school series the first being at Kloster Seeon in Germany in 2007. Since then we have undertaken annual CCS summer schools. The last held in Illinois, USA, taking the total alumni to 280 students from over 32 countries. One of the key deliverables from the schools is that the students build up a list of contacts in both developed and developing countries that should be useful to them in their future careers in what we hope will become a global business.

The IEAGHG has always recognised that communicating the results of our work and others is a necessity. We established the first newsletter for the CCS sector, called Greenhouse Issues in November 1991. The newsletter, now called Greenhouse News, continues to be well received and now has a mainly electronic distribution of around 6500 in 98 countries. Of course the GHGT conference has gone from strength to strength, from 400 attendees at GHGT-4 in Interlaken in 2000 the first of the merged series, we had 1670 attendees at the last conference in Amsterdam in 2010 (GHGT-10). Over the years the conference has established itself as the premier international technical conference on CCS.


John Gale, IEAGHG

The Future of IEAGHG

Whilst the IEAGHG 20th Anniversary Book charts IEAGHG's progress since our inception in 1991, this is not the end of our story. We have applied for and recently received from the IEA Working Party on Fossil Fuels their endorsement to extend the Implementing Agreement for a further 5 years. We believe there is much work still to be done, not just in the next 5 years. We believe everybody now recognises that we are drifting off target in terms of reducing greenhouse gas emissions to stabilise the atmospheric CO_2 concentration at 450 ppm. This only means that we must work harder in the coming years.

We are seeing a changing dynamic in use of fossil fuels for power generation. Developments in unconventional gas exploitation are increasing the market potential and longevity of supplies of natural gas. With the increased efficiency of natural gas fired power plants compared to coal there are advantages in reducing CO_2 emissions. However the use of natural gas in power generation is not sufficient on its own to reduce the atmospheric concentrations of CO_2 to achieve stabilisation and thus CCS will be required as well. Of course coal in many developing countries will still play a key role. Also biomass use for fuel production, power etc., if CCS is added has the potential to remove CO_2 from the atmosphere, which could play a role in closing the gap on where we are now to where we need to get to in terms of atmospheric stabilisation.

In the next 5 years we of course are expectant that we will see a number of demonstration projects breaking ground and starting to operate. This will in turn generate lots of new data on costs, operating efficiency etc., that should help boost

the confidence in the technology. A boost in confidence is something that CCS surely needs in the next few years to hopefully allow the industry to try and regain some of its early optimism. We do have a mountain to climb in terms of stakeholder acceptance; scepticism on climate change seems to be building so politicians need to reinforce the message that doing nothing costs more. Concerns by some local communities on the safety of storage are still present and these are having impacts on Government thinking and the ability to get projects off the ground in some countries. Equally as we know more about the technology we are finding issues we had not considered before, such an issue is amine degradation products but we must rapidly address such issues and maintain research in perspective so that we do not damn a technology on unsubstantiated science.

We are aware that we have more competition these days, but we manage that by ensuring what we do is either novel or brings added value to the other groups that are active. In terms of our membership we want to continue to grow and bring in new members from Non-OECD countries as appropriate. New membership must of course not be at the expense of our old members and in the current economic times we need to ensure we retain our existing membership block that has underpinned our growth so far.

We wish to thank all our members, and associated organisations that we work with for your support to date and we look forward to working with you in the future. We will look forward to providing a summary of our achievements at our 25th Anniversary in 2016.

Conferences & Meetings

This is a list of the key meetings IEAGHG are holding or contributing to throughout 2012. 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.

CO_2REMOVE Closing Conference
29th February 2012; Rueil-Malmaison, France

3rd Social Research Network
12th - 13th April 2012; Brisbane, Australia

7th CO_2GeoNet Open Forum and CGS Europe Workshop
17th - 19th April 2012; Venice, Italy

11th Annual Carbon Cature Utilisation and Sequestration Conference
30th April - 3rd May 2012; Pittsburgh, USA

4th Carbon Capture and Storage Summit
16th - 17th May 2012; Düsseldorf, Germany

2nd Joint Network Meeting
18th - 20th June 2012; Santa Fe, NM, USA

GHGT-11
18th - 22nd November 2012; Kyoto, Japan

Greenhouse News
ISSN 2047-220X (Print)
ISSN 2047-2218 (Online)

Greenhouse News 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 News 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 :

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