

# Greenhouse News

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## GHGT-11 Conference Summary, by Toby Aiken, IEAGHG

The Greenhouse Gas Control Technologies (GHGT) conference series is firmly established as the foremost scientific conference at which to present the latest research on technological aspects of CCS. At GHGT-11 in Kyoto, the conference organisers continued with the aims of providing an international forum in which to discuss the most recent advances, and most pressing issues in the field of greenhouse gas control technologies.

The conference series strives to promote collaboration on international research, to provide direction and support to research and development, and to encourage the exchange of ideas and results to further the science. It also acts as a platform to meet people and create networks for collaboration and exchange of information between researchers as well as those affiliated in the industry.

GHGT-11 is the latest in the series, and was held from the 18<sup>th</sup> to the 22<sup>nd</sup> of November 2012 in Kyoto, Japan.

The conference was organised by RITE in collaboration with the IEAGHG who are the custodians for the conference series.

The organisers chose to theme

this eleventh conference as 'CCS: Ready to Move Forward'.

This followed on from the theme of GHGT-10, (From Research to Reality) demonstrating progress in the intervening years. How much progress and at what pace, the GHGT-11 Summary Brochure, to be published soon, will attempt to evaluate.

In keeping with the history of growth, this event attracted over 1200 abstract submissions, making the role of the expert review panel of the utmost importance; the upside of this is that if selected, papers for both oral and poster presentations are necessarily of the best possible standard when competition is so high.

The four day conference covered all aspects of the CCS chain, with the technical sessions covering different aspects of CCS:

- CO<sub>2</sub> capture,
- transport,
- storage,
- demonstrations,
- public perception,
- industrial sources of CO<sub>2</sub>,
- integrated systems,
- utilisation,
- legal issues,
- negative emission scenarios,
- policy
- commercial issues,
- education, and
- other storage options.

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Once again, the technical programme was supplemented by a series of panel discussions, on subjects as diverse as CCS in Developing Asia, Costs of CCS, and Renewable Energy and CCS. These panel sessions encourage more wide ranging debate and allow more time for delegates to question experts on specific topics.

The following summarises the main points that arose from GHGT-11 and highlights the progress that has been made in recent years, while drawing attention to the areas that should receive further focus before GHGT-12 in Austin in 2014.

### Welcome Addresses

Kelly Thambimuthu, chair of the IEAGHG Executive Committee, opened this 11<sup>th</sup> conference in the Greenhouse Gas Control Technologies series, highlighting the history of the venue the conference was to take place in. Back in 1997, this very venue was the location that saw the meeting that first drew countries together to try to work towards an agreement to tackle climate change. After long discussions, the Kyoto Protocol was born.

Much has changed since then and, although progress has slowed in recent years, advancements continue and the changes in the world's energy mix means that in order to meet the 2 degree Celsius target, we must be serious about deploying CCS. Kelly gave the message to take away to the leaders of the world that the time is right to deploy CCS, not to otherwise adapt to a changing climate. CCS needs policy drivers in order to take the next steps.

Professor Kaya, President of RITE and co-chair of the GHGT-11 Steering Committee then addressed the conference on behalf of the hosts, RITE. Prof. Kaya highlighted the number of registrations as an indicator of the high regard the scientific community still has for CCS. There was a fear that with the current economic climate, and the more remote location of the conference for some delegates that attendance would suffer; this is not the case, and the abstract submissions evidenced this.

Prof. Kaya went on to underline the importance of the task of tackling climate change; in order to stick to the 2 degree target, we have to cut CO<sub>2</sub> emissions in half by 2050, and this will be a hard target to achieve, although it is still within reach.

The delegates were then addressed by Mr. Koichi Akashi from METI. He described the developments ongoing to determine the successor of the Kyoto protocol which will soon expire; COP-18 in Doha in November / December will seek to make significant progress towards this objective, so the next conference in 2014 will hopefully be held in a different political landscape.

### Evolution of Focus

The keynote talks at GHGT-11 came from a wider range of speakers than at previous conferences, with representation from manufacturing and steel industries, as well as talks on the potential of unconventional gas.

This change in tone is a positive step and an important development; previous conferences have been typically under-represented from other industries, and CCS in the steel and manufacturing industries are likely to be important sectors in the battle against climate change, and it was particularly interesting to hear from Henk Reimink from the World Steel Association talking about efforts with the steel manufacturing industry to improve and develop the steel used in car bodies with

the aim of making the material stronger so that the quantity of steel can be reduced, resulting in lighter weight vehicles, which will in turn use less fuel and so generate less emissions. This type of wider scale thinking is of great value, and demonstrates the impact that manufacturers can have on the end products of their materials.

### Closing Comments

The final closing session summed up the thoughts and feelings from the 4 days of technical presentations and keynote talks. Juho Lipponen (IEA) looked at the current situation for CCS globally, summarising that;

- We have technology and knowledge, but are lacking strong enough climate policy.
- We have demonstration projects, we don't have political attention and recognition.
- We have pilot projects, we don't have enough national visions and strategies.
- We have funding available for first demonstration projects, we don't have incentives.
- We have a small number of governments active in CCS, we don't have widespread acceptance.
- We have research and development, we have a lack of messages on benefits and synergies.
- We have a growing body of laws and regulation.

Jae Edmonds (Pacific Northwest National Laboratory) described the aims we need to target as developing lower costs and deeper emissions mitigation. Research has shown that costs of CO<sub>2</sub> mitigation are cut in half when CCS is available as an option. Delaying action increases costs greatly, and in such a world, the difference CCS makes to long term costs is greatly increased.

Prof. Kikkawa (Hitotsubashi University) then looked at how humans can overcome climate change. There will have to be a trade off between affluence and global salvation, and energy conservation must be the trade off.



*Clockwise from left: Breaking the seal of a ceremonial Sake barrel opened the conference; delegates network before the technical sessions; Sally Benson receives the 2012 Greenman Award; Origami cranes: A symbol used in the introduction video*

Mr Tachibana (CRIEPI) addressed the delegates, looking at the prospects for CCS over the next five years. CCS needs a large scale industry similar to the oil and gas industry; if we are serious about deployment we need to be ready in all elements... Are we there yet?

### Key Messages

We should learn from the nuclear industry, and the enthusiasm shown within our area is encouraging, but we must manage risk so that no single issue can destroy the entire industry. Delegates were also encouraged not to believe in silver bullets, they generally don't live up to their promise, and we need to learn to rely on a range of options. This conference has seen a lot of different options presented, and this is evidence of the potential we have at our fingertips to ensure that this range of options is ready as and when the economy and policy facilitates deployment; we must be ready!

In final closing, John Gale commented on the motto for the conference, CCS: Ready to move forward, and that in fact, the overarching message appears to be that CCS R&D is moving our knowledge base forward at pace, but in some regions of the world we are not moving as swiftly we would like at the demonstration phase, but progress is being maintained. North America is leading the demonstration race but Asia (particularly China, Japan and Korea) are catching up fast. ●

# Doha; From one Kyoto to another Kyoto,

by Tim Dixon, IEAGHG

International CCS attention moved from GHGT-11 held in the home of the Kyoto Protocol to Qatar where the future of the Kyoto Protocol was to be negotiated. COP-18 was held in Doha, Qatar, with apparently 17,000 delegates from over 194 countries.

## High Level

*Good news, bad news, and good news.*

Good news; COP-18 and CMP-8 have concluded after a marathon 36-hour final session, with the agreement for a second Commitment Period for the Kyoto Protocol that will run from 2013 to the end of 2020. This entails new legally-binding emissions commitments for the developed countries remaining in the Kyoto Protocol, notably the 27 EU Member States, Australia, Norway, Ukraine; developing countries are included but without emission targets.

Bad News; the emissions targets are not high enough and not enough countries are included to significantly reduce global emissions. Some major emitting developed countries will not be included; USA, Canada, Japan, Russia and New Zealand.

Good news; all this is significantly better than no second Commitment Period and no countries with emissions targets.

Whilst many think the emission targets for individual countries are set too low, this does keep the global framework for emissions reductions and emissions trading mechanism (e.g. CDM) operational while countries make progress on the Durban Platform for Enhanced Action (ADP) towards a legally-



binding agreement for 2015 for all 194 UNFCCC countries (including USA and China). There is also some limiting of the carry-over of AAUs (hot-air).

Unexpected difficulties arose in the higher-level negotiations over the issue of compensation from developed countries for 'loss and damage' to developing countries as a result of climate change (caused mostly by their emissions). The potentially un-limited nature of this is ringing alarms bells for some.

## CCS Outcomes

The text adopted by CMP-8 on CCS in CDM reflects the decision from SBSTA to defer any further consideration of transboundary projects and a Global Reserve until SBSTA 45 (expected 2016), and was as follows:

*"Welcomes the work undertaken by the Executive Board to adopt relevant documents regarding CCS in geological formations as clean development mechanism project activities;*

*Decides that the eligibility under the clean development mechanism of CCS in geological formations project activities which involve the transport of CO<sub>2</sub> from one country to another or which involve geological storage sites that are in more than one country and the establishment of a global reserve of*

*certified emission reduction units for CCS in geological formations project activities shall be considered by Subsidiary Body for Scientific and Technological Advice at its forty-fifth session.*

*Also decides that while CCS in geological formations project activities which involve the transport of CO<sub>2</sub> from one country to another or which involve geological storage sites that are in more than one country would merit inclusion under the clean development mechanism, more practical experience of CCS project activities in geological formations under the clean development mechanism would be beneficial;"*

## Technology Mechanism

The Technology Mechanism was partly operationalised, with the appointment of a consortium lead by UNEP to operate the Climate Technology Centre and Network (CTCN) for five years. It is anticipated that CCS will be included in the range of technologies assisted by this network.

## CCS During Doha

Two sets of negotiating meetings took place on the transboundary projects and Global Reserve of CERs issue. Text was agreed that consideration of both is to be postponed until SBSTA-45 (i.e. 2016) to allow time to learn from CCS projects in the CDM. Whilst this isn't a bad result in itself for the time-being, (very few wanted the Global Reserve and there were good arguments against it) it isn't as

good as the initial version proposed by the Chairs which would have removed the Global Reserve permanently, recognising the adequacy provided by the existing modalities and procedures (also described as “providing robust environmental protection” by many here).

These results of the negotiations on CCS were approved by SBSTA Plenary at 11:06pm on Saturday 30<sup>th</sup> November. Some observers expressed disappointment at the two CCS issues on transboundary and Global Reserve being deferred for four years and then brought back for consideration, not realising that the resolution of transboundary issues was always likely to take some time. For example, the London Convention, a large treaty which moves faster than UNFCCC because of its decision-making design and its double pressure of ocean acidification as well as climate change, still took three years after the major CCS amendment to reach a legal transboundary CCS amendment and another three years to make any further progress on the outstanding transboundary issues. However, the Global Reserve deferring is a different matter, there were no substantive arguments made for it or why to revive it in four years, but substantive arguments were made for it to have been taken off the agenda now.

In SBSTA Plenary the IMO were pleased to announce the progress made at the London Convention earlier this month on agreeing guidelines for transboundary CCS activities subsurface (which involved IEAGHG).

### CCS on the side

As the negotiations inched along towards agreement for a second Commitment Period for the Kyoto Protocol and for the Durban Platform for Enhanced Action (ADP) there was a realisation that although CCS negotiations had concluded, there has been a lot of other activity on CCS at this COP.

There were four ‘official’ UNFCCC Side-events on CCS and four ‘unofficial’ events. IEAGHG spoke at five, specially on the CCS Summer School, on the work on CCS for the Iron and Steel sector, on transboundary



developments (including the UNFCCC report on transboundary issues and its gaps), on UK Department of Energy and Climate Change policy for the UK Programme, on Science in policy making, and on knowledge transfer. By comparison at Durban there was only one ‘official’ Side-event on CCS (ours).

The UNFCCC Side-event of CCSA/ University of Texas/IEAGHG on CCS Education on the first Tuesday went well, was well attended (apparently the most of any CCS event here) and had a high level of interest. Especially interesting at the Side-events here were the talks by Qatar, UAE and Saudi Arabia on their CCS project activities, with several pilot projects now in development in the region, supported by R&D programmes. Bio-CCS continues to gain prominence and interest, and the IEAGHG studies in this area are proving a valuable resource.

The need for information on CCS was demonstrated both in the negotiations (e.g. where one negotiator questioned the basic risk, safety and uncertainty of CCS) and at the booths of CCS-related organisations which have been more popular than ever being visited by those seeking information on CCS. The University of Texas, CCSA and the International Energy Agency collaborated with IEAGHG in sharing our information at their booths.

There was also a media-release here by seven green NGOs (ENGOS) who, funded by the Global CCS Institute, collaborated to produce a

advocating actions to encourage CCS (see [www.engonet.org](http://www.engonet.org)).

### CCS Outside

Also in Doha, the COP-18 Reception was held at the Qatar Sustainability Expo. Of interest here were several displays on CCS, including an impressive ‘CCS elevator’ by Shell and the Qatar Carbonate and Carbon Storage Research Centre (with some video content from IEAGHG). Of note was an interesting car from Saudi Aramco which is their project to CO<sub>2</sub> capture from vehicle exhausts. Fully operational for 2,000km so far, capturing 10% of the CO<sub>2</sub>, the plan is to increase to 60%.

### Concluding thoughts

The world of climate change mitigation took significant steps forward, and CCS is now embedded as a validated option to reduce emissions in both developed and developing countries. Much work is still to be done, experience to be gained, and capacity to be built, but the building blocks for climate change mitigation are in place and prospects for CCS exist with all of them. ●

# 42<sup>nd</sup> Executive Committee Meeting,

by Millie Basava-Reddi, IEAGHG

The Executive Committee (ExCo) of the IEA Greenhouse Gas Programme (IEAGHG) was held in Kyoto, Japan and hosted by our Japanese members RITE on 15<sup>th</sup> – 16<sup>th</sup> November 2012. The meeting was timed to coincide with GHGT-11 the following week.

The meeting involved 2 days of discussion on the last 6 months activity and agreed the work programme for the next 6 months. Studies discussed and approved by members included:

- Key Messages for Stakeholders
- Interaction of CO<sub>2</sub> Geological Storage with Subsurface Resources
- Incorporating Future Technological change in Existing Capture Plants
- Implications of gas production from Shale and Coal on CO<sub>2</sub> Geological Storage.

The activities of the IEAGHG Research Networks were discussed. In particular, there were updates from the Solid Looping, Social Research and Environmental Assessment networks. A joint storage network meeting was held this year instead of the separate meetings, in part to discuss the future of the networks and an update was given on this. One of the major outcomes discussed was the idea to hold more combined meetings and have more interaction between the networks to discuss cross-cutting issues.

The ExCo approved IEAGHG undertaking the following studies:

- Operating Flexibility of CO<sub>2</sub> Storage and Transport
- Impact of CO<sub>2</sub> Impurity on CO<sub>2</sub> Compression and Transportation
- Quantifying and Monitoring Emissions reductions from CO<sub>2</sub>-EOR
- Techno-Economic Evaluation for Different Post Combustion Capture Process Flow Sheet Modifications
- Understanding the Cost of Retrofitting CO<sub>2</sub> Capture in Oil Refineries
- Cost Components for Storage of CO<sub>2</sub> in association with EOR. ●

## 6<sup>th</sup> IEAGHG International CCS Summer School, by Samantha Neades, IEAGHG

This year's IEAGHG International CCS Summer School was held in Beijing, China, from the 12<sup>th</sup> to the 17<sup>th</sup> of August. The sixth annual School was hosted by Tsinghua University and jam-packed with lectures and events throughout the week.

From the 206 applications, 47 students were selected, from 18 countries and 22 nationalities – 49% of whom were from non-OECD countries.

The week-long programme covered all aspects of CCS – from capture to storage, regulations to technical writing. Certain things that were new to this year included presentations on environmental impacts, NGO perspectives, bio-CCS and utilisation. The (very hot and humid!) field

trip day involved an interesting visit to Huaneng Group's pilot capture plant at the Gaobeidian power station, followed by a very warm but brilliant afternoon at the Forbidden City.

Not only was the programme full to the brim with lectures, students were split into 6 groups and assigned a topic to work on throughout the week and present on the Friday. This year's group winner was Group 3, whose topic was: 'How can China set up integrated CO<sub>2</sub> capture, transport and storage networks?'. IEAGHG's Jasmin Kemper was a member of the winning group - which was not a fix! This year's Best Students, as decided by the expert mentors, were Niels Berghout from Utrecht University and Vivianne Romeiro from the University of Sao Paulo – congratulations to them both, who will now be joining the 7<sup>th</sup> Summer School here in the UK in 2013.



Field trip to Gaobeidian power station



Students and Mentors of the 2012 IEAGHG Summer School



The winning group at the closing ceremony



Students enjoying the closing dinner

The students were taught and mentored by 27 experts and 3 student mentors – Viktor Andersson, Chalmers University of Technology; Bin Guo, University of Illinois and Carrie Petrik-Huff, University of Massachusetts. The hard work of the mentors ensured this was a hugely educational and enjoyable event – many staying up until the early hours of most mornings to assist the students in their group work!

The 2012 School was sponsored by the Global CCS Institute, Alstom, CIUDEN, CO2CRC, UKDECC, Gassnova, Schlumberger Carbon Services, Shell, Statoil, ZEP and Elsevier (Series Sponsors), along with local sponsors – China Huaneng Group, Shenhua Guohua Power, Tsinghua University, Alstom China and The Administrative Center for China's Agenda 21. IEAGHG would like to thank all sponsors, Local Organising Committee members, International Steering Committee members and particularly the fantastic mentors for their enthusiasm during and their input prior to the School.

We would also like to thank the students from this year's School for ensuring, as always, that the 2012 IEAGHG

Summer School was a success – your enthusiasm and hard work throughout the week was great to see and we wish you all the best for your future endeavours.

The 2013 IEAGHG International CCS Summer School will be held in Nottingham, UK. Keep an eye on our website for announcements regarding the Summer School in the coming weeks, as students are invited to apply for the next School from January 2013. Details can be found on page 15.

For more information, please see [www.ieaghg.org](http://www.ieaghg.org).

# New IEAGHG Technical Studies, by Millie Basava Reddi, Samantha Neades & Tim Dixon, IEAGHG

## *Extraction of Formation Water from CO<sub>2</sub> Storage*

IEAGHG have published a study considering extraction of formation water from CO<sub>2</sub> storage sites, which was undertaken by the Energy & Environmental Research Center (EERC).

The approach taken was to consider case studies with a wide range of geological, geographical and geopolitical conditions, which may impact the ability to implement an extracted water plan in conjunction with commercial scale storage projects. Relatively simple 3D models were formed to test different injection and extraction scenarios and incorporate vital, heterogeneous reservoir properties, including structure, porosity, permeability, water quality, lithology, temperature, and pressure, which were obtained from published sources. Literature considering water disposal and usage was reviewed as well as those looking at likely salinity ranges.

The case studies selected were Ketzin, (near Potsdam in Germany); Zama (Alberta, Canada); Gorgon (Barrow Island, Australia) and Teapot Dome (Wyoming, USA). For each case study a range of injection scenarios were considered as well as CO<sub>2</sub> surface dissolution, whereby CO<sub>2</sub> could be stored by dissolving it in extracted formation water and then injected into a geological formation.

Extracting water from a storage reservoir was observed to have variable effects based on the specific nature of reservoir rock and boundary conditions, as well as operational factors such as injection / extraction management and placement of wells. A 1:1 ratio of injected CO<sub>2</sub> to extracted water was generally appropriate, though in some situations, the volume of water to be removed from the reservoir was much higher for desired pressure or plume management tasks. Generally, simulations conducted illustrate water extraction scenarios may be capable of doubling storage capacity.

Treatment and beneficial use of extracted water was found to be feasible under certain conditions: a combination of low-to-moderate extracted water quality, availability of inexpensive energy and sufficient local water demand.

Surface dissolution involving the extraction of reservoir fluid, saturation, and subsequent reinjection was found unlikely to be a viable option in most situations as the capacity of produced fluids to dissolve and carry CO<sub>2</sub> is too low.

Existing regulations were not found that impose a barrier to the development

of water extraction as part of reservoir management operations nor for the development of procuring additional water resources, provided the water quality is fit for the intended use. If extracted water is treated and utilised, effluent will be under regulations to adhere to wastewater treatment and handling.

Despite high costs and shortcomings encountered with extracting reservoir fluids for increasing reservoir capacity and/or management, it is important to consider these options for any specific storage site in an effort to optimise the injection scenario, potentially alleviate costs through beneficial use, reduce risk and MVA costs and increase reservoir efficiency by controlling plume migration and to manage pressure and injectivity.

Knowledge gaps and areas of additional and continued research were considered and include developing a global database, evaluating additional plume management strategies, optimising injection simulation scenarios based on distance between wells using site specific data and integrating chemical and physical phenomena.

## *Financial Mechanisms for Long-Term CO<sub>2</sub> Storage Liabilities*

In November 2012, IEAGHG published a new study, 'Financial Mechanisms for Long-Term CO<sub>2</sub> Storage Liabilities'. Contracted out to ICF International, this study looks at current laws and emerging regulations on long-term aspects of liability and assesses the various potential financial mechanisms for supporting CO<sub>2</sub> liability. The study aimed to review current CCS-specific and non-CCS regulations worldwide, with a focus on financial mechanisms for long-term liability and to investigate potential financial mechanisms for long-term CCS liability. The contractors also aimed to provide recommendations on such mechanisms and assess liability transfer issues that may arise.

The report identified the types of liabilities that financial requirements typically apply to in relation to CCS. Within the EC, such liabilities could include monitoring, corrective measures and certain site operations. The US EPA advise that the CCS liabilities that are covered by financial instruments must include (and cover): corrective action for plugging abandoned wells/mines; injection well plugging; post-injection site care/closure and emergency and remedial response.

The report identifies, describes and assesses eighteen types of financial mechanisms, including third party, first party and government mechanisms. It also goes some way in analysing key generic aspects of frameworks for the transfer of long-term CCS liability to the government – aspects including threshold technical requirements, technical requirements, post-transfer cost recovery provisions and the specification of which and whose liabilities should be transferred.

Although the study does not recommend any one liability transfer framework option, it is concluded by providing two examples of frameworks which show different balances between the evaluation criteria used. In this conclusion and for these example cases, they focus on balancing the assignment of costs between government and industry, incentives to industry and providing environmental protection.

For more information please contact [Samantha.Neades@ieaghg.org](mailto:Samantha.Neades@ieaghg.org), or to request a copy of the report [Becky.Kemp@ieaghg.org](mailto:Becky.Kemp@ieaghg.org), quoting 2012-11 for Financial Mechanisms for Long-Term CO<sub>2</sub> Storage Liabilities and 2012-12 for Extraction of Formation Water from CO<sub>2</sub> Storage. ●

## Germany's CCS Law, by Franz May, BGR

The European CCS directive has been transposed into German law, effective from the 24<sup>th</sup> of August 2012. The law covers capture, transport and permanent storage of CO<sub>2</sub> in subsurface rock formations.

The purpose of this law is to facilitate the demonstration of CCS technologies and to ensure safe storage and the protection of man and environment. The German CCS law limits projects to an annual injection of up to 1.3 Mt of CO<sub>2</sub> storage site and 4 Mt in total. Thus, three small to medium sized projects to demonstrate the economical, environmental and technical feasibility of CCS could be realized under the current provisions. The law shall be evaluated in 2018 taking into account experience gained from national and international CO<sub>2</sub> storage projects and could thus be adapted for broader application of CCS. The German states are responsible for administering the law, thus for permitting CO<sub>2</sub> storage projects. Opinions of the federal agencies on geology and environment shall be obtained for state permits. Mapping and characterization of CO<sub>2</sub> storage potential, however, is a federal task. According to the so called "states' clause" states have the right to identify or exclude regions for storage demonstration, based on geological criteria, options for alternative use of subsurface structures or other public interests. The German text of the law is available online from [www.gesetze-im-internet.de/bundesrecht/kspg/gesamt.pdf](http://www.gesetze-im-internet.de/bundesrecht/kspg/gesamt.pdf). Additional information is available in the third edition of the IEA CCS Legal and Regulatory Review.

[www.iea.org/publications/freepublications/publication/CCS\\_Review\\_3rdedition\\_FINAL-1.pdf](http://www.iea.org/publications/freepublications/publication/CCS_Review_3rdedition_FINAL-1.pdf) ●

## Deepest Wells in Saskatchewan Drilled: Pioneering CCS Project Goes Deep, by A M Young, PTRC



**Saskatchewan's deep-saline storage project has gotten deep – 3.4 km deep to be exact.**

Located in South Eastern Saskatchewan, Aquistore will be the first project to demonstrate deep saline CO<sub>2</sub> storage in Canada. Partnered with SaskPower's Boundary Dam Carbon Capture venture, Aquistore will assist SaskPower in meeting their green house gas reduction targets, as a part of the world's largest commercial-scale, coal-fired carbon capture and storage project into a deep saline reservoir.

Aquistore operations have been steadily underway since July 2012. The project is now home to two wells – an injection and evaluation well and an observation and monitoring well.

At a total depth of 3396 metres, Aquistore's Injection well was confirmed on September 10<sup>th</sup> as the deepest well in the province of Saskatchewan.

Saskatchewan's Ministry of Economy confirmed the news, "At 3396 m Total Vertical Depth, the PTRC's Aquistore well is the deepest well drilled to date in the province," said the Office of Energy and Resources.

Drilling of the second observation well has continued throughout the fall, and as of December it is nearing completion. At a total vertical depth of 3400m, it is expect that this well will be confirmed as the new deepest well in the province. "We are ecstatic about the news," said PTRC CEO Dr. Malcolm Wilson, "This project is already the first of its kind in the world. To find out we drilled the deepest wells is a nice surprise."

While south-eastern Saskatchewan is well known for its oil and gas resources,

most extraction comes from shallower wells. Due to the lack of deep wells in the area, the Aquistore well is set to become a primary data point for the Deadwood formation – the deepest sedimentary unit in the Williston Basin. As Wilson noted, this is good news for Aquistore, "As the PTRC's first wells drilled, Aquistore is already the first project in the world to integrate commercial-scale CO<sub>2</sub> capture, transportation, and injection from a coal-fired electrical generating station into a deep geological formation. We knew our target injection zone, the Deadwood, was obviously quite deep.

CCS on the Canadian Prairies. The Aquistore site with SaskPower's facility in the background.



Now that we know the depth, the research opportunities afforded to us are excellent”.

The information from the second observation well will provide valuable knowledge for Aquistore’s robust monitoring, measurement and verification project. This well will assist the project in tracking the CO<sub>2</sub>. The two fully instrumented wells will provide valuable information and data to the project, and to other interested parties.

The comprehensive suite of well logs and core samples are creating a buzz within industry. Project Manager Kyle Worth explained, “To have quality cores from such a depth is a rarity and our Science and Engineering Research Committee is eager to start analysing the samples”. The complete set of logs

and other data that accompany this well are useful not only for CO<sub>2</sub> storage, but also for oil companies in the area that have interest in hydrocarbon-bearing formations. The project has already begun receiving inquiries as to the availability of these unique well logs.

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Images:

Aquistore site images available for use upon request. ●

## Economic Impacts of CO<sub>2</sub> Enhanced Oil Recovery for Scotland

This article is a transcription of the Executive Summary of the above titled report, compiled by Harsh Pershad and Emrah Durusut of Element energy. For more information, please contact them directly on [harsh.pershad@element-energy.co.uk](mailto:harsh.pershad@element-energy.co.uk) or [emrah.durusut@element-energy.co.uk](mailto:emrah.durusut@element-energy.co.uk).

Recognising that the combination of Carbon Capture and Storage (CCS) with CO<sub>2</sub>-Enhanced Oil Recovery (EOR) could bring positive impacts to the Scottish economy, Scottish Enterprise commissioned a team led by Element Energy and including Heriot Watt University and Dundas Consultants to examine the issues related to CO<sub>2</sub>-EOR and quantify the economic impacts in Scotland.

Nineteen oilfields in the UK Continental Shelf (UKCS) may be technically attractive ‘anchor’ projects for CO<sub>2</sub>-EOR. These have a combined potential incremental oil recovery of 2.5 billion barrels of oil, associated with storage in the region ca. 0.8 Gt CO<sub>2</sub>. The uncertainty in these figures is at least +/- 50%. A cluster of large CO<sub>2</sub>-EOR projects could contribute ca. 15% of UKCS oil production in 2030. Scenario modelling suggests that the highest rates of EOR deployment in the UKCS would bring £2.7 billion in Gross Value Added (GVA) to the Scottish economy, relative to a scenario where the oilfields are decommissioned. Supply chain opportunities for Scottish businesses would result in 5,300 person-years of employment (new or maintained) for projects initiated by the early 2030s. Effective engagement of the Scottish supply chain with UKCS CO<sub>2</sub>-EOR projects could double these GVA and employment figures. Domestic experience can then be leveraged to other potential CO<sub>2</sub>-EOR markets in other sectors of the North Sea and internationally.

Financial modelling reveals that for several fields CO<sub>2</sub>-EOR projects yield a positive Net Present Value (NPV) at current oil prices. Therefore EOR could be a driver towards the key outcome for the UK Government’s CCS commercialization programme to make power generation with CCS cost competitive with other large low carbon power generation technologies in the 2020s. The financial modelling identifies that the principal beneficiaries of a CO<sub>2</sub>-EOR cluster in the North Sea would be the Governments of the UK, Norway and Denmark, as a result of the high taxes applied to the offshore industry. These tax receipts could in principle be offset against public subsidies for CCS, i.e. CO<sub>2</sub>-EOR could be an enabler of CCS, although tax returns are highly sensitive to oil prices, reservoir performance, and number and choice of projects.

The commercial case for conventional oil companies to invest in CO<sub>2</sub>-EOR is fragile. Since the collapse of the original BP DF1 Miller proposal, no UKCS oil operator has indicated strong, clear commitments to developing CO<sub>2</sub>-EOR. This study has found numerous barriers and deeply-held scepticism as to the early commercial uptake of CO<sub>2</sub>-EOR in the North Sea from a

wide range of public and private stakeholders. CO<sub>2</sub>-EOR has never before been carried out in the North Sea. Oil companies will factor in a range of uncertainties and first-of-a-kind risks.

Some stakeholders believe that commercial CO<sub>2</sub>-EOR projects would only follow on the back of successful CCS demonstration, if oil prices remain high and if there is a reliable CO<sub>2</sub> supply directed towards a suitable oilfield. A wait-and-see approach to CO<sub>2</sub>-EOR in the UKCS could however lead to missed opportunities for the UKCS, as most of the UK's relevant oilfields are predicted to be decommissioned by the 2030s.

There are two proposals including CO<sub>2</sub>-EOR in the North Sea in the EU's New Entrant Reserve (NER300) programme for CCS demonstration. One of these (2Co Energy) has submitted a proposal for the use of CO<sub>2</sub>-EOR in the UKCS in DECC's CCS commercialization.

Even if an initial North Sea CO<sub>2</sub>-EOR project is demonstrated in the 2010s, multiple barriers could jeopardise commercial viability of subsequent projects. These include weak incentives and uncertainties around CO<sub>2</sub> storage liabilities, oil price, oil recovery levels, infrastructure requirements and costs, CO<sub>2</sub> supply, CO<sub>2</sub> storage capacity, and future regulation. High oil price is a positive driver of CO<sub>2</sub>-EOR, but even at high oil prices, alternative investment opportunities may provide lower complexity and better risk-reward profiles for energy companies.

The uptake of CO<sub>2</sub>-EOR in the 2020s in the North Sea will depend on many factors, including the levels of sustained policy support for CCS, oil prices, and stakeholder support. Since some of these drivers are outside of Scottish Enterprise's control, a flexible strategy designed to influence key stakeholders is appropriate. The full report details five actions that Scottish Enterprise could take if it wishes to support CO<sub>2</sub>-EOR. These are summarised below.

The full report details five actions that Scottish Enterprise could take if it wishes to support CO<sub>2</sub>-EOR. These are summarised below.

1. Support a "Champion" that can advocate a coherent view of CO<sub>2</sub>-EOR requirements and opportunities to policymakers and other stakeholders.
2. Sponsor meetings, workshops and personnel exchanges to facilitate knowledge sharing between UKCS oilfield owners, engineers, policymakers, regulators and participants in ongoing CO<sub>2</sub> injection projects worldwide.
3. Leverage existing connections with the oil and gas supply chains to raise awareness of the supply chain opportunities for CO<sub>2</sub>-EOR projects. This could include encouraging suppliers to participate in engineering studies for CO<sub>2</sub>-EOR and/or providing funding for oil and gas industry suppliers to attend CCS networking events.
4. Support preparatory work for CO<sub>2</sub>-EOR cluster development through a Task Force focussed on the needs of the relevant oil companies.
5. Facilitate continued co-operation, stability and consistency between the Scottish and UK Governments across the full suite of energy and climate policies relevant to CO<sub>2</sub>-EOR deployment, especially in the event of constitutional change.

If adopted, these recommendations will maximise the CO<sub>2</sub>-EOR opportunity, and position Scottish businesses to take full advantage of the economic benefits of CO<sub>2</sub>-EOR. ●

## Economic impacts of CO<sub>2</sub> enhanced oil recovery for Scotland

### Final report



elementenergy

dundas



# New IEA Publications

The IEA have recently published the latest editions of Energy Technology Perspectives, and World Energy Outlook. They can be ordered from the IEA's website at [www.iea.org/etp](http://www.iea.org/etp) and [www.worldenergyoutlook.org](http://www.worldenergyoutlook.org).

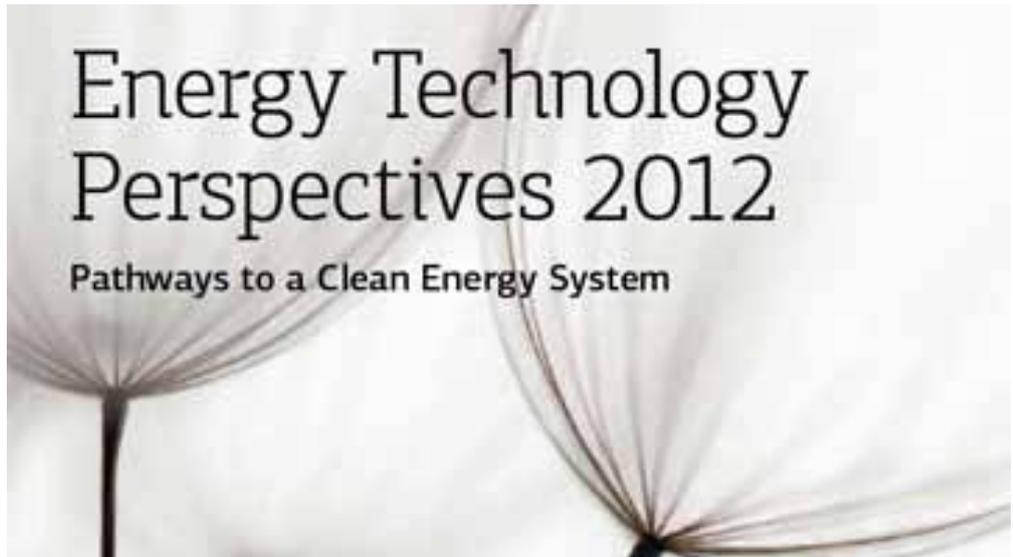
A host of new technologies is ready to transform the energy system, offering the potential to drastically reduce carbon emissions, enhance energy security and generate a huge investment return, the International Energy Agency (IEA) said in its flagship energy technology publication launched today.

The book, Energy Technology Perspectives 2012 (ETP 2012), explains how to enable and encourage technologies and behaviours that together will revolutionise the entire energy system and unlock tremendous economic benefits between now and 2050.

ETP 2012 builds on the IEA's Tracking Clean Energy Progress report, issued in April, which said that despite some recent progress in deploying renewable energy, most clean energy technologies are not on track to make their required contribution to reducing carbon dioxide (CO<sub>2</sub>) emissions and thereby provide a more secure energy system.

"While our efforts to bring about a clean energy transformation are falling further behind, I want to stress the golden opportunity before us: If significant policy action is taken, we can still achieve the huge potential for these technologies to reduce CO<sub>2</sub> emissions and boost energy security," said IEA Executive Director Maria van der Hoeven.

"Now that we have identified the solution and the host of related benefits, and



with the window of opportunity closing fast, when will governments wake up to the dangers of complacency and adopt the bold policies that radically transform our energy system? To do anything less is to deny our societies the welfare they deserve," she said.

The technological revolution will not be cheap, but the long-term benefits far outweigh the costs. ETP 2012 presents an investment plan that more than pays for itself through fuel savings by 2025. And the savings would triple by 2050: An additional USD 36 trillion of investment would be required to overhaul the world's current energy system by the middle of the century, but this would be offset by USD 100 trillion in savings through reduced use of fossil fuels.

ETP 2012 presents a 2°C Scenario, which lists the energy technology choices that can ensure an 80% chance of limiting long-term global temperature increase to 2°C. The plan leads to a sustainable energy system featuring diverse sources, low-carbon electricity and an expanded infrastructure. The system would be smarter, more unified and more integrated than today's, and ETP 2012 assesses the increasingly sophisticated low-carbon technologies that get the

most out of energy options, showing how the world can effectively and efficiently adopt solutions ranging from energy storage to flexible generation.

Improved energy efficiency offers the greatest potential for boosting energy security and reduced carbon emissions, and ETP 2012 includes a variety of technological and policy options that would cut the global economy's per-unit use of energy by two-thirds before 2050.

Fossil fuels would not disappear, but their roles would change. ETP 2012 explains how higher steam temperatures can cut coal-fired power plants' emissions by 30% even as natural gas increasingly complements so-called variable renewable sources (primarily wind and solar), providing the flexibility that energy systems would need to balance generation and demand fluctuations. The book makes clear that low-carbon fuels and technologies depend on immediate infrastructure change to build in the flexibility the new approaches require.

## World Energy Outlook:

The global energy map is changing in dramatic fashion, the International Energy Agency said as it launched the 2012 edition of the World Energy Outlook (WEO). The Agency's flagship publication, released today in London, said these changes will recast expectations about

the role of different countries, regions and fuels in the global energy system over the coming decades.

“North America is at the forefront of a sweeping transformation in oil and gas production that will affect all regions of the world, yet the potential also exists for a similarly transformative shift in global energy efficiency,” said IEA Executive Director Maria van der Hoeven. “This year’s World Energy Outlook shows that by 2035, we can achieve energy savings equivalent to nearly a fifth of global demand in 2010. In other words, energy efficiency is just as important as unconstrained energy supply, and increased action on efficiency can serve as a unifying energy policy that brings multiple benefits.”

The WEO finds that the extraordinary growth in oil and natural gas output in the United States will mean a sea-change in global energy flows. In the New Policies Scenario, the WEO’s central scenario, the United States becomes a net exporter of natural gas by 2020 and is almost self-sufficient in energy, in net terms, by 2035. North America emerges as a net oil exporter, accelerating the switch in direction of international oil trade, with almost 90% of Middle Eastern oil exports being drawn to Asia by 2035. Links between regional gas markets will strengthen as liquefied natural gas trade becomes more flexible and contract terms evolve. While regional dynamics change, global energy demand will push ever higher, growing by more than one-third to 2035. China, India and the Middle East account for 60% of the growth; demand barely rises in the OECD, but there is a pronounced shift towards gas and renewables.

Fossil fuels will remain dominant in the global energy mix, supported by subsidies that, in 2011, jumped by almost 30% to \$523 billion, due mainly to increases in the Middle East and North Africa. Global oil demand grows by 7 mb/d to 2020 and exceeds 99 mb/d in 2035, by which time oil prices reach \$125/barrel in real terms (over \$215/barrel in nominal terms). A surge in unconventional and deepwater oil boosts non-OPEC supply over the current decade, but the world

relies increasingly on OPEC after 2020. Iraq accounts for 45% of the growth in global oil production to 2035 and becomes the second-largest global oil exporter, overtaking Russia.

While the regional picture for natural gas varies, the global outlook over the coming decades looks to be bright, as demand increases by 50% to 5 trillion cubic metres in 2035. Nearly half of the increase in production to 2035 is from unconventional gas, with most of this coming from the United States, Australia and China. Whether demand for coal carries on rising strongly or changes course radically will depend on the strength of policy decisions around lower-emissions energy sources and changes in the price of coal relative to natural gas. In the New Policies Scenario, global coal demand increases by 21% and is heavily focused in China and India.

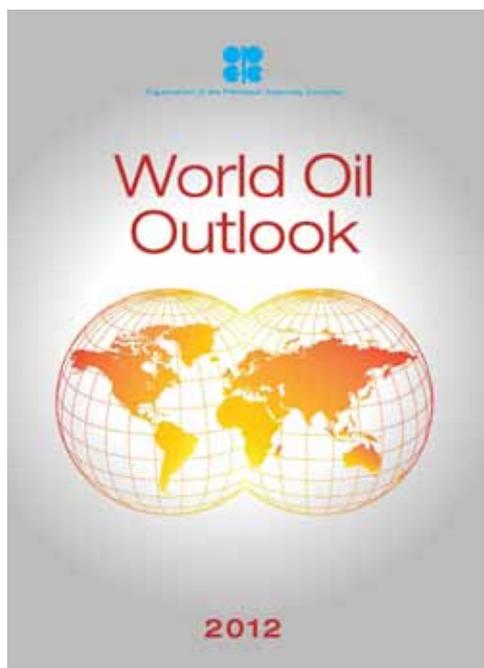
Renewables become the world’s second-largest source of power generation by 2015 and close in on coal as the primary source by 2035. However, this rapid increase hinges critically on continued subsidies. In 2011, these subsidies (including for biofuels) amounted to \$88 billion, but over the period to 2035 need to amount to \$4.8 trillion; over half of this has already been committed to existing projects or is needed to meet 2020 targets. Ambitions for nuclear have been scaled back as countries have reviewed policies following the accident at Fukushima Daiichi, but capacity is still projected to rise, led by China, Korea, India and Russia.

Water is essential to the production of energy, and the energy sector already accounts for 15% of the world’s total water use. Its needs are set to grow, making water an increasingly important criterion for assessing the viability of energy projects. In some regions, water constraints are already affecting the reliability of existing operations and they will introduce additional costs. Expanding power generation and biofuels output underpin an 85% increase in the amount consumed (the volume of

water that is not returned to its source after use) through to 2035.

“Our analysis shows that in the absence of a concerted policy push, two-thirds of the economically viable potential to improve energy efficiency will remain unrealised through to 2035. Action to improve energy efficiency could delay the complete ‘lock-in’ of the allowable emissions of carbon dioxide under a 2°C trajectory – which is currently set to happen in 2017 – until 2022, buying time to secure a much-needed global climate agreement. It would also bring substantial energy security and economic benefits, including cutting fuel bills by 20% on average,” said Fatih Birol, IEA Chief Economist and the WEO’s lead author.

WEO-2012 presents the results of an Efficient World Scenario, which shows what energy efficiency improvements can be achieved simply by adopting measures that are justified in economic terms. Greater efforts on energy efficiency would cut the growth in global energy demand by half. Global oil demand would peak before 2020 and be almost 13 mb/d lower by 2035, a reduction equal to the current production of Russia and Norway combined. The accrued resources would facilitate a gradual reorientation of the global economy, boosting cumulative economic output to 2035 by \$18 trillion, with the biggest gains in India, China, the United States and Europe. ●



OPEC have recently published the latest edition of World Oil Outlook. It can be downloaded from the OPEC website at [http://www.opec.org/opec\\_web/en/publications/340.htm](http://www.opec.org/opec_web/en/publications/340.htm)

## World Oil Outlook

OPEC's World Oil Outlook 2012 is part of the Organization's commitment to market stability and a means to highlight and further understand many of the possible future challenges and opportunities that lie ahead of the oil industry. The publication is also a channel to encourage dialogue, cooperation and transparency between OPEC and others within the industry.

The publication combines the expertise of the OPEC Secretariat, professionals in OPEC Member Countries and its Economic Commission Board, as well as input from various other sources. ●

## News From The IEA Clean Coal Centre,

by Debo Adams, IEACCC

### Latest report

Hybrid carbon capture systems by Robert Davidson is the latest report from the IEA Clean Coal Centre. In most discussions of systems for capturing CO<sub>2</sub> in coal-fired power plants, three options are described:

- post-combustion capture;
- oxyfuel combustion;
- pre-combustion capture.

Briefly, post-combustion capture uses chemical solvent sorbents although solid sorbents and membranes have also been studied. Oxyfuel combustion is a process that eliminates nitrogen from the oxidant by burning the fuel in a mixture of oxygen and a CO<sub>2</sub>-rich recycled flue

gas resulting in a product flue gas containing mainly CO<sub>2</sub> and water. In chemical looping combustion metal oxides are used to provide oxygen. Pre-combustion capture involves reacting a fuel with oxygen or air and/or steam to give mainly a 'synthesis gas (syngas)' or 'fuel gas' composed of carbon monoxide and hydrogen. The carbon monoxide is reacted with steam in a catalytic reactor, called a shift converter, to produce CO<sub>2</sub> and more hydrogen. CO<sub>2</sub> is then separated, resulting in a hydrogen-rich fuel which can be used in many applications, such as boilers, furnaces, gas turbines, engines and fuel cells.

Post-combustion capture and oxyfuel combustion have often been seen as distinct and, somehow, competing. Recently, there have been signs that this is no longer the case. Some researchers have realised that it may be possible to pick and choose among the elements of the main CO<sub>2</sub> capture systems and develop hybrid systems which are possibly cheaper and more energy-efficient.



Most hybrid systems are at a very early stage of development compared with the conventional methods with much of the research aimed at evaluation or modelling. The report provides a brief survey of these proposed systems comprising:

- post-combustion capture with oxygen enriched combustion;
- regenerable sorbents (calcium looping) with oxyfuel combustion;
- post-combustion capture in IGCC plants;
- gasification with oxyfuel;
- gasification with chemical looping.

The hybrid capture systems are mainly concepts that have not been physically studied or tested. An exception is the use of oxyfuel combustion for the calcination step in carbonate looping capture. This, though, is probably the least hybrid system of those considered.

### Next workshop

Based on the limited information available a general conclusion is that, to be successful, hybrid systems must not only be thermodynamically superior but they need to avoid introducing both higher cost and increased engineering complexity. However, the existence of hybrid capture concepts means that capture systems may not have to be limited to the trinity of post-combustion, oxyfuel combustion, and pre-combustion. The report is available at [www.iea-coal.org](http://www.iea-coal.org).

The 2nd IEA CCC Workshop on upgrading and efficiency improvements in coal-fired power plants will take place on 19<sup>th</sup>-20<sup>th</sup> March 2013 in Ratcliffe-on-Soar, UK. More information is available at <http://upgrading2.coalconferences.org>.

### Next webinar

Hermine Nalbandian will present a webinar on 'Trace elements from coal' on Weds 16<sup>th</sup> January at midday (UK time). IEA CCC Wednesday webinars take place every month, and can be viewed at any time, <http://www.iea-coal.org/site/2010/news/webinars?>.

### IEA CCC blogs

For insight into a range of coal-related events, follow the IEA CCC blogs, where members of the team review conferences and workshops that they've attended, at <http://www.iea-coal.org/site/2010/blog-section/blog?> ●

## IEA CCC Job Vacancy

### IEA Clean Coal Centre General Manager

**The IEA Clean Coal Centre is to appoint a General Manager in early 2013. This is a new position which arises from the present Director stepping down to a part-time role as an intermediate step en route to retirement.**

The IEA Clean Coal Centre is a world class centre of know-how on clean coal technologies and is closely linked to the development of carbon capture technologies. Its deliverables are a combination of expert review reports, workshops on specific technical issues, a bi-annual conference and several databases. Increasingly it has been harnessing the internet as a medium of communication and dissemination. Webinars, newsletters, blogs, use of social media are amongst the tools currently being routinely deployed.

Candidates for the General Manager position should have an extensive background in coal technologies and experience of managing an expert team, currently of around 24 people. Staff and financial management are equally important. The Centre is non-profit making, being funded by a combination of governments and large industry and with an annual turnover of about £2million. An ability to interact successfully with and to maintain these customers is fundamental to the long term health of the organisation. Hence the preferred appointee should be someone who can build relationships and can expect to remain in post for at least 5 years.

The position will be based on the IEA Clean Coal Centre's office in Putney, SW London and a competitive salary will be paid. If interested please send a cv and covering letter to the Managing Director, Dr John Topper, by email [john.topper@iea-coal.org](mailto:john.topper@iea-coal.org) Deadline for submissions is Thursday 31<sup>st</sup> January. ●

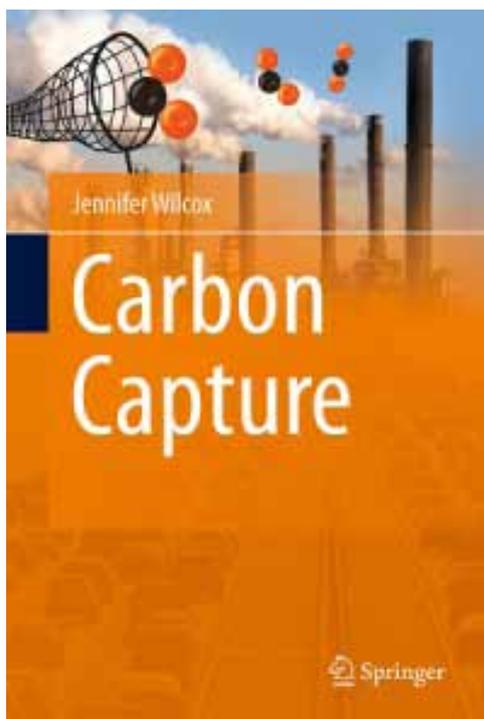
## IEAGHG Conference News

Summer School 21<sup>st</sup> - 26<sup>th</sup> July, Nottingham, UK. Applications are now being welcomed from students at: [www.ieaghg.org/index.php?/20121214320/summer-school-2013.html](http://www.ieaghg.org/index.php?/20121214320/summer-school-2013.html)

OCC3 9<sup>th</sup>-13<sup>th</sup> September 2013, Leon, Spain – Abstract submission NOW OPEN- deadline 25<sup>th</sup> January for more details: [www.ieaghg.org/index.php?/20120814317/3rd-oxyfuel-combustion-conference.html](http://www.ieaghg.org/index.php?/20120814317/3rd-oxyfuel-combustion-conference.html)

PCCC2 17<sup>th</sup>-20<sup>th</sup> September 2013, Bergen, Norway – Abstract submission NOW OPEN – deadline 13<sup>th</sup> February more details at: [www.ieaghg.org/index.php?/2nd-post-combustion-capture-conference.html](http://www.ieaghg.org/index.php?/2nd-post-combustion-capture-conference.html) ●

# First of its kind - Jennifer Wilcox's Carbon Capture



With the burning of fossil fuels currently meeting more than 80 per cent of the world's energy needs, the scientific community agrees that the solution for mitigating CO<sub>2</sub> emissions lies in a portfolio of strategies, including carbon capture and storage and potentially carbon capture and utilization. Carbon capture i.e. the mitigation of CO<sub>2</sub> through its separation from gas mixtures, such as power plant emissions will play a critical role in stabilising global warming.

In April this year I published Carbon Capture, the first book of its kind, with a particular focus as a resource for chemistry and chemical engineering students and practitioners.

Carbon Capture provides an interdisciplinary approach to the energy science subfield of carbon capture, and explains the fundamentals of gas separation and their link to the design process. It is based on fundamental chemical concepts, including thermodynamics, combustion, kinetics, mass transfer, material properties, and the relationship between the chemistry and the process of carbon capture technologies.

As an emerging field, carbon capture crosses many disciplines. In coming decades, engineers, chemists, physicists, earth scientists, mathematicians, and social scientists will advance traditional separation technologies. For example, amine-based scrubbing for CO<sub>2</sub> capture has been used for more than 70 years to purify natural gas. However, it is unclear whether this technology will be optimal for tackling the vast quantities of energy-related CO<sub>2</sub> emitted annually (31 Gt worldwide). The book covers the limitations of traditional gas-separation technologies in the context of CO<sub>2</sub> capture, and how these technologies could be advanced to meet the scale challenge required to substantially decrease CO<sub>2</sub> emissions.

Focusing solely on a variety of methods for capturing CO<sub>2</sub>, the core of the book discusses the most advanced CO<sub>2</sub> capture technologies, including absorption, adsorption, and membranes. There are also chapters on algae and electrochemical/photocatalytic CO<sub>2</sub>-to-fuel conversion processes. The reduction of CO<sub>2</sub> via photosynthesis or electrochemical/photo catalysis are routes to alternative fuels. Climate change and the development of alternatives to crude oil for transportation fuels will be strong drivers of policy, which are likely to persist for a long time, with indeterminate relative weights. Part of the motivation for including these topics is the vision that advancing new technologies

could eventually make it feasible for CCS to occur in a single process, rather than the current three-step sequence of capture, compression, and storage.

A broad range of disciplines within engineering and science are required to implement or improve carbon capture technologies. The text will benefit scientists and engineers active in the research and development of carbon capture technologies as well as engineers evaluating separation processes. It will serve as detailed educational material for science and engineering-focused industry personnel engaged in both carbon capture technologies and gas separation processes. Graduate and undergraduate students in chemistry and chemical engineering can also use it in the classroom examining separation processes in the context of carbon capture.

The three core chapters include many worked examples and end-of-chapter problems that test fundamental concepts – from the chemical physics associated with a given material that binds CO<sub>2</sub>, to the unit operations of the process, closely coupled by mass transfer. Carbon Capture provides a fundamental understanding of some of the critical technologies necessary to move to a more sustainable energy future.

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Jennifer Wilcox is an Assistant Professor of Energy Resources Engineering in the School of Earth Sciences at Stanford University. With a background in kinetics, catalysis, and chemical modeling, she investigates technologies associated with making energy production from carbonized sources cleaner. ●

After over 20 years of printed copies, the time has come to move on and evolve. Over recent years, the number of printed copies has been dropping, while the print costs have continued to rise, making the printing process less economically feasible. Added to that a move towards electronic based communications, and the time has come to make the decision to cease printing.



This will therefore be the final printed copy of the IEAGHG newsletter, and all subsequent copies will be available in electronic form only. Currently, we email around 4000 recipients with a notification of when the newsletter is available online, and although this email covers most paper-based recipients, there are some people we do not have an email address for. If you currently receive a paper copy of the newsletter, but do not receive the email notification, then we are likely to be missing your correct email address in our database. If you wish to continue to receive an electronic copy and do not currently receive the email notification, then please email [Becky.Kemp@ieaghg.org](mailto:Becky.Kemp@ieaghg.org) with your contact details, and we can ensure that your details are updated in our database. ●

## Conference: CCS – EU/RSA Partnerships A focus on Carbon Capture

13<sup>th</sup> to 15<sup>th</sup> February 2013

Eskom Academy of Learning, Midrand, Gauteng, South Africa



Conference Host

While Europe is on the verge of making its investment decisions regarding the first real CCS demonstration projects, CCS is in its early stages in South Africa. Several options for storage, to which industrial sources of CO<sub>2</sub> may connect, are still under assessment. From an EU/RSA relationship point of view, the opportunity is obvious . . .



Conference Co-ordinator

How can South African stakeholders collaborate with European partners with experience in Carbon Capture and Storage, learning from the successes, mistakes and insights gained? Likewise it is important for European CCS experts and managers to understand the specific local context of South Africa as it is diverse from the EU.

Having this aim in mind, the OCTAVIUS CCS project has chosen "EU/RSA Partnerships in CCS" as the theme for this conference with "A focus on Capture". Preceding South African CCS events have already covered storage extensively. However, as with

Storage, Capture and Transport are also prerequisites to applying CCS.

In case of electricity generation, contributing to around half of South Africa's greenhouse gas emissions, the CCS cost per tonne of CO<sub>2</sub> is dominated by the cost of Capture. Therefore, it is apparent that in assessing the economic viability of CCS for South African power generation cases, capture is of great importance. This is why the OCTAVIUS project specifically looks at the demonstration of technologies that can reduce capture cost.

There will be ample opportunities to network and gain insight both on a strategic and technical level during the conference.

Join us at this event sponsored by the European Union, hosted by Eskom and coordinated by EcoMetrix Africa and save the date!

Main topic's covered:

### DAY 1

CCS in the EU and South Africa  
Making CCS a Reality  
Cost and Financing of CCS

### DAY 2

Commercial Capture Technologies  
Next Generation Capture  
OCTAVIUS Project Results



This initiative is sponsored by the European Commission via the Seventh Framework Programme. We thank the European Union and our further sponsors among which Eskom (hosting the event), the Fossil Fuel Foundation (affiliated organisation) and the South African Centre for CCS (affiliated organisation) for making this event possible and accessible to a wide range of European and South African stakeholders.

Dates:  
13<sup>th</sup> to 15<sup>th</sup> February 2013

Times:  
9 am to 5 pm

Venue:  
Eskom Academy of Learning  
Physical Address:  
Dale Road, Halfway House,  
Midrand, Gauteng, SA

Optional site visit on Day 3 to Eskom's Kusile Power Station (under construction)

Cost: Free Participation  
South African Professional Engineers (PrEng) interested in attending the conference can acquire CPD points.

Programme & Registration:  
[www.octavius-co2.eu](http://www.octavius-co2.eu)

For more information contact: Sheilagh Koen

[KoenSh@eskom.co.za](mailto:KoenSh@eskom.co.za)

Tel: +27 (0)11 629 5426

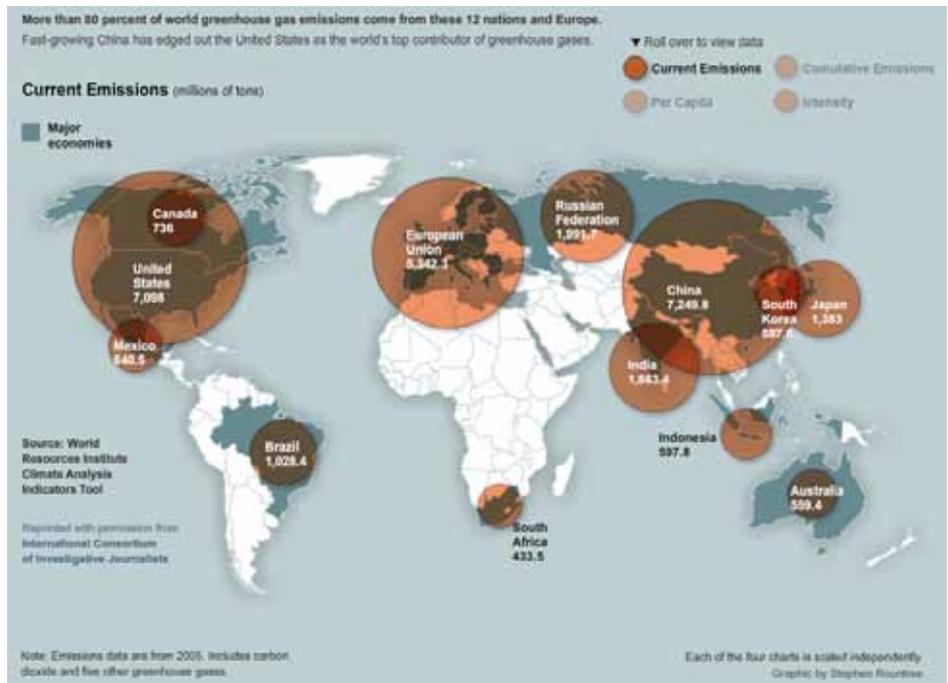
Please note that there is limited space, early booking is essential. ●

## Four Ways to Look at Global Carbon Footprints, by Toby Aiken, IEAGHG

I saw an interesting graphic a few weeks back, which I felt would be of interest to readers of Greenhouse News.

Using 4 simple representations of data, it underlines why we need to address the problem of climate change, why we need to act now, and demonstrates the reasoning behind who should lead.

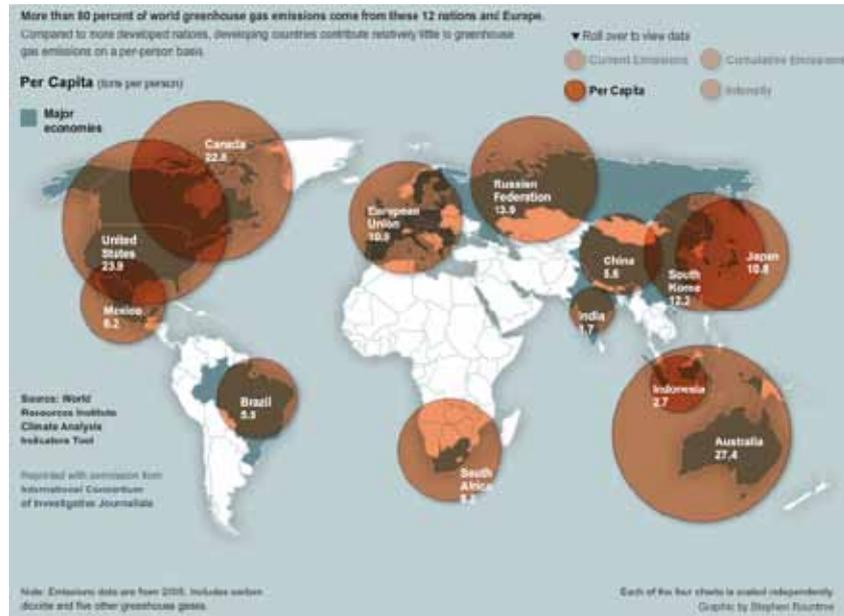
It demonstrates 4 different ways of looking at carbon dioxide emissions; current emissions, per capita emissions, cumulative emissions and emission intensity. The graphic has been prepared by National Geographic, in partnership with Shell, and demonstrates the differences depending on which option you look at.



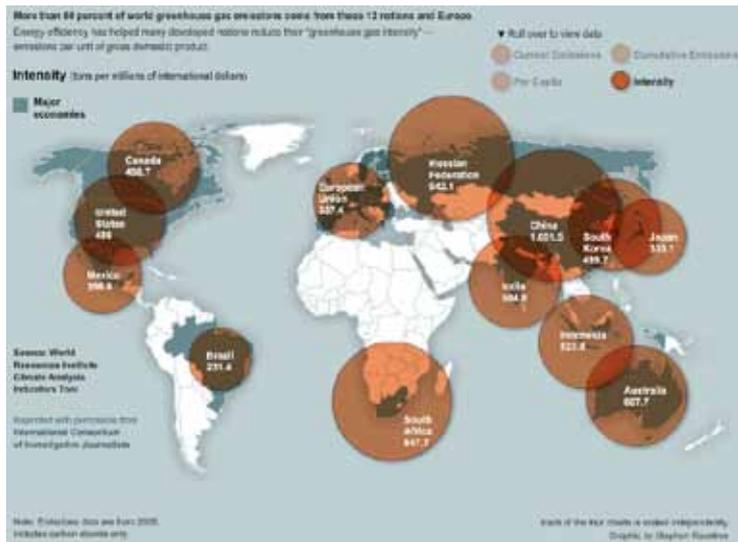
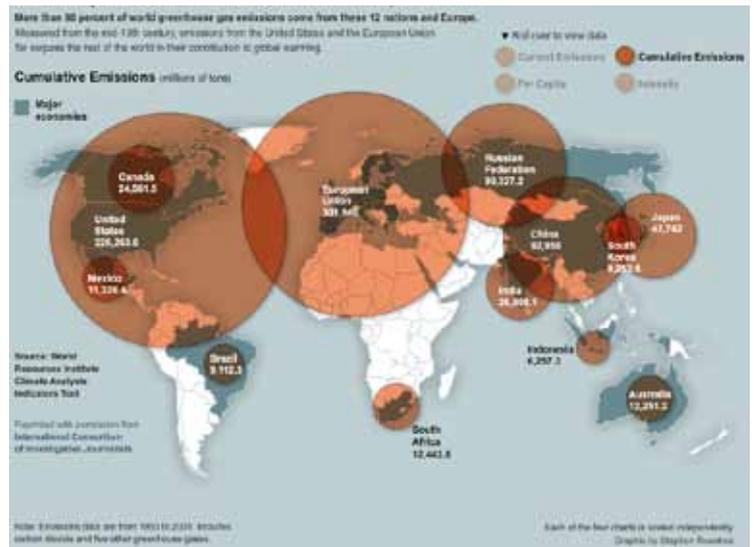
Occasionally I have heard the view expressed that questions: 'Why should developed countries do so much to curb emissions when the developing countries are not doing their bit?'

Well, quite simply, this graphic answers that.

In terms of current emissions, the three largest contributors are China, the USA and the European Union, but look at per capita emissions, and this top three switches to Australia, the USA and Canada (Canada were 8th in current emissions, and Australia were 12<sup>th</sup>).



Looking at Emission intensity, the top three are China, the Russian Federation, and South Africa, while looking at the fourth category of cumulative emissions, the European Union and the USA surpass the rest of the world in their contribution to global warming. This in itself explains the need for developed countries to take the lead. Others will follow, but the trailblazers need to come from developed countries to prove the technology, and make it accessible to those countries less able to lead in innovation.



Have a look for yourself <http://environment.nationalgeographic.com/environment/energy/great-energy-challenge/global-footprints> this really is an interesting graphical tool to look at and use, simply click on the data set you wish to view, and watch the map change to represent this data set. The maps are shown here, and can be accessed interactively through the link above.

# 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](http://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](mailto:toby.aiken@ieaghg.org).

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

## Modelling/Risk Assessment

Week of the 10<sup>th</sup> June, Trondheim, Norway

## Summer School

21<sup>st</sup> - 26<sup>th</sup> July, Nottingham, UK

## Environmental Impacts/Monitoring

Week of the 26<sup>th</sup> August, Canberra, Australia

## OCC3

9<sup>th</sup> - 13<sup>th</sup> September 2013; Leon, Spain

## PCC2

17<sup>th</sup> - 19<sup>th</sup> September 2013; Bergen, Norway



## Greenhouse News

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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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