Greenhouse News

• the official newsletter of IEAGHG and its members •

March 2011 • Issue 101

Staff Vacancies at IEAGHG

IEAGHG is looking to recruit one/two new full time team members to support our activities on CO_2 Capture and Integrated Systems Analysis. We are looking for well organised, enthusiastic individuals to join and compliment the existing IEAGHG team, which is based in our offices in Cheltenham, UK.

Our activities on capture and integrated systems are varied. These can include; technical evaluations on new capture options, assessment of transport system options, assessment of system integration issues and operational flexibility, reviews/ status reports on capture technology options, techno-economic analyses, and environmental impacts. In addition we organise three conference/network series on post combustion capture, oxyfuel and solid looping which are used to keep our members abreast of new developments and highlight areas for future study by IEAGHG. Whilst much of the focus of our activities is on CO_2 capture and storage (CCS), there is also a need to be aware of and to evaluate other technical options for greenhouse gas mitigation.

The successful candidates will be required to write clear and authoritative reports on all aspects of greenhouse gas mitigation and CCS. The successful candidates should be self-motivated, with the ability to work within a team of qualified and experienced engineers, technologists and scientists. The appointees should have an excellent command of written and spoken English, and the ability to communicate effectively with the members of IEAGHG in terms of gathering and disseminating information at meetings and conferences. Knowledge of other languages would be an advantage.

A competitive salary will be offered, and it is expected that the successful candidate(s) will be educated to degree or post-graduate standard in an appropriate engineering, environmental or earth sciences subject with relevant background in industry or in a research position. The positions available could suit a new graduate or someone with industry experience who is looking for a career change or new challenge.

More information on IEAGHG can be found at www.ieaghg.org.

If you think working at IEAGHG is of interest to you, send a letter outlining what you think you would bring to the team and a CV to: John Gale, General Manager, IEAGHG, Orchard Business Centre, Stoke Orchard, Cheltenham, Gloucestershire, GL52 7RZ, UK or email john.gale@ieaghg.org

Anybody requiring further information should contact the General Manager by email at the address shown above. The closing date for applications will be the Friday 29th April 2011.

In this issue

Hendry: Excellent response to EU funding call for CCS and innovative renewables (Press notice)


Energy Minister, Charles Hendry

17th February 2011
DECC Press Notice: 2011/013

An impressive total of 14 UK projects have applied for funding from the EU's New Entrant Reserve (NER) scheme – a fund worth between EUR4.5 billion and EUR9 billion to support carbon capture and storage (CCS) and innovative renewable projects across the European Union.

Energy Minister Charles Hendry said: "The strong level of interest received for CCS projects in particular is heartening – it shows that UK industry is keen to move forward in the development of CCS and confirms the lead that the UK is taking in this critical technology.

"The commitment this Government has shown for CCS is world-leading and it is encouraging to see that UK industry matches this ambition. Cleaner fossil fuel technologies present a huge opportunity for the UK and could potentially support up to 100,000 jobs in the country by 2030."

The Energy Minister also noted the strong interest in marine energy technologies.

Of the 14 applications received, nine were for CCS projects and five for innovative renewables.

Of the nine CCS applications:

- three are based in Scotland, six in England – with four in the Humber and two in the Teeside regions;
- seven are to capture CO_2 from coal-fired power stations and two are to capture the emissions from gas-fired plants;
- two are retrofits to existing power stations, and the other seven are new power plants providing vital additional energy supply capacity; and
- five are for pre-combustion technology, three for post-combustion and one is for Oxyfuel.

Of the five innovative renewable applications:

- three are tidal stream projects based in Scotland;
- one is a wave project based in Scotland; and
- one is an offshore wind project based in the North East of England.

The Government has until the 9th May this year to assess the applications against the NER and UK criteria and decide which to put forward to the European Investment Bank for further consideration.

Given the significant progress expected on CCS in 2011 the Government has decided to publish the CCS Roadmap in the Autumn rather than the Spring as originally planned. This is to ensure that we capture all the lessons learnt from the Electricity Market Reform consultation, completing the Front End Engineering Design studies for the first demonstration project, finalising our approach to three further demonstrations, as well as assessing the nine projects applying for NER funding.

Applications of CCS in Finland,
by Sebastian Teir and Antti Arasto, VTT

Sebastian Teir, Janne Kärki, Tiina Koljonen, Antti Arasto, Eemeli Tsupari, (VTT Technical Research Centre of Finland)
Lauri Kujanpää, Antti Lehtilä, Matti Nieminen (VTT Technical Research Centre of Finland)
Soile Aatos (Geological Survey of Finland)

The possibility to apply CCS in Finnish conditions has been assessed by VTT Technical Research Centre of Finland and the Geological Survey of Finland (GTK) in a three year long project (CCS Finland, 2008-2011), coordinated by VTT. The costs and the potential for reducing CO_2 emissions using CCS have been studied both on a national energy system level and on an application level by process modelling of a few example facilities. In addition, Finnish carbon dioxide point sources have been mapped and the geological prerequisites for storage of CO_2 have been assessed.

The project ended in February 2011 and two reports are in press (both in Finnish): one CCS state-of-the-art review and one summary report of the conclusions from the project. The project had a total budget of 1.4 M€. It was financed by Tekes (the Finnish Funding Agency for Technology and Innovation) and Fortum, Foster Wheeler Energy, Metso Power, Pohjolan Voima, Ruukki, and Vapo.

As an EU member state Finland follows the greenhouse gas emission (GHG) reduction targets set for Finland and EU. According to the national climate and energy strategy the main methods for emission reductions in the near future are based on improving energy efficiency, and expanding the use of nuclear power, wind power and biomass fuels. The long-term target is an 80% reduction in GHG emissions by 2050. The results from the project indicate that if such significant emission reductions are pursued, CCS may have a significant role in achieving this target also in Finland.

According to the detailed energy system analysis performed in the project, Finland's GHG emissions could be reduced by 80% by 2050, but it would require that the price for emission allowance rights rise from its present level to 70–90 euro per tonne carbon dioxide by 2050. Using CCS technology Finnish carbon dioxide emissions could be reduced by 10–30 % or 6–20 Mt/a CO_2 by 2050, which could be achieved by applying CCS to a few large facilities. For instance, the 14 largest facilities in the Finnish emission trading registry accounted for 19 Mt CO_2 in 2008, which was half of the total sum of emissions from the 600 facilities in the registry. The largest CO_2 emitting plants in Finland are power plants, steel plants and oil refineries (Figure 1 and Figure 2). Finland has also significant, large point sources of biogenic CO_2 (Figure 2). This originates mostly from large pulp and paper mills but also from co-firing of biomass in power plants. This makes bio-CCS a particularly interesting option for Finland. Currently, however, there are no incentives for capturing biogenic CO_2 emissions, since the EU emission trading scheme does not apply to biogenic CO_2.

Application of CCS demands large investments in additional equipment for CO_2 separation, purification and pressurisation, and requires a lot of additional energy. In this project, process modelling and techno-economic assessment were performed for three fictive CCS applications set to start up in 2015. The results

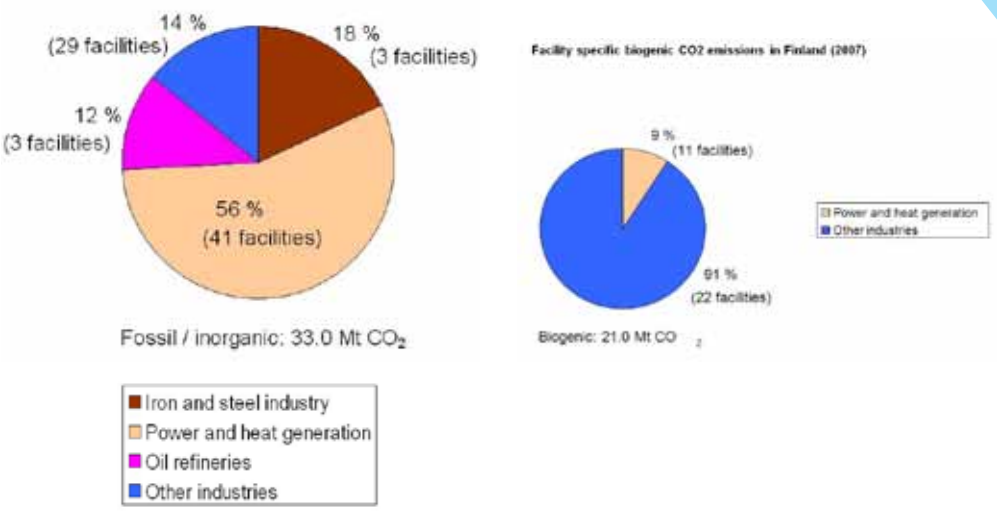

Figure 1: CO_2 emissions from the 76 largest facilities (each emitting >0.1 Mt CO_2/a) in Finland, categorised according to industrial activity (data for year 2008).

showed that the costs for CCS were heavily dependent not only on the characteristics of the facility and the operational environment but also on the chosen system boundaries and assumptions. The cost for avoided CO_2 emissions were typically around 70–100 €/t. In certain applications, such as industrial applications and combined heat and power plants, significant improvements can be achieved with heat integration, for instance, in the production of district heat. The feasibility can also be optimised by using the new operational options that CCS brings. For instance, CO_2 capture could be bypassed during periods of peak electricity prices.

The largest uncertainties with CCS are related to storage of CO_2, such as verification of storage capacity and permanence but also public acceptance. The bedrock of Finland does not enable permanent storage of captured carbon dioxide, making cross-border transportation a requirement for applying CCS in Finland. The closest possible offshore storage formations are located in the Barents Sea, North Sea and southern Baltic Sea, while the closest possible onshore storage formations are located in the northern area of Poland and Germany, as well as southern Denmark. Most of the largest Finnish CO_2 point sources are located in close vicinity of the coast line, which enables transportation of CO_2 by ship. A detailed cost assessment of the transportation costs were performed, which showed that ship transportation of CO_2 is more economic for amounts under 10 Mt/a CO_2. Due to the large distances to a storage site (about 1500-2500 km) the CO_2 transportation costs for CCS applications in Finland are larger than those typically mentioned in literature: the total costs for CO_2 transportation by ship were in the range of 10 – 20 €/CO_2.

Since the Meri-Pori CCS demonstration project was cancelled, it is likely that there will be no large-scale CCS application in Finland before year 2020. The first commercial CCS applications in Finland would probably arise in fuel refineries, since this industry already has existing experience with separation of CO_2 for commercial use. Upcoming biomass-to-liquid (BtL) production plants are very potential first CCS applications in Finland, since relatively pure CO_2 is a by-product from these refineries, making CCS considerably cheaper to apply. In the near future more power plants are expected to be built in

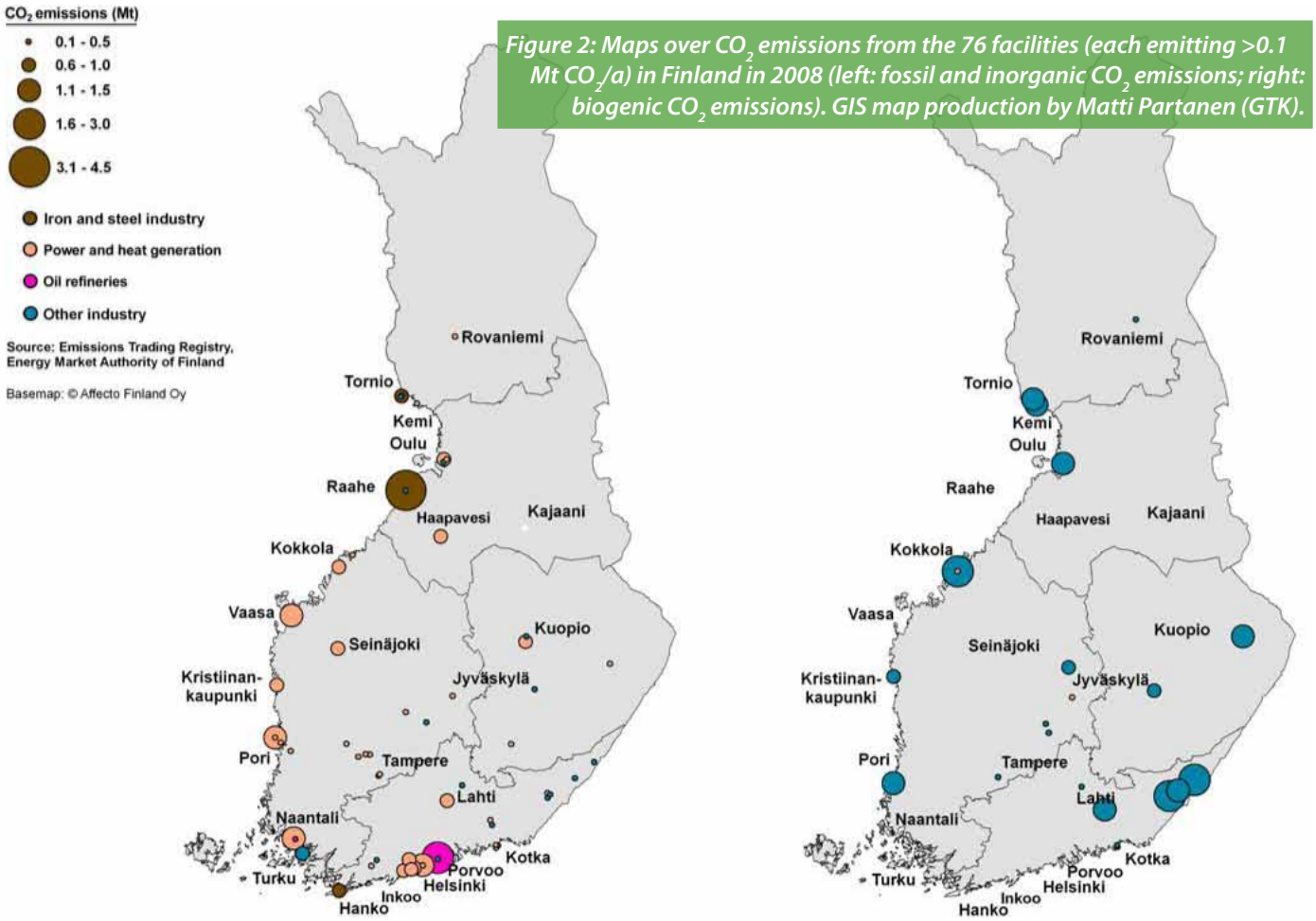

Figure 2: Maps over CO_2 emissions from the 76 facilities (each emitting >0.1 Mt CO_2/a) in Finland in 2008 (left: fossil and inorganic CO_2 emissions; right: biogenic CO_2 emissions). GIS map production by Matti Partanen (GTK).

Finland, which opens up the possibility for CCS or at least CCS-readiness for the plants. In particular, large new combined heat and power (CHP) plants, which can burn coal, biomass or peat, appear to be promising candidates for CCS.

In summary, there is use for CCS also in Finland if large (80-90%) GHG emission reductions are required by 2050. For many industrial facilities, such as steel plants, oil refineries, cement plants and lime kilns, CCS is one of the few options for achieving significant CO_2 emission reductions. High prices of emission allowances would raise the production costs and possibly weaken the industry's ability to compete on the international market. With the application of CCS this financial burden could somewhat be reduced. However, there are fewer and less developed methods for applying carbon capture in industrial processes than in power plants. Technology development is obviously needed for improving the energy efficiency and feasibility of the capture process. Oxy-fuel combustion is seen as a promising technology for Finland, both in terms of domestic CCS applications and as an opportunity for Finnish technology developers. The most important prerequisite for the commercialisation of CCS technologies, and most other climate change mitigating technologies as well, is a binding global climate agreement. Commercialisation can be accelerated by developing and demonstrating the technology, but the economical prerequisites arise from an international mutual understanding and a climate agreement.

The research on CCS in Finland is planned to continue in a five year research programme (2011-2015) of the Finnish Cluster for Energy and Environment (CLEEN Oy), called CCSP. This 20 M€ research programme, which has applied for funding from Tekes, is bringing together professionals from the world leading technology and application providers, research institutes, potential users of the technologies and consultants for concept development.

Major contributors to the research program are among others Fortum, Foster Wheeler, Rautaruukki, Neste Oil and Helsinki Energy complemented by VTT and the other leading Finnish research institutes. The research is focused on integrating the CCS technology to the Finnish expertise on energy and environment, such as CCS in connection to Combined Heat and Power production, advanced oxyfuel combustion based on Chemical Looping Combustion and CCS in biomass based energy conversion processes. ●

CCS Regulatory Test Toolkit Launched,

by Kristina Stefanova, GCCSI

The Global CCS Institute's latest publication, a CCS Regulatory Test Toolkit, seeks to ensure best practice in developing regulations and permitting processes around CCS projects providing a valuable blueprint for governments seeking to roll out the technology.

As part of its role to accelerate the commercial deployment of CCS globally, the Institute commissioned the toolkit, which was produced by the University of Edinburgh on behalf of the Scottish Government.

Implementing the toolkit will assist governments, regulators, and industry to work quickly together to map, test and understand national regulatory processes for carbon capture and storage projects.

This includes:

- Who needs to be involved
- What resources are required
- What permits are required;
- What information and analysis is required;
- What the consents timelines are likely to be; and
- How to follow-up on lessons learned.

It guides users through a regulatory test exercise, which provides a low-cost, low-risk approach to testing regional and national legislation and regulatory systems for CCS projects, gaining the benefits in follow-up activities. This will identify opportunities for process improvement as well as any gaps in knowledge, legislation or procedures.

The toolkit has been endorsed by the European Union, which through its CCS Demonstration Project Network will encourage member states to use the tool to test their domestic regulatory regimes. Romania has expressed interest in using the toolkit to test rules around its demonstration project.

"This toolkit reflects the growing global commitment to CCS and will help jurisdictions around the world deploy this leading-edge technology," said Ron Liepert, Energy Minister for the Province of Alberta, Canada. "We've heard time and time again from experts around the globe that this technology is a safe and effective way to reduce CO_2 emissions in the atmosphere."

Bob Pegler, General Manager – Europe of the Institute said the release of the toolkit marks a significant step in the Institute's efforts to share knowledge and best practice globally.

"The toolkit is a very practical, much needed tool for governments implementing CCS," he said.

"It can help governments easily and effectively test the adequacy of their regulatory regimes, ensuring that CO_2 transported with minimal disruption to communities and that it is safely and securely store underground. It's a good tool for coordination and testing the interdependence of numerous CCS regulatory processes."

The toolkit builds on a 'dry-run' regulatory simulation of a hypothetical CCS project run in Scotland in August 2010, which brought together regulatory agencies, project developers, public interest groups and others including the Institute.

"This is an example of the kind of practical tools and solutions the Institute provides for the CCS community – be it projects in their effort to deploy quickly, or governments trying to work out best policy and regulatory options," said Pegler.

Scottish Energy Minister Jim Mather said that Scotland is a leader in CCS, the country was a natural choice for developing the tool.

"The Scottish Government used a mock CCS project to test our own regulations and identify any streamlining opportunities and challenges that lie ahead," Mather said. "It is therefore appropriate that we have taken the lead in sharing this experience with other nations and regions."

He added: "This blueprint will now be rolled out across the globe to equip governments, regulators and developers with the knowledge they need to be confident that CCS applications are processed efficiently and in accordance with the relevant planning and environmental obligations."

Click here to see the full toolkit. http://globalccsinstitute.com/CCSRegToolkit

Malaysia Takes Next Step On CCS, by Kristina Stefanova, GCCSI

The end of January saw the completion of a scoping study on CCS in Malaysia, which was officially handed to the Ministry of Energy, Green Technology & Water Malaysia (KETTHA) in Kuala Lumpur.

The study was undertaken over a period of six months under a partnership between KETTHA, the Global CCS Institute and the Clinton Climate Initiative (CCI) as well as other relevant Malaysian government and industry stakeholders.

At the handover ceremony, Minister Dato' Sri Peter Chin thanked the Institute and CCI for their strong support and cooperation with Malaysia. Since joining the Institute as a Legal Member, Malaysia has benefited in a number of ways, including through support of this study and various capacity building initiatives, he said.

The Minister stated that the scoping study would help chart the future of CCS in Malaysia, noting that it is one of the key technologies which will help the country in achieving its commitment to cut carbon intensity by 40 per cent in 2020 based on 2005 levels.

KETTHA will now plan for CCS implementation in Malaysia, starting with the establishment of a multi-stakeholder steering committee to consider the recommendations of the study.

"We are pleased to have completed this important piece of work for the Malaysian Government, which has shown keen interest in exploring CCS as a climate mitigation tool," said Peter Grubnic, the Institute's General Manager – Projects, Financial and Commercial, who attended the handover ceremony.

"Taking this kind of work forward will ensure that the world can reduce its greenhouse gas emissions. It also places Malaysia in a leadership position in terms of seeking sustainable and effective ways of achieving those targets domestically."

The scoping study focused on the long-term role for CCS in Malaysia's energy and industrial future, opportunities for near-term deployment, technical and financial feasibility, and next steps for further investigation. Key findings include:

- the opportunity to reduce significant volumes of carbon dioxide emitted by Malaysian point sources using CCS technologies; and
- that CCS can reduce emissions directly from the power, oil and gas, and industrial sectors in Malaysia.

Ira Magaziner, Chairman of the CCI, said: "I am pleased that CCI has been able to support the Malaysian Government's work in this globally significant field, and we look forward to continuing to assist in the implementation of the recommendations."

DOE Releases Third Carbon Sequestration Atlas,

US DOE News Alert

There could be as many as 5,700 years of carbon dioxide (CO_2) storage potential available in geologic formations in the United States and portions of Canada, according to the latest edition of the U.S. Department of Energy's (DOE) Carbon Sequestration Atlas (Atlas III). The updated preliminary estimate, based on current emission rates, documents 1,800 billion to more than 20,000 billion metric tons of CO_2 storage potential in saline formations, oil and gas reservoirs, and unmineable coal areas. This suggests the availability of approximately 500-to-5,700 years of CO_2 storage for the U.S. and covered Canadian areas, according to the third edition of the Atlas.

Safe and permanent geologic CO_2 storage is an important element in carbon capture and storage (CCS) technology, considered by many experts as a major component in a portfolio strategy for reducing atmospheric carbon dioxide build-up due to human activity.

The primary purpose of Atlas III is to update U.S./Canadian CO_2 storage potential and provide updated information on the activities of DOE's seven Regional Carbon Sequestration Partnerships (RCSPs), comprised of more than 400 organisations, 43 states, and four Canadian provinces. Atlas III also outlines DOE's Carbon Sequestration Program and international carbon capture and storage (CCS) collaborations, as well as worldwide CCS projects, and CCS regulatory issues. It also presents updated information on the location of CO_2 stationary source emissions, as well as the locations and geologic storage potential of various formations and it provides details about the commercialisation opportunities for CCS technologies from each RCSP.

There are two editions of the new Atlas available:

1) An interactive version located at the NATCARB Web site, and
2) A print version available for viewing and downloading at the NETL Web site.

NETL has now created three atlases in collaboration with the RCSPs and the National Carbon Sequestration Database and Geographical Information System (NATCARB) team.

More information on the Regional Carbon Sequestration Partnerships can be found at: www.fossil.energy.gov/programs/sequestration/partnerships.

NETL-Developed Process for Capturing CO_2 Emissions Wins National Award for Excellence in Technology Transfer, USA Today, DOE Fossil Energy News Alert - February 3rd, 2011

A process developed by researchers at the Office of Fossil Energy's National Energy Technology Laboratory (NETL) that improves the capture of carbon dioxide (CO_2) emissions from power plants while reducing the cost has been selected to receive a 2011 Award for Excellence in Technology Transfer.

The Basic Immobilised Amine Sorbent (BIAS) Process separates CO_2 from the flue or stack gas of power plants, preventing its release into the air. The captured CO_2 can then be permanently stored in a carbon sequestration scenario. Application of this technology reduces the costs and energy associated with more conventional scrubbing processes to capture CO_2 in large-scale power generation facilities; consequently, its transfer from the laboratory to the marketplace is another important step in moving forward the commercialisation and deployment of innovations that help decrease atmospheric emissions of greenhouse gases. This national award is presented annually by the Federal Laboratory Consortium for Technology Transfer (FLC) in recognition of outstanding work by researchers in the transfer of technology from federal laboratory to the commercial marketplace. NETL's McMahan Gray and Henry Pennline received the award for their effort on this project. The BIAS Process will use low-cost, regenerable, solid CO_2 sorbents in large-scale fossil fuel-burning power plants. An amine compound, composed of nitrogen and hydrogen atoms, is treated to make it more selective and reactive towards CO_2. Combined with a porous solid support, the amine becomes a sorbent, which selectively reacts with CO_2 to extract it from the flue gas. The sorbent is then heated to release the CO_2 for storage, thereby refreshing the sorbent for reuse.

As a result of NETL's technology transfer efforts, a company is now ready to invest in BIAS Process technology for capturing CO_2 from power plants and is developing commercial applications. Additional organizations are interested in using the sorbent for applications other than power plants. The FLC is a nationwide network of federal laboratories that promotes the rapid transfer of laboratory research results and technologies into the marketplace. Its national and regional awards programs recognise laboratory employees who have done an outstanding work in technology transfer over the past year. NETL is one of more than 250 federal laboratories and centers, and their parent departments and agencies, that are members of the FLC.

The award will be presented at a ceremony held on Thursday May 5th 2011 at the FLC National Meeting in Nashville, Tennessee. A panel of technology transfer experts from industry, state and local government, academia, and the federal laboratory system reviewed applications from multiple national laboratories for this prestigious award.

http://www.energycentral.com/functional/news/news_detail.cfm?did=18676750

EC Commissioner backs CCS as key climate change technology

Published: Jan 25th, 2011

Carbon capture and storage (CCS) stands out as one of the most important technological solutions if Europe is to achieve its goals for energy and climate change, insists the EU Commissioner for Energy, Guenther Oettinger.

Speaking at the Annual Technology Evening of the European Power Plant Suppliers Association (EPPSA) in Brussels yesterday, Oettinger argued that CCS represented a business opportunity for Europe's equipment manufacturers, with the potential for CCS to be retrofitted to around 300 power plants across the continent. "Greenhouse gas emissions must peak and fall in the next decade and we cannot rely on wind and solar alone for this. Fossil fuel will remain an important source for power generation for many years but we cannot continue to burn it in the same way," said the Commissioner. "CCS can play an important role in reducing emissions for coal and gas plants as well as heavy industry, while we further develop renewable energy solution."

Commissioner Oettinger called for increased cooperation between member states in developing a network for the transportation of CO_2, pointing out that not all countries were able to develop storage facilities themselves. He said that greater public engagement would be required in the future if acceptance of CCS was to be achieved but that this would not be easy. "It will take time and resource and clear communication to bring local communities onboard," said Oettinger. Speaking in a panel discussion following the Commissioner's Keynote speech, Helen Donoghue, from the Energy Strategy Unit of the EC's Energy Directorate, said that the price of carbon was too low at present t o

encourage low-carbon technologies. "The carbon price will determine the future of CCS," said Donoghue. Spokesman for WWF, Mark Johnston said that Europe was not doing enough to lower carbon intensity. "The less that is done now, the more will be required later," said Johnston. "Rationing (emission permits) might work but we need to create more scarcity to force up prices." The European Commission, European Investment Bank and member states are planning to part-finance up to eight CCS demonstration plants under its NER300 programme, which will see around EUR4.5bn ($6.2bn) raised through the sale of new emission allowances for CCS and renewable energy projects. The balance of funding must come from member states schemes and there is concern that in some countries, policies are not in place to accomplish this.

EPPSA used the opportunity of the Technology Evening to introduce Franz-Josef Mengade as the incoming president of the association. Mengade, who is head of Business Unit Power Generation at ABB Management Services, replaces Andreas Wittke, German country president of Alstom, who is stepping down after five years in the role.

http://www.powergenworldwide.com/index/display/articledisplay/2121886504/articles/powergenworldwide/coal-generation/coal-generation-equipment/2011/01/ec-commissioner_backs.html ●

GHGT-10 Conference Summary Published,

by Toby Aiken, IEAGHG

Delegates have the opporunity to discuss the posters presented in the poster sessions

To encapsulate the key learnings and messages to be taken from the recent GHGT-10 Conference in Amsterdam, IEAGHG have prepared a conference summary brochure that brings attention to the highlights of the technical programme and keynote talks, and sums up the key messages for the future together with the areas identified as targets for ongoing research and development.

A few of the key messages included in the brochure are repeated here, but for full details, please visit www.ieaghg.org and download the full PDF brochure.

The capture sessions of the conference were noted as demonstrating the wide range of research being undertaken with the specific aim of developing more options for capture technology installation. The amount of wide ranging research now being undertaken is illustrative of the increased interest in CCS as a climate mitigation option and the presentations and subsequent questions showed a keener interest from commercial companies. This is indicative of a gradual move from the academic focus of previous conferences, which again illustrates the increased awareness and interest in CCS technologies.

The storage related sessions reported on numerous ongoing projects and research activities. It was noted that the range of monitoring technologies available are growing more reliable and thorough as time progresses, and existing technologies are being deployed in novel ways, such as triangulating a network of atmospheric sensors to detect a leak. This has been demonstrated with a controlled release to test the efficacy of the system.

The sessions addressing the experiences of public perception and communication through practical project experiences were very informative, and a lot of information can be gleaned to assist in the formation of best practices. ●

GHGT-11 Seeks Sponsors, by Toby Aiken, IEAGHG

It is a pleasure to announce that the 11th event in the Greenhouse Gas Control Technologies conference (GHGT) series will be held in Kyoto, Japan, between the 18th and 22nd of November 2012.

The GHGT conference series has established itself as the principal international platform for exhibiting and discussing new greenhouse gas mitigation technologies. This series has become a focal point for international research on CO_2 Capture and Storage (CCS).

The GHGT conference series is a non-profit event that traditionally attracts significant government and industrial sponsorship. We are now inviting key companies and organisations in CCS to join in sponsoring the conference.

Kyoto International Conference Centre venue for GHGT-11

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 three 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.

Anyone wishing to discuss sponsorship or support of the conference should approach Toby Aiken (toby.aiken@ieaghg.org) in the first instance. ●

Cancun CMP6 Meeting, by Tim Dixon, IEAGHG

The news on CCS from Cancun was that CCS is eligible for the Clean Development Mechanism, providing certain conditions will be met by a work programme. A one year work programme is created, consisting of submissions by Parties and observers (by 21st Feb), a technical workshop with technical and legal experts, and the UNFCCC to prepare draft rules specifically for CCS in CDM based upon this work, to be ready for COP -17 meeting in South Africa, December 2011. This is significant progress after five years, although it isn't straight-forward and there are risks in the work programme.

How this was achieved?

CMP6 reached conclusion on CCS in CDM, at 5am their time on 11th Dec. They reconvened after all other business completed in order to come back to this issue, as informal consultations behind the scenes had been continuing late. The chairs conclusion was to "adopt Option 1", and no one objected. So CCS became eligible for CDM, providing the work programme set out does everything asked of it on all the issues listed. Australia intervened to thank all especially the Mexicans for this progress. Brazil intervened to say "with great reluctance did not oppose adoption". So a significant step forward for CCS. Still many risks ahead in the detail of the work programme before its 'in the bag', but the most progress for five years.

A decision text was adopted on 4th Dec by the Subsidiary Body for Scientific and Technological Advice (SBSTA) on whether CCS should be included under the Clean Development Mechanism (CDM). This was after four intense meetings of the negotiating group, the last running on until 01:30am on the 4th Dec! This text was to be forwarded to the Kyoto Protocol Parties (CMP) who are responsible for deciding if CCS should be included under CDM. The significance of this SBSTA decision is that it provided two options for consideration by the Parties' (at Minister's level). This issue had been deadlocked for a number of years and the

technical negotiations have failed to date, therefore it was encouraging that this decision was forwarded at last to CMP as this issue would only be resolved through a political agreement. In past meetings the opponents have put a tremendous amount of effort in preventing the SBSTA from developing and releasing a text and presenting minsters with an opportunity to consider the issue. On this occasion the SBSTA succeeded in agreeing a text. This was assisted by the Mexican President of the negotiations initiating high-level bilaterals on this issue at the heads of delegation level, which continued through to the end of the CMP.

The text was clearly a compromise and not ideal but Option 1 outlined a work programme that could result in a workable framework for CCS projects. It should be noted that the forward work programme under option 1 provides plenty of opportunities for further delay and blocking by opponents. Option 2 would result in CCS not being supported under the CDM with no forward work programme and would effectively mean that CCS is ruled out of the CDM, with the negative implications for it inclusion in any future mechanisms.

Elsewhere in the UNFCCC meetings, CCS was discussed under the future CDM (in AWG KP) but progress here is was parked waiting for the CMP decision above, and under AWG LCA, CCS was included as an example in the discussions towards a 'technology mechanism'.

IEAGHG in Cancun

IEAGHG worked very closely with the IEA, the Global CCS Institute and the CCSA

Within the UNFCCC arena, a total of five CCS events were organised by the Global CCS Institute, in the Bellona room in the negotiation venue, and one CCS event was organised by CCSA in the Side-event venue.

One of the new topics for CCS there is biomass CCS, and the IEAGHG's work, including the new study by ECOFYS on global potential, was presented at a dedicated Global CCS Institute event on biomass CCS (within the COP-16 venue) and also at the CCSA Side-event on CCS, generating a lot of interest.

The new WRI Policy Brief on CCS issues in the UNFCCC was timely and useful and able to highlight the 2009 Experts Report on CCS in CDM. This WRI Policy Brief was launched at a dedicated Global CCS Institute event on 4th Dec within the COP-16 venue. As well as Sarah Forbes WRI presenting, also presented at this launch was IEAGHG's previous work on the CDM market impacts by Paul Zakkour.

Also new at this COP were the CCS update briefings provided to business-related stakeholders by the Global CCS Institute working with IEAGHG and CCSA.

Relevant IEAGHG publications, including on Lake Nyos and Natural Analogues, were disseminated via the IEA and CCSA stalls and at the Bellona event room. It was interesting that at most events in the Q&As, fundamental and basic concerns on CCS continued to be raised, and were able to be addressed.

So the most progress for CCS in the UNFCCC for five years, but with a lot of work still to do! For more information see: **http://cdm.unfccc.int/about/ccs/index.htm.**

EAGE SES Meeting, by Saskia Bouwer, EAGE

EAGE is partnering with a number of organisations to produce the first Sustainable Earth Sciences (SES 2011) conference in Valencia, Spain on 8th –11th November 2011.

This exciting new initiative stems from EAGE's belief that its members have an important role to play in the further development of applied science and technology with regard to sustainable use of the earth and related environmental geosciences.

One way of doing this is by offering a platform for scientists working in these fields, which is how SES 2011 came into being. SES aims to include as many relevant disciplines as possible. In order to integrate the multi-disciplinary approach and at the same time promote co-operation between organisations working in this area, a partnership was formed between several organisations including IEA Greenhouse Gas R&D Programme (IEAGHG), CO_2GeoNet, the International Geothermal Association (IGA) – European Branch and House of Geoscience. The main objective of the meeting is to exchange knowledge and technology between the geoscientists within the different disciplines under three main conference headings – CO_2 Storage, Deep-Earth Storage, and Geothermal Energy. Each day will start with an integrated plenary session, after which the parallel sessions per main topic will start. The technical programme will offer both oral and poster presentations. In order to have a full range technical programme available, a list of topics has been set. Should you wish to contribute to the technical programme, please note the deadline for submission of extended abstracts is 15th April 2011. The event will also be offering exhibition opportunities and a special student programme. With an irresistible venue in Valencia, Spain's third largest city on the Mediterranean Gulf of Valencia, SES 2011 promises to be a very special event.

All details including the Call for Papers can be found at : **www.eage.org.**

Launch of a Pan-European Coordination Action on the Geological Storage of CO_2,

by Rowena Stead and Gary Kirby, CO_2GeoNet

CO_2 Geological Storage (CGS) is the focus of a three-year Co-ordination Action – "CGS Europe" – launched on 1st November 2010 under the EC FP7 programme. The project is based on networking between 34 research institutes, all with CO_2 storage research experience, and offers a wide European coverage across 24 EU Member States and 4 Associated Countries.

Participants at the CGS Europe kick-off meeting, Paris, 29th-30th November 2010

The Kick-off meeting and 1st General Assembly of CGS Europe took place in Paris on 29th–30th November 2010 with a good turnout. 46 attendees gathered together to discuss and map out immediate activities. The EC Scientific Officer, Jeroen Schuppers, was there to offer advice on project expectations and existing CO_2 storage-based initiatives and programmes with which CGS Europe will seek collaboration.

The objective of CGS Europe is to establish a credible, independent, long-lasting and representative pan-European scientific body of expertise on CO_2 geological storage. This will build on the sound nucleus of the CO_2GeoNet Association, and the task will be made easier by the fact that the CGS Europe consortium includes key geoscientific institutions from the existing CO_2NET EAST and ENeRG networks, as well as additional institutes from EuroGeoSurveys.

Benefitting from the experience of these existing networks, CGS Europe will:

1. Instigate durable networking of research capacity on CO_2 storage in all the relevant EU Member States and Associated Countries
2. Liaise and coordinate its activities with other stakeholders and existing initiatives in Europe to help define and harmonise CO_2 storage research roadmaps and activities at national, European and international level
3. Help reduce the existing gap between the 'forerunner' countries, where CCS activities have been started or are planned, and those countries where these actions are not yet happening
4. Contribute to the large-scale demonstration and industrial deployment of CCS
5. Support the implementation of the European Directive on the geological storage of CO_2 and other regulatory regimes

The creation of CGS Europe is timely, because although the European Union has already made significant progress in advancing CO_2 Capture and Storage (CCS) as a key technology for combating climate change, there is now a strong need for an acceleration in this process and achieving an even spread of knowledge throughout EU Member States and Associated Countries. This will help support the 10–12 large-scale CCS demonstration projects in Europe in all relevant areas, so as to promote commercial deployment from 2020.

Essentially based on networking, CGS Europe will promote cooperation both:

- Internally – between the participants with true European coverage: leading to capacity building between the 34 institutes involved, including staff exchange in common research areas.
- Externally – reaching out to the general public, but also national, European and international stakeholders and initiatives within the CCS community:

The ZEP Technology Platform, the European CCS Demonstration Project Network, the European Carbon dioxide Capture and Storage Laboratory Infrastructure (ECCSEL), the European Energy

Research Alliance (EERA), the European Industrial Initiative (EII), the IEA Greenhouse Gas R&D Programme (IEAGHG), the Carbon Sequestration Leadership Forum (CSLF), the Global CCS Institute (GCCSI), the International Performance Assessment Centre for Geological Storage of CO_2 (IPAC-CO2).

To achieve these aims, CGS Europe will further enhance the collection, dissemination, and homogenization of scientific knowledge on CO_2 storage.

The work plan consists of five work packages (WPs), with efforts concentrating on:

- Consortium management (WP1)
- Integration & networking (WP2) - both internally and externally
- Knowledge management – including:

1. Knowledge repository (WP3): to collect, structure and summarise existing CGS knowledge for easy use
2. Knowledge development (WP4): to foster this knowledge by bridging the gaps between the different countries and aligning research programmes for increased capacity,
3. Knowledge dissemination (WP5): to disseminate the results to a broader audience in a clear and appropriate manner

One major outcome of CGS Europe will be a better understanding of the current status of CO_2 geological storage throughout Europe; a pan-European knowledge pool structured to provide relevant information (reports, best practices, country status, etc.) to a wide and varied audience. Through various dissemination tools (knowledge-dissemination and awareness-raising workshops, a website with an online knowledge repository, publications, spring/summer school, etc.), CGS Europe will offer access to unbiased scientific advice to national regulatory authorities, industrial stakeholders, the scientific community, media and the general public.

The most concrete outcome of CGS Europe, at the end of the EC funding period, will be a durable Europe-wide scientific body on CO2 geological storage, able to provide both detail and overviews of national, European and Worldwide perspectives and needs in the field of CO_2 geological storage.

Country coverage of CGS Europe

Calendar of Events

- Early February 2011: Launch of the CGS Europe Website (www.cgseurope.net).
- 13th–14th April 2011: 1st CGS Europe Regional CCS-awareness-raising workshop, Vilnius, Lithuania. Topics will include: Role of CCS in climate change mitigation, Global CCS perspectives, European policy and regulations; CCS status and developments in the Baltic Region, Research results and innovations in CGS.
- 9th–11th May 2011: CO_2GeoNet 6th Open Forum, Venice (www.co2geonet.com/Venice2011). This annual CO_2GeoNet event will be organised in 2011 through CGS Europe. It will bring together CCS stakeholders and provide them with the latest results and progress in the field of CO_2 geological storage. A European country-by-country overview will be presented, including an update on CCS demonstration projects, FP7 results and the status of the transposition of the EU CCS Directive.

CGS Europe events in Venice will also include:

- the 1st CGS Europe knowledge-sharing workshop focused on "Legal and regulatory issues for the implementation of the EU Directive on the geological storage of carbon dioxide" and
- the 2nd project General Assembly (12th May).

- Summer 2012: the 1st one-week CGS Europe CO_2 geological storage school for 25–30 students.

CGS Europe: Key Facts

3-year Coordination Action
Funding: EC FP7
24 Participants, including the CO_2GeoNet Association (11 members as third parties)
34 Institutes specialised in CO_2 storage matters
24 EU Member States and 4 Associated Countries

Coordinator: BRGM – Isabelle Czernichowski-Lauriol (i.czernichowski@brgm.fr)

Secretariat: University of Zagreb – RGNF – Zeljka Kurelec (info@cgseurope.eu)

Participating countries: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Turkey, UK.

Brine Displacement Study,
by Neil Wildgust, IEAGHG

Many regional surveys of CO_2 geological storage potential around the world have shown deep saline formations (DSF) to provide the largest theoretical capacity or resource. However, limited operational experience of large scale injection into DSF, coupled with a general lack of characterisation data, means a greater level of uncertainty exists in comparison to storage prospects in depleted hydrocarbon fields. A key area of uncertainty relates to the effects of pressurisation on DSF storage performance.

IEAGHG commissioned Permedia Research of Canada to investigate this topic, through literature review and modelling of case studies, including scenarios based on a standard dataset of the Society of Petroleum Engineers.

A critical factor in modelling of DSF storage and associated pressurisation effects is the assignment of boundary conditions. Open systems assume formation brine is free to migrate laterally within the storage formation, allowing dissipation of pressure so that injectivity can be maintained. Closed systems assume impermeable boundary conditions to the storage formation, effectively limiting storage capacity to compressibility of rock and pore fluids and creating the likelihood of decreasing injectivity. In this context, the report also notes that dissolution of CO_2 in formation brine may be insufficient to counter the negative effects of a closed system.

Shale is likely to form the predominant vertical boundary layer for most DSF. Given the potential compartmentalisation of many DSF due to such features as sealing faults or stratigraphic thinning ('pinch out'), the permeability of shale is likely to govern boundary conditions for many storage sites. However, characterisation of regional shale permeability is problematic.

This study, through literature review and modelling exercises, has demonstrated that shale permeability in the order of microdarcies (E-18 m2) would allow brine migration and therefore alleviation of pressurisation in typical large scale DSF storage projects. In contrast, relatively impermeable shale (E-21 m2, nanodarcies) would prevent significant brine migration and lead to loss of injectivity. The report considers empirical relationships between such factors as depth, capillary entry pressure, porosity and permeability; whilst data derived from core scale laboratory analyses suggests that shale could be relatively impermeable at depths relevant to storage, consideration of field evidence from North Sea hydrocarbon fields indicates that regional shale permeability may sufficient to allow brine displacement. This contradiction can be easily explained by up-scaling effects, because laboratory testing of cores bias permeability measurements towards rock matrix, rather than bulk, properties.

Some further key conclusions drawn from the study were as follows:

- Pressure footprint size is highly sensitive to caprock permeability and thickness;
- Threshold pressures and CO_2 containment potential are insensitive to caprock thickness;
- Pressure responses to injection are strongly affected by storage compartment size and related boundary surface area;
- An ideal storage scenario appears to be a relatively thin shale caprock with microdarcy permeability – with brine dissipation maintaining injectivity but with adequate CO_2 containment potential. This permeability is likely to occur in a specific depth window, subject to factors such as shale clay content and burial history;
- Characterisation of regional shale permeability will be subject to a high degree of uncertainty;
- Compressibility of storage formation rock and pore fluids, and dissolution of CO_2 in brine, are unlikely to make major contributions to the alleviation of pressurisation;
- The use of abstraction wells to relieve pressure will require careful design to minimise the likelihood of CO_2 breakthrough, since formation heterogeneity may lead to channelised plume development;
- The closed system approach to modelling DSF storage is only likely to be valid for relatively small pressure compartments and where boundary shale exhibits permeability in the nanodarcy range;

The report is based on literature review and theoretical modelling; further large scale demonstration projects are required to better calibrate predictive models and improve understanding of DSF performance. Nevertheless, the results of the study show that system approximations for pressurisation and brine displacement in large scale DSF storage projects, require modelling to consider regional context and geologically realistic boundary conditions. ●

New IEAGHG Report: Evaluation and Analysis of Water Usage in Power Plants with CO_2 Capture, by Stanley Santos, IEAGHG

All types of thermal power plant (fossil fuel, biomass, nuclear, solar thermal or geothermal) potentially require large quantities of water. In places where the availability of water is limited and there are competing demands, the choice of power generation technology could be affected by the water requirement. Including CO_2 capture in a power plant often increases the water requirement but if water availability is a concern there are techniques that could be used to reduce water usage.

IEAGHG has undertaken a study to quantify the water requirements of power plants with and without CO_2 capture, to identify techniques that could be used to reduce the water requirements should this be necessary and to estimate the resulting impacts on thermal efficiency and costs of electricity generation. The study was carried out for IEAGHG by Foster Wheeler Italiana.

This study has been carried out to estimate the performance and costs of a coal fired power plants with CO_2 capture based on post-, oxy- and pre-combustion CO_2 capture technologies.

The study evaluated and analysed the water usage profile of power plants with and without CO_2 capture in coastal area where there is no limitation to the access of water, and in areas where there is a severe limitation to access of water.

The scenarios addressed in the study cover the following conditions:

Matimba Power Plant operated by Eskom in South Africa is an example of the use of air-cooling methods

- Pulverised coal fired power plant with ultra-supercritical steam cycle without CO_2 capture;
- Pulverised coal fired power plant with ultra-supercritical steam cycle with post-combustion CO_2 capture based on standard MEA solvent;
- Pulverised coal fired power plant with ultra-supercritical steam cycle using oxyfuel combustion for CO_2 capture;
- IGCC using GE Energy's Quench type gasifier without CO_2 capture;
- IGCC using GE Energy's Quench type gasifier with pre-combustion CO_2 capture based on physical solvent.

IEAGHG Seminar: Control of Nitrosamine Formation in CO_2 Capture Plants, 1st – 2nd February, 2011, Essen, Germany, by Chris Satterley, E.ON and Mohammad Abu Zahra, IEAGHG

The environmental impact of CO_2 capture plants is an area where the IEAGHG remains committed to facilitating discussion amongst the academic community, technology suppliers and utility companies. Following on from a successful workshop, Environmental Impacts of Amine Emission during Post-Combustion Capture, in 2010, the IEAGHG held the above seminar to discuss the potential for, and control of formation of nitrosamines in the capture plant process. E.ON, Gassnova and GdF Suez co-sponsored the seminar held at the Zeche Zollverein world heritage site near Essen, Germany. Sixty of the world's leading technical experts from 13 different countries representing academia, technology suppliers and the utility sector were in attendance.

The potential for nitrosamine formation in CO_2 capture plant by the side reaction of amines with NO_2 is now part of the public debate on CCS. In the public domain, there is significant uncertainty as to the expected levels of nitrosamine formation in capture processes and the potential for emission of these harmful compounds to the environment. Gaining widespread public support for CCS is very important for its successful implementation and this seminar provided a forum for experts to discuss this particular issue and find a way forward in order to address it. Key topics were nitrosamine formation pathways, verified measurement techniques and methods to minimise the formation of nitrosamines in the process.

At the start of the seminar, Mohammad Abu Zahra welcomed the delegates and acknowledged the sponsors on behalf of IEAGHG and hoped for a fruitful workshop. Then he gave a short introduction to the IEAGHG, explaining the background of the programme and its

members. The background and origination of the workshop was explained, touching briefly on the main aims of the workshop and the reasons for international activity in the control of nitrosamine formation in CO_2 capture plants.

In his opening presentation, Joost van Dijk, Chief Operating Officer, Steam Fleet of E.ON Generation highlighted the importance of CCS in the fight against climate change and its flexibility and cost advantages as a key source of low CO_2 energy in the future. He encouraged the attendees to have open-minded discussions: "A joint engagement of academia, suppliers and future operators ensures a successful further development of this key technology."

The technical session of the seminar began with a presentation by representatives of BASF SE, the world's largest chemical supplier, entitled Amine quality for CO_2 Capture. The cost dependencies of amines were discussed along with current impurities present in technical grade amines. BASF also commented that global uptake of amine-based post-combustion capture would significantly increase the global demand for amine products.

E.ON followed on with a presentation entitled Expected NO_2 levels at the inlet of CO_2 capture plants. It was shown that NO_2 is effectively removed by a wet flue gas desulphurisation system, but re-oxidation of NO to NO_2 is favoured under the conditions found at a typical FGD outlet. During recent tests using power plant flue gases, E.ON have found that small amounts of NO_2 are likely to be present at the inlet of the capture plant absorber, if additional control of NO_2 immediately upsteam of the capture plant is not present.

After this initial discussion regarding the key inputs into the capture system, two presentations were given concerning the analytical detection of nitrosamines. The first by Henkel, a German consumer chemicals and cosmetics manufacturer, entitled Plausibility of Total and Individual Nitrosamine Measurements and Improvements. The second by SINTEF, a leading Norwegian independent research organisation, entitled Nitrosamine Analysis – Challenges and approaches in CO_2 capture. Both presentations confirmed that there were reliable methods for detecting nitrosamines; however there are no recognised standards currently in place. It was acknowledged that the collection and preparation of samples from capture plant was an area where reliable procedures needed to be developed as there is a significant risk of false positive readings in nitrosamine measurements arising from incorrect collection and handling of samples.

Norwegian Energy Company Statoil, a major partner in the Test Centre Mongstad CO_2 capture project, presented on their approach to nitrosamines. Following a report by the Norwegian Institute for Air Research, NILU, suggesting the potential formation of nitrosamine from atmospheric amine emissions, there has been significant governmental and media pressure in Norway around this issue. As a result Statoil have embarked on a research programme investigating nitrosamine formation in the capture process and from atmospheric amine emissions using laboratory analysis, atmospheric studies and pilot plant testing.

Moving on from the potential formation of nitrosamines in the process, E.ON provided a further presentation detailing their work utilising real power plant flue gases to evaluate some potential methods of controlling nitrosamine concentrations in solution. A number of potential chemical inhibitors were tested, but found to only be effective in high concentrations. The effect of UV irradiation of solvent was also studied and found to have a significant effect in reducing the concentration of nitrosamines. This work represents a promising step forward to manage nitrosamine levels in the process.

A representative from the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) detailed their research on CO_2 capture including their 3 pilot plants in Australia and 1 in China. CSIRO have studied the atmospheric formation of nitrosamines using their dedicated Smog Chamber facilities and have also embarked on a laboratory research programme of studying and detecting nitrosamine formation and stability. During these studies it was found that UV is effective in destroying nitrosamines and CSIRO intend to investigate nitrosamine formation further on their pilot plants.

The seminar presentations were accompanied by an inclusive and detailed discussion by the attendees and a broad consensus was achieved on how this issue should be tackled. In his concluding remarks, Prof. Hallvard Svendsen of the Norwegian University of Science and Technology (NTNU) highlighted some of the key learning points from the seminar:

- If preventative measures are not taken, nitrosamines could be formed in post-combustion capture plant and maybe emitted (albeit in low concentrations approaching current detection limits).
- Analytical methods for the detection of nitrosamines are available, but recognised standards regarding sampling, preparation and analysis are still required.
- UV irradiation shows promise as a method to mitigate against possible nitrosamine formation.

Prof. Svendsen then went on to detail a research programme to be undertaken this year to test the efficacy of UV irradiation in limiting nitrosamine concentrations in the laboratory capture pilot plant at NTNU. The results of these tests will be published in due course.

Addressing SO_2/SO_3/Hg and Corrosion Issues Under Oxyfuel Combustion,

Stanley Santos, IEAGHG, Terry Wall and Rohan Stanger, University of Newcastle in Australia

A Special Workshop Addressing the SO_2/SO_3/Hg and Corrosion Issues During Oxyfuel Combustion was successfully held at Rembrant Hotel, London from 25th to 26th of January 2011.

The primary purpose of this workshop is to establish the current state of understanding relevant to these issues – especially this knowledge and understanding has an important contribution to the on-going discussion relevant to CO_2 quality impact to the oxyfuel technology for CO_2 capture and storage.

About 80 delegates attended representing the world's experts in the area.

The programme consists of three keynotes presentations delivered by Prof. Terry Wall (Newcastle University, Australia); Dr. John Pavlish (EERC, N. Dakota, USA) and Dr. Axel Kranzmann (BAM, Germany) discussing about the fate of sulphur, fate of Hg and corrosion issue during oxyfuel combustion respectively.

In addition to the keynote presentations, there are 6 Sessions with 24 other presentations covering the following topics:

- Fate of sulphur during oxyfuel combustion – measurement experiences and results
- Fundamental research in behaviour of Mercury during oxyfuel combustion
- Fundamental research in corrosion and ash deposition
- Fate of sulphur and the performance of flue gas processing units and
- Experiences in large scale combustion test facilities

Some of the main conclusions of this workshop are:

- It was agreed that SO_3 measurements using Condensation Method and Isopropanol method should be acceptable with careful monitoring of temperature to reduce the error.
- If sulphur is not recycled back in the flue gas – SO_3 tends to be similar with air fired case.
- The use of adsorbent injection could effectively reduce the SO_3 in the flue gas of oxyfuel combustion.
- Experimental results presented in this workshop showed that there is an increase oxidation of Hg during oxyfuel combustion. However, this should be further verified by extensively testing the current Hg measurement techniques.
- There are still a lot of gaps in knowledge with regard to the understanding the corrosion mechanism both in high and low temperature regime during oxyfuel combustion. On this basis, it was recommended that a working group in corrosion and ash deposition under oxyfuel combustion should be organised to follow up the discussion of this workshop.

Finally, We would like to acknowledge the partial support of the UK's Technology Strategy Board to this workshop.

Details of the workshop and all the presentations are posted in the Oxyfuel Combustion Research Network website:

http://www.ieaghg.org/index.php?/2009112021/oxy-fuel-combustion-network.html

For any query with regard to the workshop, please contact Stanley Santos at:

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Oxyfuel Combustion for Power Generation and Carbon Dioxide (CO_2) Capture, by Ian Borthwick

Edited by Dr Ligang Zheng, CanmetENERGY Ottawa Research Centre, Natural Resources Canada, Canada

Oxy-fuel combustion is currently considered to be one of the major technologies for carbon dioxide (CO_2) capture in fossil-fuel-fired power plants. The advantages of using oxygen (O_2) instead of air for combustion include a CO_2-enriched flue gas that is ready for sequestration following purification and low NOx emissions. Unlike post-combustion capture, there is no need to add a major chemical process to capture CO_2. Furthermore, there is no need for the power generation industry to adopt a new process (such as integrated gasification combined cycle plant - IGCC) for its core business.

This simple and elegant technology, which can be applied to both existing and new units, has attracted considerable attention since the late 1990s, rapidly developing from pilot-scale testing to industrial demonstration. Currently, the Vattenfall 30 MW (thermal) oxy-fuel demonstration plant has been running for more than 2 years and the Australian Callide 30 MW (electrical) oxy-fuel plant is scheduled to be in operation this year. The U.S. Department of Energy has announced plans to build a 200 MW oxy-fuel coal fired unit in Illinois, which should be in operation by 2016. The main challenges of the oxy-fuel process are the major energy penalties of oxygen production and CO_2 capture; these must be reduced through overall system optimisation and the development of new processes.

This new book, Oxy-fuel combustion for power generation and carbon dioxide (CO_2) capture, comprehensively reviews the fundamental principles and development of oxy-fuel combustion in fossil-fuel-fired utility boilers.

Following a foreword by Professor János M. Beér, the book opens with an overview of oxy-fuel combustion technology and its role in a carbon-constrained environment. Part I introduces oxy-fuel combustion further, with a chapter comparing the economics of oxy-fuel vs. post-/pre-combustion CO_2 capture, followed by chapters on plant operation, industrial scale demonstrations and circulating fluidized bed combustion.

Part II critically reviews oxy-fuel combustion fundamentals, such as ignition and flame stability, burner design, emissions and heat transfer characteristics, concluding with chapters on O_2 production and CO_2 compression and purification technologies. Finally, Part III explores advanced concepts and developments, such as near-zero flue gas recycle and high-pressure systems, as well as chemical looping combustion and utilisation of gaseous fuel.

With its distinguished editor and internationally renowned contributors, Oxy-fuel combustion for power generation and carbon dioxide (CO_2) capture provides a rich resource for power plant designers, operators and engineers, as well as academics and researchers in the field.

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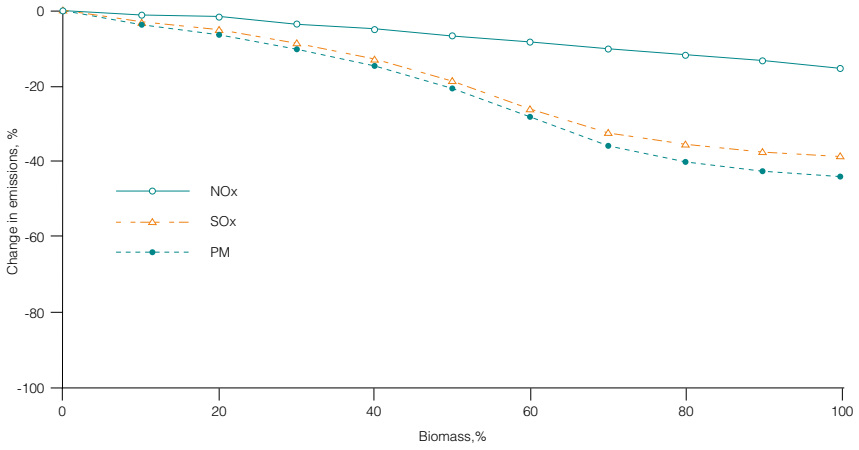
News From The IEA Clean Coal Centre,
By Debo Adams, IEACCC

This is the first article in a series on news from the IEA Clean Coal Centre, a sister organisation to the IEA GHG.

Clean Coal Technologies Conference

The next event in the calendar of the IEA Clean Coal Centre is the Fifth International Conference on Clean Coal Technologies which will take place from 8th-12th May 2011, in Zaragoza, Spain. There will be sessions on:

- Ash and slag
- Biomass cofiring
- Carbon capture and storage
- Carbon capture solvents
- Carbonate cycling and solid sorbents
- Chemical looping combustion
- Combustion
- Gas cleaning
- Gasification
- IGCC and precombustion carbon capture
- International and regional perspectives
- Mercury and flue gas cleaning
- Oxyfiring



Plots for average emission impacts of co-firing coal with biomass

In addition there will be keynote sessions and a poster session. Technical visits are offered to the Instituto de Carboquímica laboratory and a full day visit to the Puertollano IGCC plant by high speed train. Visit **www.cct2011.org** for further information.

Mercury Emissions from Coal Workshop

The IEA Clean Coal Centre has been running the Mercury Emissions from Coal (MEC) experts meeting annually since 2003 and in this time it has been held in Europe, North America, Asia and Australia. For May 2011, the meeting will be moving for the first time to South Africa. MEC was previously run as an invitation only meeting. However, the meeting is now open to general attendance, numbers permitting, to maximise discussion and information exchange.

The MEC workshop series was established to facilitate the interaction of international experts representing the utilities, governmental bodies, research institutes and commercial industries, allowing discussion of how they can work together to address the problem of mercury emissions from coal combustion.

The workshop will take place from 18th - 20th May 2011. As always, the meeting will be relatively casual with active interaction and discussion promoted and encouraged. At this stage the agenda is open and abstracts on all aspects of mercury behaviour, measurement and control from coal combustion will be happily received. However, since the work towards the UNEP Global Legally Binding Treaty on Mercury is taking form, we are particularly keen on papers concerning work on emission inventories and methods for mercury control in developing countries and economies in transition.

Visit **http://mec.coalconferences.org** for further information.

CO_2 Sequestration Technologies for Clean Energy,
by S.Z. Qasim and Malti Goel, STAC

Our earth is facing a dilemma of accelerated climate change due to increased concentration of CO_2 in the atmosphere. The atmospheric CO_2 concentrations have increased from 280ppm in 1800, the beginning of industrial age to 390ppm today. This abrupt imbalance has disturbed the earth's carbon cycle. The CO_2 contributes up to 68% of total greenhouse gases. In the present scenario, the most important challenge is to achieve human development while safeguarding the ambient environmental conditions. The most pressing technical and economic challenge of the present time is to meet energy demand for the world economic growth. The CO_2 Sequestration technology is amongst the range of energy technology strategies for addressing concerns of increasing greenhouse gas emissions in the atmosphere and achieving clean energy from fossil fuel use.

The book 'CO_2 Sequestration Technologies for Clean Energy' is an epitome of various techniques used for capture and storage of carbon dioxide which is produced from power plants, industries, automobiles exhaust and other anthropogenic activities. Energy industry is the target industry for carbon sequestration. There are 16 chapters in the book dealing with clean energy technology relating to management of CO_2 by capturing and fixing it away from the atmosphere. New insights about the present planetary emergency which our earth is currently facing and various policies / perspectives regarding the carbon capture and storage (CCS) are given. International Energy Agency has been taking lead in developing policy guidelines for CCS projects and bench marking of storage projects. A Global Institute of Carbon Capture and Storage (GCCSI) has come up in Australia to provide thrust towards research and demonstration of industrial scale projects on CCS technology.

Past evidences of CO_2 temperature coupling and various technological perspectives in CO_2 fixation i.e. clean coal technology, underground CO_2 trapping, CO_2 sequestration through ocean, land and forest are discussed. Generic methodologies to capture CO_2 from flue gas, issues in CO_2 capture and efficacy of various fixation approaches are discussed in detail. Advances made in various gas separation technologies including chemical absorption, physical adsorption, membrane separation, and androgenic method of CO_2 sequestration over silver containing adsorbents, calcium aluminum oxide and calcium silicate and lithium zirconate in the temperature range 45-750o are also explained.

Biological methods of post combustion CO_2 sequestration dealing with microalgae and microbial research using laboratory scale on photo bioreactors / solar bio-reactors as safe and novel concepts using different micro-remediation techniques for permanent capture of CO_2 are explained. It further explains various other beneficial uses of algae. It underlines the need to extend the research & development for high productivity of biomass with high content of oil and reduction of cost of the whole process. Approach to CO_2 storage in ocean waters and Ocean Iron Fertilization (OIF) of phytoplankton in presence of iron filing as catalyst are presented. Carbon Concentrating Mechanism (CCM) based on biochemical process in photoautotrophic organisms such as C4 photosynthesis and crassulacean acid metabolism in terrestrial higher plants, active transport of inorganic carbon primarily in cynaobacteria and CO2 concentration following acidification in compartment adjacent to Rubisco found in some eukaryotic algae. Forest ecosystem has a carbon stock. Studies have been carried out in Manipur, NE India on rate of sequestration in different ecosystem, which is governed by species composition, age of trees, type of soil and climatic factors.

Extraction and utilisation of coal mine methane, various forms of coal bed methane recovery, status of CBM activity, various prospects and challenges of enhanced coal bed methane recovery in India are covered. CO2 mitigation strategies adopted in Indian Power sector are described. The efficacy and capacity of CO_2, sequestration and important highlights of storage projects for enhanced oil recovery such as Sleipner (STATOIL), In-Salah, Weyburn and Snohvit are discussed. Carbon Sequestration Leadership Founder (CSLF) began in 2003 as multi-country initiative of Department of Energy, USA. The CSLF Technical Roadmap addresses to individual technical issues and suggest the pathways toward commercial deployment of – to collaborate on development of improved cost-effective technologies for the separation and capture of CO2 for its transport and long-term storage. India became a founder member to CSLF in 2003 among 16 other countries.

This book on 'CO_2 Sequestration Technologies for Clean Energy: Awareness and Capacity Building' by S. Z. Qasim and Malti Goel is published by Daya Publishing House, pp 205, ISBN 81-7035-660-1, ISBN 978-81-7035-660-8 in 2010. It is compilation of papers presented in the Awareness and Capacity Building on Carbon Capture and Storage held during July 2009 at Indian National Science Academy, New Delhi, India. This book is of considerable interest to teachers, students, scientists and other professionals particularly in understanding and pursuing the CO_2 management science. ●

Conferences & Meetings

This is a list of the key meetings IEAGHG are holding or contributing to throughout 2011. 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.

Modelling/Wellbore Combined Network Meeting
26th - 28th April 2011; Perth, Australia

10th Annual Conference on Carbon Capture & Sequestration
2nd - 5th May 2011; Pittsburgh, USA

Post Combustion Capture Conference, PCCC1
17th - 19th May 2011; Abu Dhabi, UAE

Monitoring Network Meeting
7th - 9th June 2011; Potsdam, Germany

6th Trondheim Conference on CO_2 Capture, Transport and Storage
14th - 16th June 2011; Trondheim, Norway

Risk Assessment Network Meeting
21st - 23rd June 2011; Pau, France

IEAGHG International Summer School
18th - 22nd July; Illinois, USA

High Temperature Solid Looping Network Meeting
31st August - 2nd September 2011; Vienna, Austria

2nd Oxyfuel Combustion Conference, OCC2
12th - 16th September 2011; Yeppoon, Queensland, Australia

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