



# ieaghg

## Greenhouse News

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### GHGT-12 in Austin, by Siân Twinning, IEAGHG



With just a few weeks until the conference, what can you expect when you get there?

Hopefully you will be familiar with the conference programme, speaker and technical line up so what else is there? Austin prides itself on being the live music capital of the world and their biggest music festival (Austin City Limits) is being held the weekends before and after the conference – some day passes are still available if you have time to visit. Austin is also famed for its tagline – **“Keep Austin Weird”**, a slogan you will find on m u g s ,

## KEEP AUSTIN WEIRD

t-shirts, bumper stickers and basically anything with a printable surface, but it reflects the strong small business presence in the city. It also makes souvenir shopping easy!

Austin was first announced as the venue for GHGT-12 at the GHGT-11 closing session and delegates were presented with a list of compelling reasons to travel to Austin (other than the conference of course!) these included:

1. Dine and network under the stars in Texas Hill country
2. Dance the Texas Two-Step with friends at the Broken Spoke
3. See the world’s largest urban bat colony emerge from under the Congress Avenue Bridge (just 3 minutes from the conference centre!)
4. With over 200 parks, Austin has an outdoor recreation and fitness opportunities for everyone under clear skies at 25°C.

This is just a small indicator of what is on offer in the friendly, vibrant city.

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As well as the ACL festival, there is also the SVRA 2014 US Vintage National Championships at Austin's brand new Circuit of the Americas race track on the 10<sup>th</sup> October. So if music doesn't appeal, there are still plenty of other attractions to visit, from art galleries, museums and theatres, to zipline adventures over Lake Travis.

Austin is not short of great venues to eat and catch a live band, Sixth Street is where it all happens at night. For

food on the go, Austin is dotted with food carts selling everything from tacos to cupcakes. With so many carts to choose from, they even have their own iPhone app (AustinFoodCarts). The conference dinner will allow you to tick the box of enjoying a Texan Barbeque at the world famous Salt Lick (a vegetarian option will, of course, be available!).

If you arrive early and for a quick flavour of the city, I can recommend the Duck Tours, an amphibious tour of Austin lasting 75 minutes and packed with sightseeing and commentary on landmarks around the city.

We look forward to seeing you in Austin! ●



Cupcake Food Cart - One of Many Varieties!



Austin - Sixth Street

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

The most recent in the Series of IEAGHG's reputable Summer Schools was held from the 6<sup>th</sup> to the 11<sup>th</sup> July 2014 in Austin, Texas. Hosted by The University of Texas at Austin and held at the AT&T Conference Center on campus, this was another hugely successful event in the Summer School Series.

This year's 47 students were young scientists, selected from over 140 applications and coming from 21 different

countries, making the 8th annual School another truly international, multi-cultural and multi-disciplinary teaching event from IEAGHG. Over 30 speakers attended throughout the week – 20 of whom were dedicated 'Expert Mentors', staying the whole week to allow students to benefit from their knowledge of CCS. The Expert Mentors are key experts in their field, with many attending from all over the world to be part of this prestigious School.

The week was jam-packed with lectures and the students were treated to talks on the entire CCS chain – from capture to storage, from policy to public engagement, and from economics to bio-CCS. New topics within the 2014

School programme included induced seismicity, developing countries



Students at the capture pilot plant at the National Carbon Capture Center in Texas



The 2014 IEAGHG Summer School group



Student-led, interactive sessions at this year's IEAGHG Summer School

context and shale gas. This year's field day took the students to the Pickle Research Campus of The University of Texas at Austin, home of the Bureau of Economic Geology. Activities during this day 'off-site' included a CO<sub>2</sub> geological storage design workshop, a workshop on storage capacity (using BEG's EASiTool software), a tour of Austin's Core Research Center and a tour of the National Carbon Capture Center's CO<sub>2</sub> capture pilot plant.

The students were randomly assigned to one of 6 groups and each group assigned a topic to work on throughout

the week, before presenting their findings to all on the final day of the School. This year was a first for the Summer School, with a tie being declared between the two 'Best Groups' – Groups 5 and 6, whose topics were 'is CCS a viable option for developing countries?' and 'should CCS be mandatory in the developed world? What are the pros and cons?' This year's Most Outstanding Students, as decided by the Expert Mentors, were Luc Steel (from Heriot-Watt University in the UK) and Grace Womack (from Drexel University, USA). IEAGHG wish to congratulate them both again

on this achievement; chosen on overall performance, enthusiasm and participation throughout the week.

The IEAGHG Summer School Series is kindly sponsored by Schlumberger Carbon Services, DECC, Alstom, Shell, Statoil, Gassnova and CO2CRC. Elsevier supports each year's Most Outstanding Student award, and the contributions of the Series Sponsors along with several local sponsors make each School viable and, above all else, successful.

For further information on IEAGHG's Summer School Series, please contact [Samantha@ieaghg.org](mailto:Samantha@ieaghg.org).

## Press Release: UK and Australian Researchers Join Forces on Climate Change



# UK CCS RESEARCH CENTRE

On the 10<sup>th</sup> July 2014, international collaborative research to develop carbon CCS projects was furthered with the signing of a Memorandum of Understanding (MoU) by representatives of the UK Carbon Capture and Storage Research Centre (UKCCSRC) and the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC).

The signing of the MoU, which cements an already cooperative relationship between the two organisations, was welcomed by Prof Jon Gibbins, UKCCSRC Director who said, "UK researchers have enjoyed meeting and working with Australian colleagues over many years and it will be excellent to use this MoU to deepen and broaden these interactions."

CO2CRC Chief Executive, Dr Richard Aldous said, "we're delighted that Australian researchers will have an opportunity to collaborate with UK counterparts, who have diverse CCS research capability."

The new agreement formalizes an already strong relationship between the two organizations and researchers in both countries.

On the 20<sup>th</sup> June 2014, UKCCSRC announced £2.5 M funding for CCS research including the project Quantifying Residual and



The Signing of the Memorandum of Understanding

Dissolution Trapping at the CO<sub>2</sub>CRC Otway Project Injection Site, which excitingly involves collaboration with CO<sub>2</sub>CRC and provides UK researchers the opportunity to conduct research at the unique Otway subsurface research site.

In addition, last year, UKCCSRC funded an Early Career Researcher (ECR) exchange programme which saw students being funded to undertake research at Australian institutions.

The UK is leading on CCS deployment in Europe, with two FEED studies under way, Electricity Market Reform arrangements that provide a level playing field for all forms of low-carbon electricity generation, including CCS, going forward and excellent offshore CO<sub>2</sub> storage potential. This MoU brings together two of the world's

leading CCS research organisations whose breadth and expertise combined is a huge boost to international collaboration on CCS research.

The signing of the MoU, by Tim Dixon, UKCCSRC Board Member and Prof John Kaldi, CO<sub>2</sub>CRC's Chief Scientist at the IEAGHG Summer School at the University of Texas in Austin, marks a commitment by the UK and Australia to work together to explore and advance CCS technologies, which prevent carbon dioxide produced through energy generation and heavy industrial processes from reaching the atmosphere and are vital to the global effort to tackle climate change. ●

## IEAGHG Monitoring Network and Modelling Networks Meeting, Morgantown, WV, by James Craig and Tim Dixon, IEAGHG

A combined Modelling and Monitoring networks meeting was hosted by the National Coal Research Center for Coal and Energy (NCRCE), West Virginia University at Morgantown on 5<sup>th</sup> - 7<sup>th</sup> August. The meeting brought over 60 delegates from eight countries including Australia, Canada, France, Germany, Japan as well as the UK and USA. The three day meeting focussed on the theme of reducing uncertainty with the application and effectiveness of monitoring and modelling.

The first day concentrated on the latest research on the ability to monitor CO<sub>2</sub> in the overburden with the use of isotopes. There were also contributions from

speakers on some of the challenges of monitoring CO<sub>2</sub> from controlled release experiments into the atmosphere and into the sea where rapid dispersion can make reliable measurements difficult. Detailed appreciation of near surface sediment conditions, and background baseline monitoring, can help to show where CO<sub>2</sub> emissions might occur. In a marine environment both seasonal and tidal conditions need to be taken into account. Changes to sediment pore fluid chemistry is a more sensitive parameter than open water detection. Some excellent examples of seismic monitoring were presented which demonstrated how effective the technique can be for monitoring plume migration, and in the case of Snohvit, highlighting the impact of heterogeneity. The use of seismic is particularly well suited to offshore surveys where large areas can be covered relatively rapidly. The conclusions included that:

- Pressure monitoring is providing a lot of information at many sites in terms of reservoir performance and overburden monitoring, and is likely to be an early indicator of leakage.
- Microseismicity has distinct benefits. Data from current projects is reducing uncertainty by highlighting small scale structures within reservoirs and reducing uncertainty.
- The application of tracers may be possible to detect the origin of CO<sub>2</sub> in the overburden, but there is uncertainty over their effectiveness.
- Recent advances in seismic using a P-cable configuration are providing high resolution on shallow overburden off the coast of Texas.
- Seismic surveys applied offshore can be cheaper than onshore per unit area.
- There is a need for benchmarking and more accurate commercial sensors for near-surface monitoring.

The discussion on modelling opened the debate on the length of time that should be considered especially in the context of public

perception. This was the first meeting where the impact of glaciation was raised. Successive ice sheets have retreated and advanced over the North Sea Basin, however there is no evidence that oil and gas reservoirs have been compromised. Glacial processes are important for understanding changes to the sea floor such as glacial channels. During general discussion there was a consensus that models need to be continually reviewed to take account of site-specific conditions revealed by different monitoring techniques. The discussion also revealed that models can help to simulate different conditions such as pressure build up within reservoirs and fault behaviour under shear processes.

The meeting concluded with a discussion between three storage site developers, two from the USA and one from the UK, and a representative from the US Environmental Protection Agency (EPA). Much of the discussion focussed on the Class VI regulations for CO<sub>2</sub> injection and storage. There have recently been the first five permits issued (to ADM and to FutureGen2) which will set precedents for meeting the requirements. Applications under this regulation need to be science-based



Attendees of the Network Meeting

and well documented. Experience from both the US and UK shows that there have been, and continue to be, open and detailed dialogue between regulators, site developers and the research community. This was welcomed.

Overall, it is clear from a number of projects around the world that monitoring data continues to improve to model predictions. Continual iteration between observed and predicted phenomena is essential and is proving effective. In the future improvements in real time continuous

monitoring, using robust and reliable sensors, will be essential. The goal of reaching the right balance between cost and achieving the right level of sensitivity to meet regulatory requirements at a commercial scale will need to be addressed and developed.

The meeting included a visit to the NETL facilities in Morgantown and a geological field trip to recently exposed rock formations relating to CO<sub>2</sub> storage in the Central Appalachians.

Copies of presentations will be available from the IEAGHG website, and a report of the meeting will be produced. ●

## RWE PCC Pilot in Niederaussem, by Karl-Josef.Wolf, RWE



PCC Niederaussem

**“Successful post-combustion capture development at the pilot plant Niederaussem goes to the next round.”**

BASF, Linde und RWE Power have started the third phase of their joint development program. The German Federal Ministry for Economic Affairs and Energy is funding the project with 2.5 mil. Euro, so that the total funding for all three project phases sums up to 10 mil. Euro. For up to additional three years modified scrubbing solvents and ultra-sensitive measurement technologies are tested to further optimize the CO<sub>2</sub> capture process for power plants.

Since five years the pilot plant at

Niederaussem is in operation with an availability of 97%. The innovative OASE® blue capture technology from BASF is meanwhile tested for 26,000 hours under real power plant conditions. The pilot plant can alternatively be supplied with flue gas from a conventional wet limestone flue gas desulphurization (FGD) plant, or from a high performance FGD which also

contains a wet electric precipitator, a fly ash dosing system and a SO<sub>2</sub>/SO<sub>3</sub> dosing system during some testing phases. These different testing configurations allow the injection and control of trace elements in the flue gas stream, so that all aspects of emission formation in the amine-based post-combustion capture process can be investigated. Also the testing of two new developed emission mitigation measures will be one focus in the first year of the testing program. It is also planned to adjust the flue gas composition to that of a natural gas fired power plant by means of lower CO<sub>2</sub> concentration and higher oxygen content. From the next year on two new OASE blue variants will be tested, which promise once more optimized properties."

Contact: Dr. Peter Moser, RWE Power: [peter.moser@rwe.com](mailto:peter.moser@rwe.com) ●

## IEAGHG Annual Review 2013 Now Available



The IEA Greenhouse Gas R & D Programme (IEAGHG) has now published its 2013 Annual Review. The review looks back at activity across our project portfolio in 2013 with key technical studies being outlined.

*"This year has been another active year in the CCS research and development arena for IEAGHG. In travelling to various meetings that we attend I repeatedly get asked how many staff work at IEAGHG and, when I say 14, most people are quite surprised that we are so few."* John Gale, General Manager, IEAGHG

It also includes commentary from the Chairman of our Executive Committee, Kelly Thambimuthu and our General Manager, John Gale, reviews the year. An overview of IEAGHG is given, along with some information on our key conferences and meetings. For more information, and to view the Annual Review 2013, please visit [www.ieaghg.org/publications/general-publications/466-annual-review-2013](http://www.ieaghg.org/publications/general-publications/466-annual-review-2013) where the Annual review is now available to download. ●

## New IEAGHG Reports

### 2014-05 Biomass and CCS – Guidance for accounting for negative emissions, Jasmin Kemper, IEAGHG

Biomass use for energy production in processes such as combustion and gasification, and its use to produce biofuels such as bioethanol, results in CO<sub>2</sub> emissions. If carbon dioxide capture and storage (CCS) is applied to these emissions, because the CO<sub>2</sub> is recently taken-up by the biomass from the atmosphere, then actual CO<sub>2</sub> removal from the atmosphere can take place. This is referred to as 'negative emissions'. At present there is only one technology which may be able to be deployed at the required scale – biomass with CCS (bio-CCS or BECCS).

There is a need for analysis of the options for correctly accounting, reporting and rewarding all emissions relating to bio-CCS, and of ways of including it in emissions trading schemes (ETS) to

appropriately recognise its greenhouse gas (GHG) reduction performance. IEAGHG commissioned this analysis to Carbon Counts Company (UK) Ltd.



Key messages from the report:

- Most schemes at least recognise negative emissions from bio-CCS by either allowing for net-back accounting on a portfolio level ("pooling") or the

generation of credits (“offsetting”).

- Regional cap-and-trade schemes generally do not recognise negative emissions from bio-CCS. However, the architecture of most schemes would allow for either pooling or offsetting if the regulating bodies implement these methods in the schemes.
- Incentivising bio-CCS remains a challenge, due to the baseline of many schemes. Currently, there is a debate about whether bio-CCS delivers a double dividend for emissions abatement and thus should receive double credits.
- Land use change (LUC) is a big concern. Especially in developing countries “carbon leakage” is likely to occur. Some schemes might accelerate forest clearing in these countries. The opposite can happen as well, i.e. generation of more forest plantation due to increased demand. Low carbon fuel standards (LCFSs) include detailed GHG accounting rules for calculating upstream emissions and also consider LUC effects to some extent.
- Regulating bodies in the EU and US are currently discussing how to address the sustainability concerns around bio-CCS, including the parity of treatment between fossil and biogenic CO<sub>2</sub>. This broader discussion will likely initiate a complex political process.

#### 2014-06 Summary report of the 5<sup>th</sup> HTSLCN Meeting in Cambridge published, Jasmin Kemper, IEAGHG

The IEAGHG High Temperature Solid Looping Cycles Network (HTSLCN) aims at bringing together researchers and developers of CO<sub>2</sub> capture technologies that operate at high temperatures in cyclic processes using either circulating or fixed beds of solids.

The 5<sup>th</sup> HTSLCN Meeting was held from 2<sup>nd</sup> to 3<sup>rd</sup> September 2013 at Queens’ College, University of Cambridge, UK.

Key messages and impressions from the meeting are:

- The results from the pilot plants show that there is further improvement in CO<sub>2</sub> capture efficiencies and fuel conversion rates in both calcium looping (CaL) and chemical looping combustion (CLC).
- Certain impurities, such as SO<sub>2</sub> and H<sub>2</sub>S, have an adverse effect on the sorbent carrying capacity in CaL and the reduction rate in CLC but there are ways to enhance performance.
- CaL processes can be more environmental friendly than conventional CO<sub>2</sub> capture technologies.
- For both CaL and CLC only limited cost estimates are available, so it will be necessary to establish and validate techno-economic performance figures.
- The most pressing question, in particular regarding CaL, at the moment is: when will the first large-scale demonstration go online?
- The attendees were able to visit the research facilities at Cranfield University.
- The Scientific Committee gave away two awards for the best presentations to Markus Junk (Technische Universität Darmstadt) and Vincenzo Spallina (Eindhoven University of Technology).

IEAGHG gratefully acknowledges University of Cambridge and Cranfield University for joint organisation and the UKCCS Research Centre and Johnson Matthey for financial support of the meeting.

The next HTSLCN Meeting will take place in autumn 2015. We will keep you posted about the details.



UNIVERSITY OF  
CAMBRIDGE

Cranfield  
UNIVERSITY



Johnson Matthey



Please turn over for further studies.

The report summarises the presentations and outcomes from the "Iron and Steel Industry CCUS and Process Integration Workshop". The workshop took place from 5<sup>th</sup> to 7<sup>th</sup> November 2013 at Tokyo Institute of Technology in Japan. IETS (Industrial Energy-related Technologies and Systems), the World Steel Association (WSA) and IEAGHG jointly organised this meeting.

Key messages from the meeting's discussion forum are:

- CO<sub>2</sub> storage demonstration is crucial to kick-start any CCS activities in the iron and steel industries.
- A global approach towards CCS is necessary to establish a level playing field among the industries in different countries.
- In the beginning, CCS implementation will increase steel prices but the role of incentives remains unclear.
- Public acceptance for CCS in parts of Europe is currently lacking.
- The technology is ready but the current economic situation prevents implementation of CCS in the steel industry.

In conclusion, the workshop was a great opportunity to catch up with the most recent developments regarding CO<sub>2</sub> emission reduction technologies in the iron and steel industries. IEAGHG aims at organising another meeting after a reasonable amount of time, in order to look at future development and progress.

IEAGHG, IETS and WSA gratefully acknowledge Prof Tatsuro Ariyama for being the host of this meeting.



### 2014-08 Techno Economic Evaluation of Different Post Combustion CO<sub>2</sub> Capture Process Flow Sheet Modifications, John Davison and Prachi Singh, IEAGHG

Post combustion CO<sub>2</sub> capture technology is one of the potential technologies which will most likely to be applied at large scale CO<sub>2</sub> capture facilities in power plants. One of the main concerns for the solvent based CO<sub>2</sub> post combustion capture (PCC) technology for power plant is the relatively large energy penalty. A reduction in energy penalty for solvent based CO<sub>2</sub> post combustion capture process can be achieved by improving solvent properties, better integration with power plant as well as by improving process design. Regarding to the improvement in process design, different process flow sheet modifications have been reported in various literature and patents for chemical solvent based CO<sub>2</sub> absorption processes. These process modifications reduce the energy penalty imposed by the CO<sub>2</sub> post combustion capture plant.

The proposed process flow sheet modifications are multi-component column, inter-stage temperature control, heat integrated stripping column, split flow process, vapour recompression, matrix stripping and various heat integration options. Comparison of these reported modifications was difficult as these were evaluated based on different solvent properties and process conditions. Also there are some process modifications more suitable for particular solvent than the others. In order to identify the suitable process modification for full scale PCC application it was necessary to evaluate further in detail these modifications on the same process condition for their energy savings, additional unit required and additional cost.

Therefore, there was a requirement to evaluate these process modifications on similar solvent and process conditions with a state of the art rate-based CO<sub>2</sub> absorption model. This IEAGHG study evaluate the feasibility of these different amine-based CO<sub>2</sub> post combustion capture process modifications for coal and natural gas based power plants.

In this study post combustion capture process improvements that are already well established such as intercooling in the absorber and improved heat integration with power plant, combined with improved solvents typical of those that are expected to become available by 2020, is implemented for the coal and natural gas power plant base case. These improvements should substantially reduce the efficiency penalty on power plant. Further in this study various process modifications were investigated for coal and natural gas power plants.

Overall it can be noticed from this study that once all current improvements have been implemented in the solvent based post combustion capture process, different process modifications for coal and natural gas power plant, only bring slight improvements in the power plant efficiency penalty.

The performance and cost of different post combustion capture process modifications depend on the type of solvent used. Therefore, for new solvents further evaluation for all process modifications will be required. ●

# News from the UK-China (Guangdong) CCUS Industry Promotion and Academic Collaboration Centre, by Xi

LIANG<sup>1&2</sup>, Jia Li<sup>1&2</sup>, Lan CHEN<sup>3</sup> and Heping ZHU<sup>4</sup>

(<sup>1</sup>UK-China (Guangdong) CCUS Centre, <sup>2</sup>University of Edinburgh, <sup>3</sup>Guangdong Electric Power Design Institute, <sup>4</sup>China Resources Power

The UK-China (Guangdong) CCUS Industry Promotion and Academic Collaboration Centre is an open platform for institutes and individuals who have interest in developing high quality research and engineering activities or participating in developing CCUS demonstration projects in South China. Remarkable progress was made in the first 8 months of the Centre. The Centre secretariat office opened and started operating at the Guangdong Electric Power Design Institute building in May 2014. The China Resources Power (Haifeng) CCUS project entered the pre-feasibility study stage in the same month. Engineering preparation works for the CO<sub>2</sub> capture technology innovative testing platform started at the Haifeng site in August 2014. The Centre successfully recruited a prestigious international Advisory Board.

Supported by both Guangdong and UK government departments, the UK-China (Guangdong) Carbon Capture, Utilisation and Storage Industry Promotion and Academic Collaboration Centre ("UK-China (Guangdong) CCUS Centre" and "Centre") was officially founded on December 18<sup>th</sup>, 2013. Initial co-founders included China Energy Engineering Construction Group Guangdong Electric Power Design Institute (GEDI), Clean Fossil Energy Development Institute (CFEDI), UK CCS Research Centre (UKCCSRC) and Scottish Carbon Capture and Storage (SCCS). The core function of this Centre is to develop CCUS and other near-zero emission technology demonstration projects.

The Centre is an open platform that welcomes industry and academic members who share interest in participating in CCUS demonstration projects or developing high quality research projects in South China. The current industry and



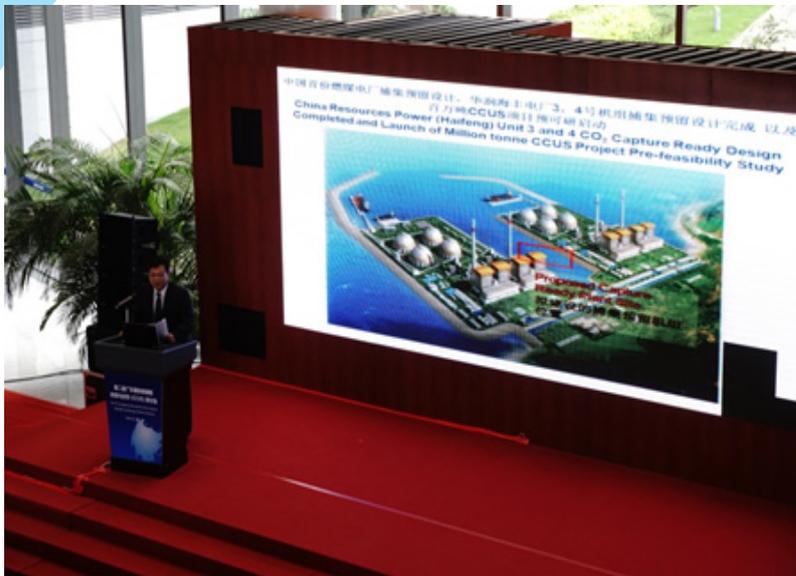
Picture 1: Mr Gregory Barker (Minister of State for Energy and Climate Change in the UK) with colleagues at the UK-China (Guangdong) CCUS Centre and British Consulate General to Guangzhou, in front of the Centre Office in Guangzhou, China, 15<sup>th</sup> May 2014

academic members include China Resources Power (the 7<sup>th</sup> largest power company in China), China National Offshore Oil Corporation (CNOOC, the largest offshore oil company in China), CIMC Group (the largest energy transport tanker manufacturing company in the world), Howden Group, Alstom, Shell Cansolv, DNV GL, Linkschina Advisory, University of Edinburgh, South China Sea Institute of Oceanology of Chinese Academy of Sciences, and Guangzhou Institute of Energy Conversion of Chinese Academy of Sciences.

The Centre consists of three closely connected working groups, including (1) Demonstration Project Working Group, (2) Technical Working Group, and (3) Commercialization and Policy Working Group. Within the Demonstration Project Working Group, the Centre has established a China Resources Power (Haifeng) CCUS Project Sub-Working Group and an Innovation, Cost Reduction

and Manufacturing Sub-working Group. Within the Commercialisation and Policy Working Group, the Centre aims to develop a robust and sustained public communication programme to follow public perceptions on CCUS in South China and in particular views on CCUS demonstration projects.

During the launch on 18<sup>th</sup> December 2013, the Centre achieved three significant events: (1) The Centre held the First Guangdong International CCUS Expert Workshop in Guangzhou that attracted more than 100 Chinese and international experts; (2) the Demonstration Project Working Group lead institute, China



Picture 2: Mr Lan CHEN (Centre Director) announces the completion of CO<sub>2</sub> Capture Ready Design for China Resources (Haifeng) Project Unit 3 and 4 and kicked off the pre-feasibility study for the demonstration project in Guangzhou, China, 15<sup>th</sup> May 2014



Picture 3: Mr John Gale (IEA GHG General Manager) introducing CCS work in the IEA GHG programme to senior management of China Resources Power in Shenzhen, China, 29<sup>th</sup> June 2014

Resources Power, signed a collaboration agreement with GEDI and the University of Edinburgh to develop a CCUS demonstration project and conduct CCS ready design for the project; (3) The Centre launched its first issue of the Near Zero Emission Magazine.

The 2<sup>nd</sup> Guangdong International CCUS Workshop was held on 15<sup>th</sup> May 2014 in Guangzhou with a theme of 'Identifying CCUS Opportunities in South China'. The workshop was opened by UK Minister of State for Energy and Climate Change Mr Gregory BARKER, and Deputy Governor of Guangdong Province Mr XU Shaohua. The 2<sup>nd</sup> workshop encouraged speakers and participants to brainstorm potential priority work areas for the Centre. The Director of the Centre, Mr CHEN Lan kicked off the pre-feasibility study for the CCUS demonstration project and announced the completion of the first CCS Readiness Design in China (Picture 1). China National Offshore Oil Corporation (CNOOC) also

contributed thoughts on an offshore storage-related CCUS demonstration project programme.

The Centre actively identifies and develops potential CCUS demonstration projects in South China. A short-term priority for the Centre is to construct an innovative CO<sub>2</sub> capture testing platform at China Resources Power (CRP) Haifeng project (2x1GW in construction, 6x1GW in planning), Unit 1 to test and to compare at least three different technologies under the same conditions. The civil engineering preparation works have started with the aim of commencing operation by June 2015. The best performance technology will be applied for a million tonne CCUS demonstration project at Unit 3. The exciting Testing Centre will be coordinated by the UK-China (Guangdong) CCUS Centre, with support from Chinese and international experts. The Centre is very pleased that Mr John Gale visited the project site and China Resources Power headquarters to discuss the demonstration project. John has kindly accepted to be a deputy chair of the Advisory Board. The Centre looked forward to working with John and other Advisory Board members (Picture 3).

The Centre has established a prestigious international Advisory Board chaired by Mr DONG Xiaoli, Assistant General Manager of China Offshore Oil Corporation with four experienced deputy chairs: Mr Andrew Minchener (General Manager of IEA Clean Coal Programme), Mr John Gale, Mr LI Kejun (Independent Director of CIMC Group), Prof ZHOU Di (Professor of South China Sea Institute of Oceanology) and fifteen advisory members: Mr Allan ZHANG (PwC), Mr Bill SENIOR (Senior CCS), Dr David REINER (University of Cambridge), Mr John Robert Gibson (City University of Hong Kong), Mr KANG Xiangwu (Ministry of Science and Technology), Prof LI Xiaochun (Institute of Rock and Soil Mechanics, Chinese Academy of Sciences), Prof LIAO Cuiping (Guangzhou Institute of Energy of Energy Conversion), LIN Qianguo (GCCSI), Mr LIU Lianbo (Huaneng Group), Dr LIU Qiang (National Climate Centre), Prof Mr Malcolm Ricketts (Scottish Government), Prof Peta ASHWORTH (University of Queensland), Prof PENG Bo (Chinese University of Petroleum), Mr Richard SMITH (Howden), Mr ZHANG Guohua (Shell Cansolv).

Centre Website: [www.gdccus.org](http://www.gdccus.org) ●

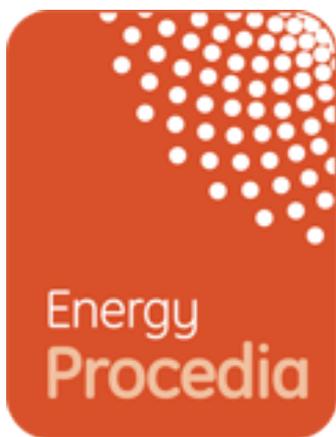
# Illinois Industrial Carbon Capture and Storage Project

In 2010, the U.S. Department of Energy, National Energy Technology Laboratory, selected the Archer Daniels Midland Company (ADM) team, which includes Schlumberger Carbon Services, the University of Illinois - Illinois State Geological Survey, and Richland Community College (RCC) to conduct the Illinois Industrial Carbon Capture and Storage (IL-ICCS) project, which is designed to inject up to 2.5 million tons of carbon dioxide (CO<sub>2</sub>) to a geological depth of over 7,000 feet. ADM will capture CO<sub>2</sub> from its ethanol plant in Decatur and geologically sequester it deep underground at a rate of approximately one million tons per year.

The IL-ICCS project leverages the mission of RCC and the University of Illinois to facilitate the offering of education and outreach for K-12, higher education, professional, and community audiences.

An International Workshop on Public Education, Training, and Community Outreach for Carbon Capture, Utilization, and Storage (CCUS) was held at RCC in Decatur, IL on July 30<sup>th</sup> and 31<sup>st</sup>. This inaugural event featured the National Sequestration Education Center on Richland Community College campus. Over 40 Illinois teachers registered for the workshop where presenters from United States, Canada, Germany, and South Africa shared information and educational activities from various CCUS projects. ●

## Energy Procedia



In 2009, Elsevier set up Energy Procedia to fill the demand for the online publication of proceedings from energy related conferences. GHGT-9 was proud to be the first conference published on this new venture and has since been joined by another 49 issues including 2 more GHGT conferences and soon to be a third in the new year. IEAGHG, as Guardians of the conference series, took a deliberate decision to make the articles in the proceedings open access with the aim of disseminating the information as widely as possible. Scopus now lists the top 25 most cited articles from the Energy Procedia site as all coming from Volume 1, the GHGT-9 proceedings, demonstrating the far reaching effect of the conference and the value in submitting a paper to the proceedings. The rapidly increasing number of conferences also signing up to publish through Energy Procedia also reflects the prestige now being associated with this online publication.

It is easy to become focussed on the impact factors of major journal publications such as the IJGCC, however, it is important not to overlook the significant impact that the proceedings have both as a resource for the CCS community and also the authors in getting their work published and recognised by peer groups. IEAGHG and the GHGT conferences look forward to facilitating the publication of many more papers significant to the CCS development and deployment. ●

## News from the IEA Clean Coal Centre,

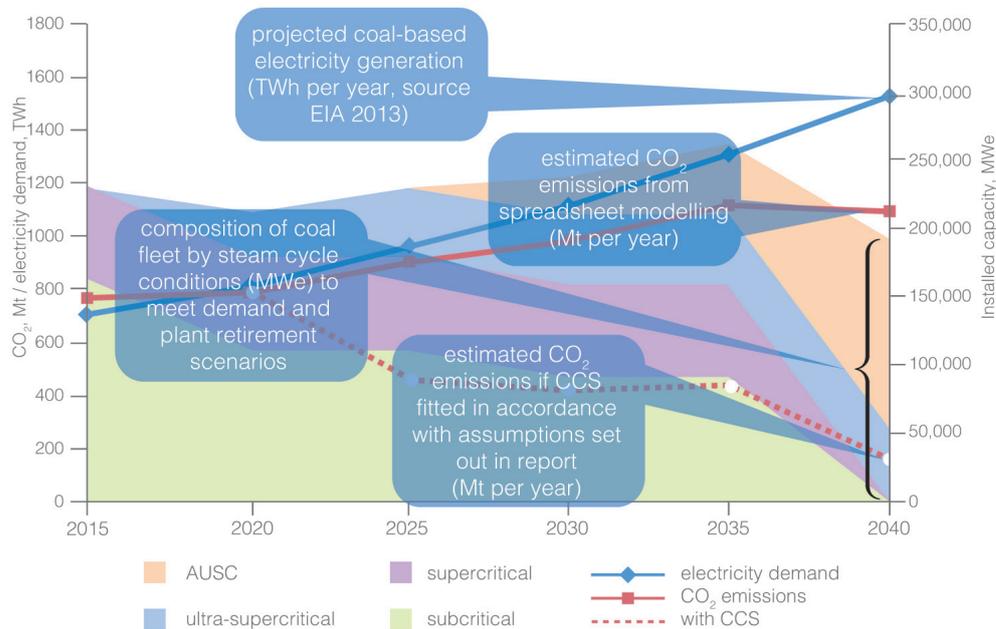
by Debo Adams, IEA CCC

### How much CO<sub>2</sub> can be saved by upgrading the global coal fleet?

Dr Ian Barnes has examined the potential of high efficiency, low emission (HELE) coal-fired power plant to reduce CO<sub>2</sub> emissions in a number of major coal using countries: Australia, China, Germany, India, Japan, Poland, Russia, South Africa, South Korea and the USA.

**HELE plant upgrades are a 'no regrets' option** for coal plant owners and operators. A current state-of-the-art coal-fired plant operating with a high efficiency ultra-supercritical steam cycle will be more efficient, more reliable, and have a longer life expectancy than its older subcritical counterparts. Most significantly, **it would emit almost 20% less CO<sub>2</sub>** than a subcritical unit operating under similar duty.

Article continues overleaf.



**Example presentation of study results (India, 25 year plant retirement scenario)**

Developments in advanced ultra-supercritical (AUSC) steam cycles should continue this trend and a plant operating at 48% efficiency (HHV) would emit up to 28% less CO<sub>2</sub> than a subcritical plant, and up to 10% less than a corresponding ultra-supercritical plant.

Dr Barnes calculated the coal fleet profile of each country to meet future electricity demand under three scenarios; continuing with the existing fleet, and retiring and replacing older plant on the basis of a 50 year and 25 year plant life. He quantified the potential impact of HELE upgrades on emissions of CO<sub>2</sub> and costs of implementation.

Ian commented: "It was interesting to quantify the potential for efficiency improvements in coal-fired generation plant. Rather like the modern developments to the internal combustion engine that has been around for a similar

period of time, the implementation of modern materials, emission controls and control technologies can transform established coal-power technology making it more efficient and capable of meeting increasingly demanding emissions standards".

Ian identified a number of trends:

- Countries such as China and India, experiencing a prolonged period of economic growth meaning that additional capacity is needed and that the coal fleet is relatively new, have rising emissions of CO<sub>2</sub>, but they could be offset by the use of AUSC over ultra-supercritical plant for new build.
- Countries like South Africa, again experiencing a prolonged period of economic growth and so needing additional capacity, but with a more mature coal fleet have rising emissions of CO<sub>2</sub>, but again they could be offset by the use of AUSC over ultra-supercritical, particularly when older plant is retired and replaced by AUSC units.
- Countries such as Poland and Russia, experiencing a prolonged period of growth and so needing additional capacity, but with an old and relatively inefficient coal fleet see falling levels of CO<sub>2</sub>

emissions, even with growth in electricity demand.

- Countries like South Korea, with relatively low to moderate levels of growth and an efficient coal fleet do not see significant benefits until 2040 when some older plant is retired.
- As an existing coal fleet evolves to a HELE composition it becomes smaller in respect of the installed capacity. This has potential benefit for the siting and replacement of plant, particularly in countries where planning regulations are demanding and time consuming.
- The greatest gains are seen when plant life is limited to 25 years (evolving practice in China) rather than 40 years or more (common in OECD countries). Policies and incentives to encourage shorter timescale plant renewal would enhance CO<sub>2</sub> savings.
- When CCS readiness is considered, in all cases, the 25 year life scenario represents the best option for CCS deployment as all coal fleets transition to a high HELE content quickly and enjoy maximum CO<sub>2</sub> abatement as any remaining lower efficiency capacity is retired. This is particularly evident in the Indian case where the effects of a rapidly increasing demand for electricity and attenuated by a combination of HELE and CCS technologies.
- Economics will govern the decision to replace plant unless policies and incentives drive the selection towards HELE technologies.

The IEA Clean Coal Centre will follow up this work with a series of individual country to give a more comprehensive view on regional HELE implementation pathways.

This article is based on the report, **Upgrading the efficiency of the world's coal fleet to reduce CO<sub>2</sub> emissions**, by Ian Barnes CCC/237, 99 pp, July 2014, which is available for download from the IEA Clean Coal Centre Bookshop <http://bookshop.iea-coal.org>.

Two other reports were published by the IEA CCC in July:

- **Prospects for coal and clean coal technologies in Turkey**, CCC/239, by Dr Stephen Mills 109 pp, July 2014
- **Blending of coals to meet power station requirements**, CCC/238 by Dr Lesley Sloss, 69 pp, July 2014

Residents of member countries and employees of sponsoring organisations can download the report at no charge after a one-off registration.



### Forthcoming events

- 3<sup>rd</sup> IEA CCC Workshop on upgrading and efficiency improvement in coal-fired power plants, 16<sup>th</sup> - 17<sup>th</sup> September 2014, Shanghai, China. Programme available at workshop website, <http://upgrading3.coalconferences.org>
- 2<sup>nd</sup> IEA CCC Workshop on advanced-ultrasupercritical coal-fired power plants, Rome, Italy, 14<sup>th</sup> - 15<sup>th</sup> October 2014. Visit workshop website, <http://ausc2.coalconferences.org>
- 4<sup>th</sup> IEA CCC Workshop on Cofiring Biomass with Coal, 5<sup>th</sup> - 6<sup>th</sup> November, State College, Pennsylvania, USA. Programme available at workshop website, <http://cofiring4.coalconferences.org>

Visit [www.iea-coal.org](http://www.iea-coal.org) for more information about the work of the IEA Clean Coal Centre. ●

## Passing the Baton to the Next Generation: 1<sup>st</sup> North Sea Young CCS Researchers Meeting

**CCS is not a quick and dirty project. It requires careful planning and long-term international co-operation. That is why CATO organised the 1<sup>st</sup> North Sea Young CCS Researchers Meeting in June.**

### Relay race

Sander van Egmond, communication manager for CATO, came up with the idea. "CCS is always about delivering results for the generations after our own," he explains. After having observed that national funding for CCS research is not as readily available as a few years ago, he wanted to find a way to strengthen international research networks. "The CATO PhD excursion to the United Kingdom in March was a good starting point for building international networks. If we want to deliver a large scale CCS project with offshore storage in the North Sea, it makes sense to pass the baton in this relay race to younger researchers. They are a vital part of advancing CCS, both now and in the future."

### First Declaration of Amsterdam

Rami Eid was one of the early career researchers who handed the Declaration to John Gale the following day, during the 7<sup>th</sup> Dutch CCS Symposium. He explains how the following text was chosen after careful consideration.

*"At the recent 1st North Sea Young CCS Researchers meeting, early career researchers from the Netherlands, United Kingdom and Norway convened in Rotterdam to strengthen the European CCS ECR network and to discuss and produce the First Declaration of Amsterdam.*

*The process for writing the declaration was divided into two parts. Firstly we separated into groups of four to brainstorm ideas, ensuring that the entire CCS research-chain was covered, across multiple institutions, so that each ECR contributed and provided an opinion. Each group worked on three sections:*

1. *Considerations: Why is CCS important? Why is international collaboration important?*
2. *Actions to be taken by other people: What role do the governments and key stakeholders play in moving CCS forwards? What platforms are needed to do so?*
3. *Our own actions as young CCS researchers: What role can we play moving forwards? How can we improve the current state of CCS, not just in research, but also in the public's eyes?*

*This was then followed by plenary discussions where we discussed each part of the declaration to ensure that the text is just right, as wording is key (similar to that of the recent IPCC summary report!). The chosen points are representative of what the early career researchers believe are the key challenges and actions required in order to stimulate CCS research and implementation, and importantly, encourage international co-operation to help tackle climate change. We believe the final declaration represents this."*

The final declaration is as follows:

Considering that

- Climate change is a global issue for present and future generations;
- CCS is a key mitigation measure to reach the climate goals in a cost-effective way;
- Countries around the North Sea (and the world)



John Gale, General Manager of IEAGHG



PhD Line Up Declaration

have a common interest in CCS and therefore international co-operation is essential.

We declare that:

- Multidisciplinary and international discussion should be encouraged to develop public support for CCS;
- Governments should create a (financial) regulation framework to enable CCS which encourages companies to invest in CCS;
- An international exchange programme for (young) CCS researchers around the North Sea should be developed.

We declare that we will:

- Scale-up research, share knowledge and results;
- Provide objective CCS information to the public;
- Initiate and participate in international CCS research collaborations and CCS networks.

#### Exchange of information and contacts

Juliana Sara da Silva about her experience:

*"My expectations of the 1st North Sea Young CCS Researchers Meeting were exceeded. It was not just an opportunity to meet new colleagues, but it was also a valuable experience for learning, for exchanging information, for giving and receiving feedback, for expanding knowledge. I had the chance of presenting my research to a new audience that was able to provide me with insights never thought of before. This event was also a key moment in my research. I'm now conducting a survey, which requires good networking. The help of the other young researches is crucial to gather sufficient data.*

*I believe that initiatives such as the 1st North Sea Young CCS Researchers Meeting can be considered a stepping stone of a prosperous international cooperation towards the achievement of a successful CCS deployment."* ●

## Update to the IEAGHG Website, by Siân Twinning, IEAGHG

IEAGHG staff regularly attend and present at external meetings and conferences. The presentations that are given at these events are posted to our website and can be found at <http://www.ieaghg.org/publications/ieaghg-presentations> or from the Publications menu.

We are also planning to add news of newly published reports, information papers and presentations onto our homepage [www.ieaghg.org](http://www.ieaghg.org) so check back regularly to see our most recent publications. ●

# Conferences & Meetings

This is a list of the key meetings IEAGHG are holding or contributing to throughout 2014/2015. 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: [becky.kemp@ieaghg.org](mailto:becky.kemp@ieaghg.org).

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

## **GHGT-12**

5<sup>th</sup> - 9<sup>th</sup> October 2014; Austin Texas, USA

## **3<sup>rd</sup> Conference on CO<sub>2</sub> as Feedstock for Chemistry and Polymers**

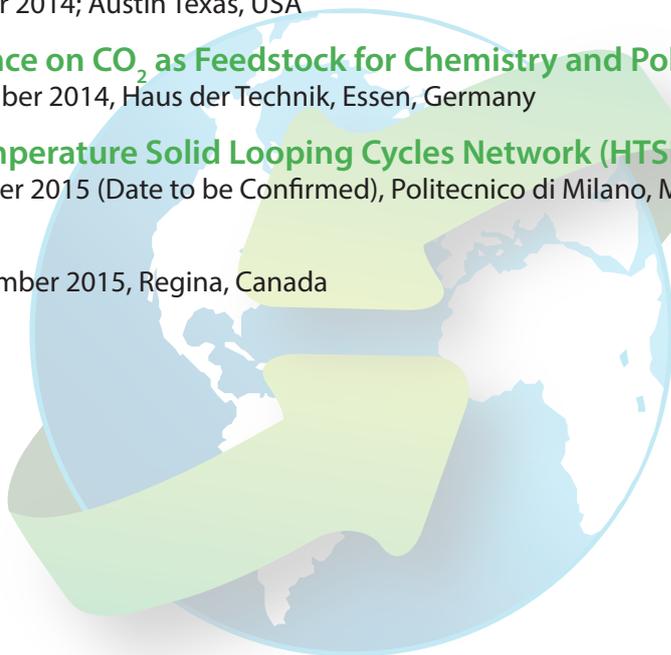
2<sup>nd</sup> - 3<sup>rd</sup> December 2014, Haus der Technik, Essen, Germany

## **6<sup>th</sup> High Temperature Solid Looping Cycles Network (HTSLCN) Meeting**

Early September 2015 (Date to be Confirmed), Politecnico di Milano, Milan, Italy

## **PCCC3**

8<sup>th</sup> - 11<sup>th</sup> September 2015, Regina, Canada



## **Greenhouse News**

ISSN 2047-2218 (Online)

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

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