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Greenhouse News

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GHGT-12 in Austin, by Siân Twinning, IEAGHG

Asleep at the Wheel? Well it seemed there was plenty to keep everyone awake at the conference! There were plenaries that were exciting, informative, uplifting and maybe even a little controversial and technical sessions and posters that provided up to the minute results and project details. Also, there were discussion panels that challenged the ethics of CCS in developing countries, considered unanticipated leakage, showcased the US Regional Partnership projects, asked how we engage industry in the deployment of CCS, and took a first look at CCS standards, we can only feel for those unable to attend!

With many of the U.S. programs on CCS maturing, the seven U.S. regional partnerships producing significant results on storage and a number of North American projects on the verge of demonstrating large scale systems, optimism at the conference was easy to find. Given the faltering state of CCS in Europe, this conference timing and energy seemed a much needed dose of enthusiasm for our European colleagues.

The conference closed with the usual panel discussion format but with an added twist. The subject matter – the opportunity for the CCS community to respond to the IPCC AR5 WG3 report which had focused a little too negatively on CCS. Panellists were challenged to summarise the breakthroughs, developments and successes in their field in the 10 years since the IPCC SRCCS reports and the new review in just 5 minutes each. Olav Bolland rose to the challenge for capture technologies, Sally Benson presented the storage developments in powerful numbers. Bill came next and we have to confess to being slightly worried when we saw his slides the night before the panel. The three slides showed Roger Bannister, mobile phones and an Arab proverb!

In this issue

Our fears were of course unfounded and Bill managed to tell the story of demonstration projects, the enormous effort and teamwork required to get to the demonstration stage, the progression of technology from the first prototype to a marketable product and how new technologies become publicly accepted. It was then over to Sean McCoy to bring us up to date on the global policy developments. Jonas Helseth closed the presentations addressing the BECCS issue.

And then came the twist; we asked the audience to text questions and comments and presented these on large screens for all to view. Some questions were addressed by other audience members, some were picked up by the panel chair, Kelly Thambimuthu and posed to the panel to address, others were more thought provoking and others more frivolous and the pigeon that had snuck into the hall got a few mentions!

Hindsight is always a 20/20, and our only defence for not having a mediator to support Kelly was: we had no idea what kind of response to expect and were overwhelmed with the amount of audience participation that the subject evoked.

So we found ourselves with almost 100 questions and comments that we wanted to value but had no idea how to do so – enter our Public Perception expert, Peta Ashworth. Peta came to our rescue and offered to run the responses through her Leximancer analysis tool. We felt it would be very interesting to see what happens when the very tools used to help us understand how CCS is perceived are used on the CCS community. This analysis picked up on 8 major themes running through the comments with the most important – low carbon technologies - appearing in red, with CCS in orange as the next most important with the other issues working their way down through the colour wheel to reflect their importance in the discussion.

Peta's analysis went into greater depth and the full version can be read here **www.ieaghg.org/docs/General_Docs/Publications/Responses_from_final_panel_session.docx**

Social media was a big focus for IEAGHG staff during the conference, our aim as always was to enhance the conference experience. With regular tweets, blogs and interviews, we tried to pick up the mood of the conference, quotes that stood out, recognise side events and share this with delegates and anyone following through Twitter, Facebook and LinkedIn. How successful was this? If the number of retweets and other postings under the hashtag ghgt12 is anything to go by, we know that this was embraced by some and hope our efforts were appreciated by all who just read, forwarded or got involved.

So getting back to where I started with Asleep at the Wheel, we can't reflect on the conference without a mention of Austin, a very cosmopolitan city that embraced the conference and made us feel very welcome, recognition of the conference dinner at the world famous Salt Lick BBQ, the bats of Congress Bridge and our hosts, The University of Texas at Austin, who should feel immensely proud of the show that was GHGT-12.

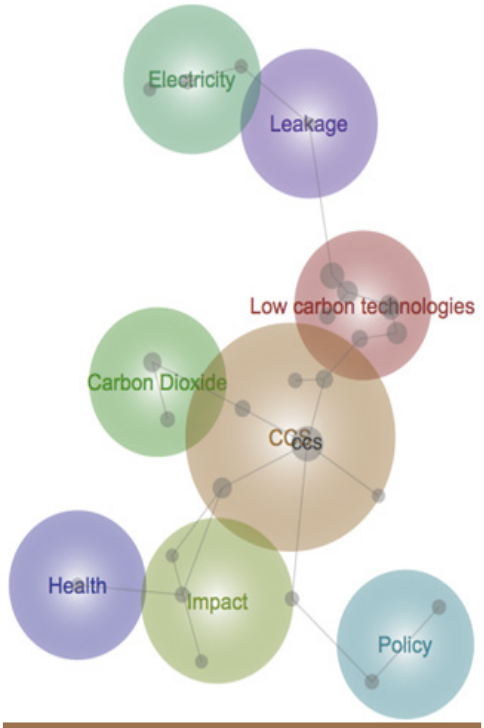


Figure 1 Major themes arising from comments

The papers have been sent to Elsevier for the production of the conference proceedings, eagerly anticipated for very early in the New Year, we will of course let you all know when and how to access them as soon as they are published. This leaves us with little more to do than thank everyone involved in the conference organisation, content and delegation. The GHGT-12 Summary Brochure will soon be available to view and download at **www.ieaghg.org** and we look forward to doing it all again at GHGT-13 in Lausanne, Switzerland, 14th - 18th November 2016.

GHGT-12 Key Messages, by John Gale, IEAGHG

The Latest in the Greenhouse Gas Control Technologies conference series (GHGT-12) was held in Austin, Texas, USA in October 2014. It was attended by 1150 delegates from 35 countries. Some 842 technical papers were presented at this conference covering the full technical breadth of the CCS system and an in depth analysis of policy and public awareness research.

This summary provides a series of key messages from the conference, drawn principally from the closing panel discussion, on the status of CCS and the progress made to date on the development of this technology. The key messages that can be drawn from the conference are:

1. There was universal agreement that, since the IPCC Special Report on CCS (SRCCS) was issued in 2005 there has been tremendous progress on CCS across all parts of the CCS technology chain and, in the policy and regulatory arena.
2. The most significant new development presented at the conference was the first commercial-scale power plant using CCS in operation – the SaskPower Boundary Dam project in Canada.
3. Demonstration projects will reduce the perceived risks of CCS in a range of applications, and through learning, they will assist in bringing the cost of capture down and make CCS more competitive in the future. Mike Monea of SaskPower stated at the conference that having built Boundary Dam 3 they had identified capital cost savings of 30% than can be achieved for Boundary Dam 4 & 5.
4. Amine scrubbing technologies have been developed that reduce the energy consumption of amine scrubbing from 300-350 kwh/tonne in 2005 to 200-250 kwh/tonne CO_2 removed in 2014.
5. Research activities and pilot scale testing have identified and resolved amine scrubbing problems with corrosion, thermal degradation, and nitrosamines. We have identified and quantified problems with amine aerosols and amine oxidation and are working toward solutions.
6. There are now 4 industrial scale storage projects, which are injecting about 5million tonnes per year of captured anthropogenic CO_2 as well as over 120 CO_2-EOR projects injecting about 50 million tonnes a year of non-anthropogenic CO_2.
7. The experience gained from the injection projects underway supports an important conclusion from the IPCC SRCCS: the risks for CO_2 storage should be comparable to those of analogous activities such as CO_2-EOR and natural gas storage. Also that the biggest risk associated with any injection project is seepage of gas up old or abandoned wells. To date, there has been only minor seepage which was easily remedied at the two sites where this occurred.
8. Huge progress has been made with respect to understanding and quantifying the importance of secondary trapping mechanisms for CO_2 storage, such as solubility trapping, residual gas trapping and mineralization. Depending on the site characteristics, these processes can make large contributions to increasing storage integrity over time.
9. Country-specific estimates of storage capacity have been completed in many regions of the world. Harmonization of capacity estimation methods from teams around the world has increased confidence in these estimates. Nevertheless, there are important unresolved issues, such as the extent to which pressure build up and associated geo-mechanical deformation will limit storage capacity. Additional efforts are needed to resolve this
10. Monitoring methods have improved dramatically over the last decade. In addition to seismic monitoring methods, a large number of other methods are now available, including pressure monitoring, electrical and electromagnetic imaging, gravity, InSAR for land surface deformation, micro seismicity, fluid sampling, tracers, eddy covariance for measuring surface fluxes, mobile platforms for surface gas sampling.
11. A new discipline of CO_2 storage engineering has emerged over the past decade. Sophisticated models for optimizing the location and number of wells, the potential for pressure management, and optimization of trapping are all possible now. A strong and talented cadre of engineers and scientists have the knowledge, tools, and skills to design and operate these projects safely and effectively.
12. Bio CCS and the prospect of negative emissions is a topic that has emerged since the IPCC SRCCS in 2005. Interest in BioCCS is growing because it could substantially reduce atmospheric CO_2 concentrations in the future, particularly beyond 2050, which provides flexibility in the timing and depth of CO_2 emissions reductions in difficult sectors (e.g. aviation). This role is particularly important given the current delay in taking collective action to reduce emissions. "Bio CCS is not science fiction, it is science fact, as evidenced by the Illinois Basin - Decatur Project (IBDP) in Illinois, which couples

bioethanol production with CCS".

13. Biofuels production can generate a relatively pure CO_2 stream, and thus be a relatively low-cost capture option. Barriers to the introduction of Bio CCS are generally not related to technology, but rather policy. Bio CCS is not incentivized in the EU Emissions Trading System (ETS), for example.
14. The CCS community accepts and understands that many groups have concerns over the effectiveness and safety of CCS. Many of these concerns are not unique and are faced by many other industries, including some other low carbon technologies (e.g. wind, nuclear, geothermal). The CCS community feels it has information from research and a growing list of projects that could address many of these concerns; however, for many reasons, certain groups may never be comfortable with the concept of CCS or, more specifically, certain projects. Often these unresolvable concerns relate trade-offs between emissions reduction options and the broader framing of CCS in society.
15. With regard to some of the specific concerns raised in the IPCC 5th Assessment Report (AR5) Working Group III (WGIII) summary:
    - **Storage Security** – the fundamental processes underpinning storage security are now very well understood compared to the IPCC SRCCS. This knowledge has developed due to the large amount of research on primary and secondary sealing mechanisms that has occurred since the IPCC SRCCS and been presented at conferences like GHGT.
    - **Transport Risks** – the more than 20-year operational history of CO_2 pipelines in the USA is extremely well documented, and this history shows that transport risks are minimal.
    - **Induced Seismicity** - it was speculated, in an article about a year ago, that this could lead to damage of the seal and migration of the injected CO_2 out of the reservoir. Currently there are no research results that support this theory but there is plenty of evidence to suggest it is not the case.
    - **Environmental Impacts of Leakage** - There are now some 20 controlled release research projects studying the impact of CO_2 migration to the surface and the impact this has on the ecosystems present. All the projects show that if leakage was to occur, the CO_2 is dispersed over a large area and that the environmental impacts of CO_2 leakage are localised.

There was a new wave of optimism at the conference that CCS is moving forward triggered by the Boundary Dam announcement and the reality of other commercial-scale projects which are close to start up. In the two years between now and the next conference GHGT-13 we look forward to seeing more progress on CCS deployment particularly in the power generation sector.

In 2 years' time we expect to have at least 2 more commercial-scale, CCS-equipped plants in operation and several more under construction. These projects will include power plants with the full range of capture technologies (post combustion, oxyfuel and IGCC) and a range of different industrial processes (e.g. iron and cement production, natural gas liquefaction) equipped with capture.

Disclosing CCS Barriers: Assessing the Interrelation Among Important Barrier for Deploying CCS, by Juliana Sara da Silva, Delft University of Technology

What are the main barriers for the deployment of CCS projects in the Port of Rotterdam? What is more important: CO_2 price, political support, public acceptance or maybe financial incentives? How can they be described in terms of interdependencies and relative influences? Is there a common opinion or do organizations perceive these barriers differently?

Different barriers may affect the deployment of CCS initiatives around the world, which may lead to postponement or even cancellation of some projects. They are connected directly or indirectly and may have different reasons: economic, technological, regulatory, social, legal, environmental. Each of them with different influence, importance and impact on the project. Understanding key barriers is fundamental for designing strategies, allocating resources more efficiently and for choosing appropriate management approaches and methods. Knowing which barriers should be addressed first can be a great opportunity improving the results of a project.

An Intricate Relation

Besides many barriers for CCS deployment might be well-known, it is not very clear the intricate relation between them: how important are some barriers in relation to others? How do they influence each other? How favorable or unfavorable are their current situations? Are there differences or similarities among the perceptions of different organizations involved in CCS?

To answer these questions, an online questionnaire was designed. It is part of a PhD research at the

Delft University of Technology, (TUDelft) in the Netherlands and involved CCS experts from different types of organizations in the Netherlands and abroad. The survey assessed important barriers that were previously identified via literature review: "liability of CO_2 storage" (LiSt), "financial incentives" (FiIn), "CO_2 price" (CO2P), "public acceptance" (PuAc), "political support" (PoSu), "cooperation among actors" (CoAc) and "technological uncertainties" (TeUn). The results were grouped based on the types of the organization of the respondents: users of CO_2 (including suppliers, carrier or consumer of CO_2), public organizations, NGO's, academia and research institutes. Other types of organizations, such as consultancy, investors, magazine organizer and trader association, were grouped in others. This classification was chosen by the respondents during the survey.

Revealing the intricate relation

The results of the survey showed that the different types of organizations analyzed perceive the economic barriers ("financial incentives" and "CO_2 price") as the most important barriers for deploying CCS (Figure. 1). Therefore, they should be considered priorities for investments. Together, they represent more than 55% of the rankings. Only exception is made for the research institute group, where "political support" (PoSu) received almost the same percentage (15.4%) as "CO_2 price" (17.4%). In general, the two last positions are occupied by "cooperation among actors" and "technological uncertainties". However, for academia and others, "public acceptance" also received very low percentages; therefore not being perceived as a problem for deploying CCS projects.

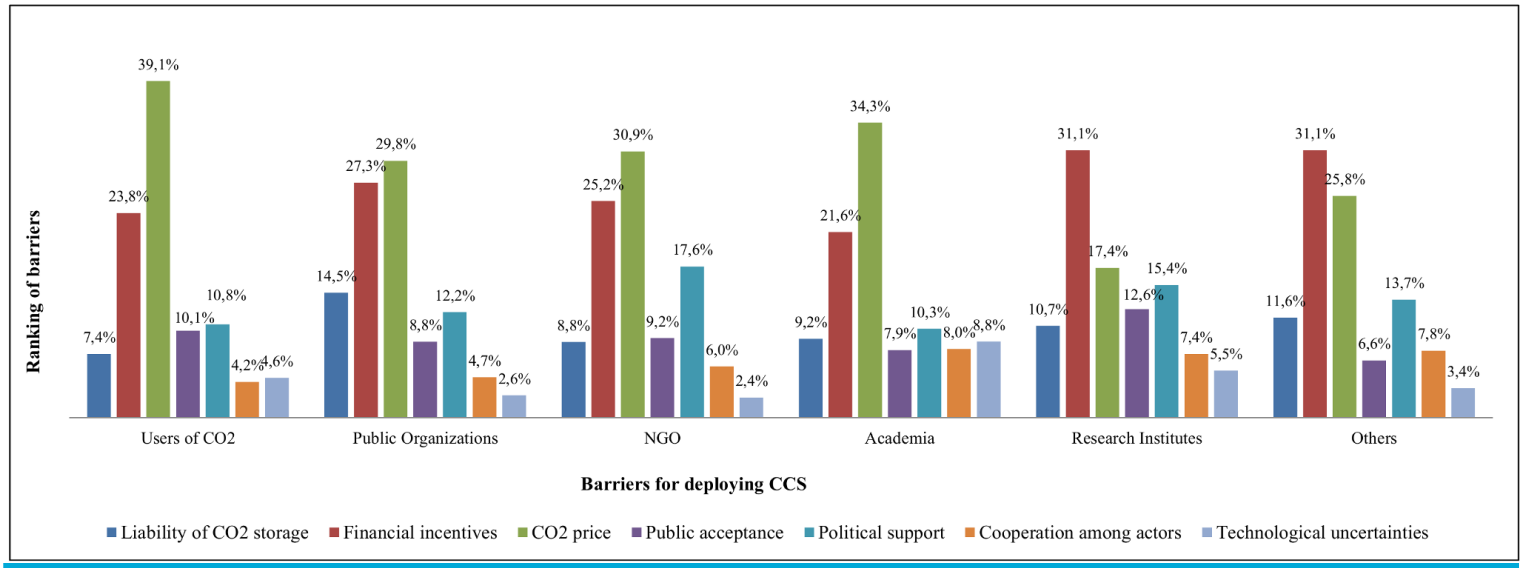


Figure 1: Ranking of the barriers for CCS initiatives according to different types of organizations

In relation to the influence that each barrier exerts on the others, the analysis of the survey concluded that all the barriers are highly interconnected. Figure 2 presents the results in a normalized form, with the most influential barrier receiving the score 1. Barriers with positive values are considered dispatchers: they influence other barriers. Therefore, a change in these barriers impacts the others. The higher the score, the more influential is the barrier. On the other hand, barriers with negative values are called receivers: they are influenced by other barriers.

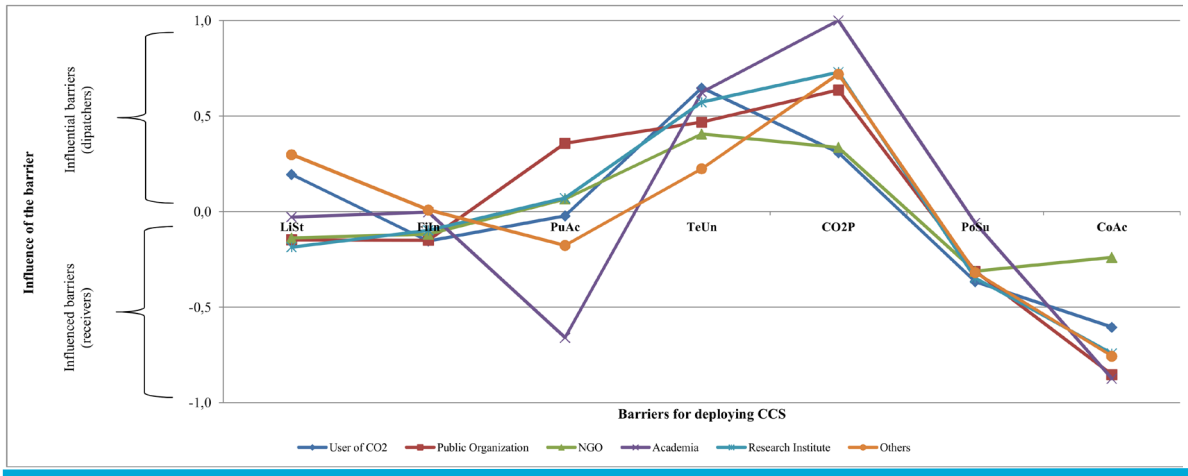


Figure 2: Influence of the barriers for CCS initiatives according to different types of organizations

For all the types of organizations analyzed, "CO_2 price" and "technological uncertainties" are the most influential barriers. On the other side, "cooperation among actors" is the most influenced one, followed by "political support". "Financial incentives" is also normally perceived as being influenced by the other barriers.

The perceptions of the influences of "liability of CO_2 storage" and "public

acceptance" vary. Some groups perceive these barriers as dispatchers (influence other barriers); while for others they are receivers (are influenced by other barriers).

The survey also assessed the perception about the current situation of each barrier. When considering all the responses together, once they were very similar, it could be observed that the current situation of the most important barriers is very unfavorable. For "CO_2 price", 97.1% of the responses considered it as being in highly unfavorable or unfavorable situation, while the remaining 2.9% considered it only as neutral. For "financial incentives", 70% of the responses considered the situation as being highly unfavorable or unfavorable, while 8.6% and 17.1% considered it in a neutral and favorable situation, respectively. On the other side, "technological uncertainties" and "cooperation among actors" received the most positive scores: respectively 52.9% and 47.1% of the respondents considered these two barriers in a favorable or highly favorable situation. Even with the situation of other barriers being more favorable, which can positively influence "financial incentives" for example, improving the conditions for a proper deployment of the CCS project can be quite challenging.

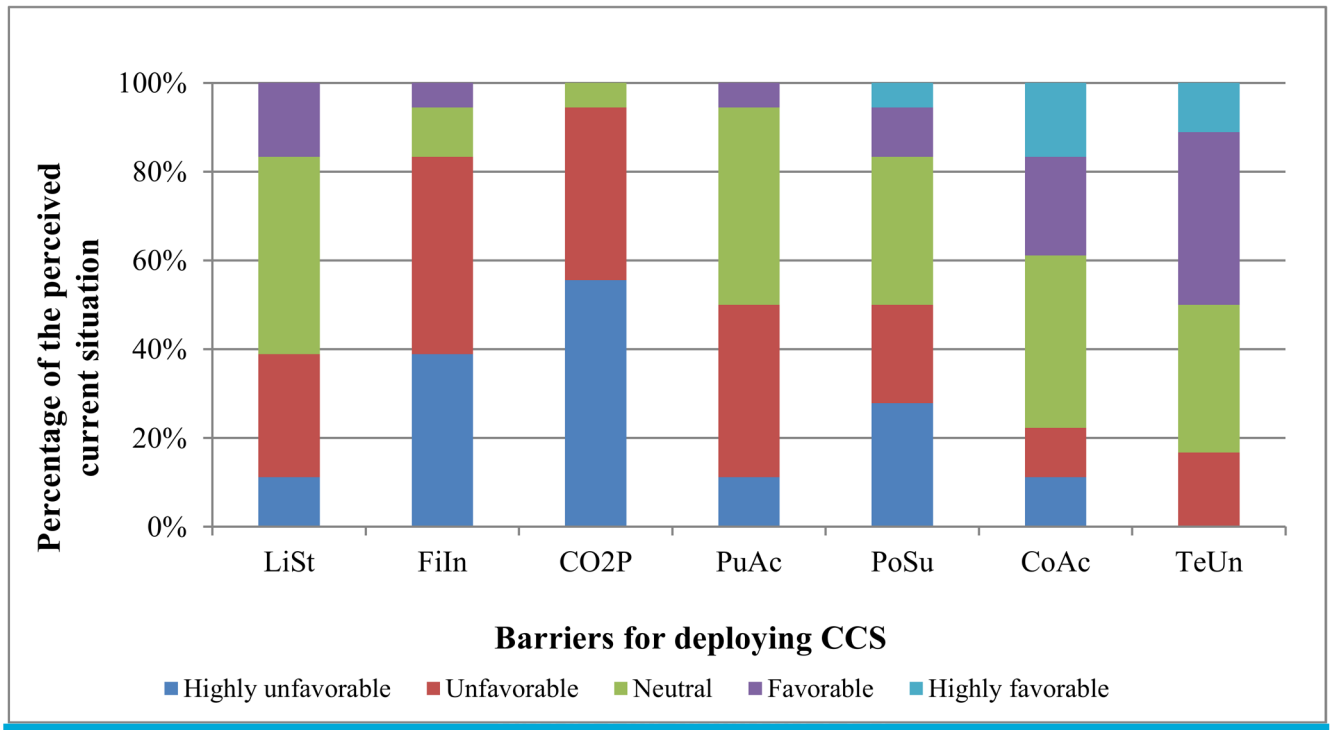


Figure 3: Perceived current situation of the barriers for CCS initiatives

Economic barriers: similar importance, different strategy approaches

Besides the two economic barriers were considered the most important ones, the analysis of their mutual influence with other barriers reveal that decision-makers need different types of strategy approaches to improve them. "CO_2 price" is a very influential barrier; therefore strategies should be designed that directly try to influence it. "Financial incentives", on the other hand, is influenced by other barriers. In this sense, strategies should be created to influence other barriers that will, indirectly, have impact on it. According to respondents' perceptions, improving political support and the price of CO_2 as well as reducing technological uncertainties can enhance the achievement of financial incentive goals.

Public acceptance: a real barrier?

An interesting observation is that "public acceptance" was perceived as having low importance and low influence. However, according to an open question in the survey, this "public acceptance" was mentioned by more than 30% of the respondents as one of the main barriers faced by CCS. These apparently contradictory results may indicate that, besides this barrier (and probably the other barriers analyzed) is relevant, the economic factors are predominantly more important than the others.

Common vision among the different types of organizations: a good start

The different groups of organizations analyzed had, in overall, similar points-of-view, which is very important for defining common strategies to overcome CCS barriers. Different opinions can lead to a very long and costly decision-making process. A common vision is a good start for creating consensus and for defining collective actions that will effectively overcome the difficult barriers that CCS initiatives are facing today.

IPCC 5th Assessment Report: 'Synthesis Report' Now Published, by John Gale, IEAGHG

The IPCC published its 'Synthesis Report' of its 5th Assessment Report in November 2014. The report is considered to be the most comprehensive assessment of climate change yet undertaken. This Synthesis Report brings together the three underlying reports already published on the Science of Climate Change, Impacts and Adaptation, and Mitigation, and so aims to provide a clear and up to date view of the current state of scientific knowledge relevant to climate change, produced by many hundreds of scientists. There is much to be drawn out of these comprehensive reports, which are available at www.ipcc.ch . Human influence on the climate system is clear...

The key messages from the Synthesis report are:

- The more we disrupt our climate, the more we risk severe, pervasive and irreversible impacts
- We have the means to limit climate change and build a more prosperous, sustainable future
- Energy production remains the primary driver of GHG emissions
- The window for action to limit temperature rise to 2°C is rapidly closing
- Ambitious mitigation Is affordable
- Unmitigated climate change would create increasing risks to economic growth.

The report presents its analyses in terms of risks. The risks of climate change and its impacts, it states, are immense and should be of great concern to all. The report also examines pathways to reduce the risks, by mitigation of emissions and by adaptation. For example one headline-grabbing message is that fossil energy without CCS should be phased out by 2100. The challenge is great, but the risks and costs of not tackling climate change are far greater.

In terms of CCS, its importance, both for reducing emissions from fossil fuels and also for combining with bioenergy to take CO_2 out of the atmosphere (BECCS or BioCCS) are clearly set out by the IPCC. The importance of CCS jumps out of table SPM2 (Table 3.2 in full report) where their analysis shows that removing CCS from the low carbon energy mix will increase mitigation costs by a massive 138%, and may not achieve a 450ppm scenario at all. This is by far the highest increase from any of the technologies analysed (bioenergy, wind, solar, nuclear). The report also adds a note, "Note that many models cannot reach concentrations of about 450 ppm CO_2eq by 2100 in the absence of CCS". So the message is unequivocal we really do need CCS in the portfolio of low carbon energy technologies to prevent the serious consequences of climate change.

The report also identifies that CCS also has benefits for the fossil fuel producers, where the report points out that the availability of CCS would reduce the adverse effects of mitigation policies on the value of fossil fuel assets.

The value of CCS as part of any low carbon energy deployment therefore has been fully emphasised by the IPCC report.

Regular readers of Greenhouse News will be aware that I was quite critical of comments regarding the status of CCS and the barriers to the deployment of the technology highlighted in the Working Group III report on mitigation (June GHG issues). I am pleased to say that the barriers that I thought were negative towards CCS are not included in the Synthesis Report (SYR).

IEAGHG members were active in the process of reviewing the SYR, and of close examination was made of the WGIII report, its Technical Summary (TS), and Summary for Policy Makers (SPM). In IEAGHG's view there was an inconsistency between the content of the WGIII report and the conclusions in its two summary documents. This was then carried over to the draft of the SYR. IEAGHG made great efforts to raise these inconsistencies in the review process. An example we can cite being that transport risks are listed as a barrier in the WGIII summaries, but in the underlying Chapter 7 section 7.6.4 on CO_2 Transport there are no references to barriers due to risks of transport, in fact the opposite is the case as there was direct reference made to the extensive experience in North America with CO_2 pipelines.

In conclusion I am pleased to say the negativity in the WGIII summary has not been carried over I the Synthesis report and I hope my teams efforts contributed to that. However as a previous author under the IPCC I am not sure how this situation arose. It seems that the summary text in the WGIII differed from the main report? The text in such a situation should have been agreed and signed off by the chapter members and approved by the secretariat. It seems that in this case this did not happen. The fact that it did not means that the IPCC process was not followed correctly in this case which undermines the integrity of the IPCC reporting process. I think the IPCC secretariat should look into this in detail to ensure their credibility is maintained and that there are no other examples in their AR5 or future reports.

A New Optimism That A Global Climate Deal Can be Agreed, John Gale, IEAGHG

One presentation in particular struck home with me at GHGT-12 which was that of David Victors (see www.ghgt.org/ghgt/12). At the time he shocked me when he showed how little of the global emissions are now covered under the UNFCCC, Kyoto protocol - only 18%. This does focus the mind that we need some agreement of some form but is the UNFCCC process going to challenge the world to agree to reduce emissions with both hands tied behind its back?

One of his points of conjecture was that if the top 10 emitters got around the table, instead of the 160 or more at the UNFCCC, then we might make swifter progress. Since GHGT-12 I am pleased to see that the two largest CO2 emitters - USA and China - have just announced a new joint accord on GHG mitigation. Please the the 2014-IP23 US-China Joint Announcement on Climate Change and Clean Energy Cooperation which is available at: www.ieaghg.org/docs/General_Docs/Publications/Information_Papers/2014-IP23.pdf

In Beijing in early November, President Obama set a goal for the United States to cut its greenhouse gas emissions by 26-28 percent from 2005 levels by 2025. The Chinese President Xi Jinping announced that Chinese emissions will peak by 2030, if not before. As I am aware, this is the first time that China has announced it will actually reduce its emissions which is something of a landmark.

These two countries alone account for 45% of global CO_2 emissions much more than the UNFCCC covers. Of course there are those sceptics that will always demand more; but at least we now have commitments to reduce emissions from the two largest emitters. Add to that the recent EU climate change pact obliging the EU as a whole to cut greenhouse gases by at least 40% by 2030 - http://ieaghg.org/publications/blog/122-policy-and-legal/508-eu-climate-agreement

Then, in late November, we observed that countries like the USA, UK, Germany, Japan, France and many other have pledged $9.3bn to the Green Climate Fund to help developing countries cut greenhouse gas emissions and prepare for the impacts of global warming.

All these pieces start to add up to the fact that governments are starting to take climate change seriously and are planning to take some action. I think there is a new wave of optimism that same form of global climate deal might be reached through the UNFCCC/COP process which is good news for all of us.

CCS Project News from Illinois, USA,

by Lori Gauvreau, Schlumberger

As of the end of the third quarter of 2014 the Illinois Basin – Decatur Project (IBDP) led by the Illinois State Geological Survey (ISGS) at the University of Illinois along with project partners Schlumberger Carbon Services, and the Archer Daniels Midland Company (ADM) have safely injected over 950,000 tonnes of CO_2 into the Mt. Simon Sandstone at the ADM site in Decatur, IL. The project, a large scale geologic test, is on schedule to complete injection of 1 million tonnes by the end of November 2014.

The United States Environmental Protection Agency has issued a draft Class VI Underground Injection Control (UIC) Permit, which specifies post injection monitoring for IBDP. A public hearing is planned for November 5th, 2014 in conjunction with the public comment period.

Also in Decatur, IL, the Illinois Industrial Carbon Capture and Storage (ICCS) Project partners, ADM, ISGS, Schlumberger Carbon Services, and Richland Community College are awaiting final approval for their Class VI UIC Permit. Once a final permit is issued, ICCS can drill their injection well.

The ICCS project is a commercial scale injection project led by ADM with plans to inject up to 1 million tonnes per year of CO_2 over a three-year period. After completion of the IBDP injection, the Illinois ICCS Project will integrate the current IBDP compression and dehydration facilities at the ADM site along with the more recent expansion.

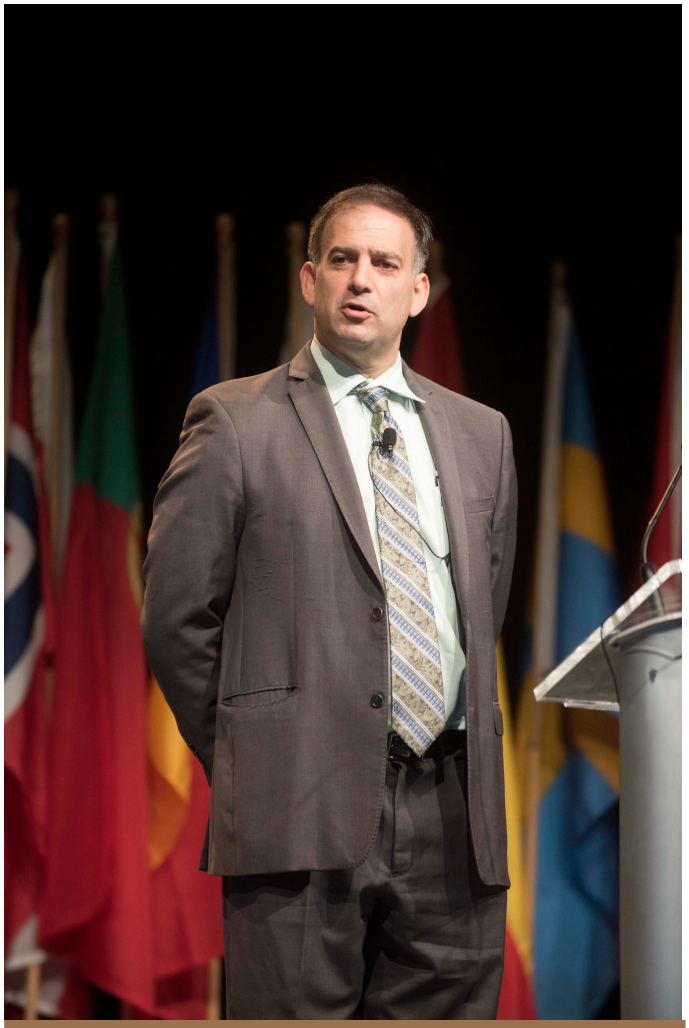
The IBDP and the Illinois ICCS Project complement each other and will help better understand the potential for CCS in the Illinois Basin.

An Interview with Dr Julio Friedmann, US Deputy Assistant Secretary for Clean Coal at GHGT-12, by Becky Kemp, IEAGHG

What do you think of the conference so far?
I'm actually really delighted so far. Delighted with turnout, I'm delighted with the content and I'm delighted that we have so much progress to show.

What do you think were the key messages from your opening plenary talk?
First message is that there is a lot of grounds for optimism; we've covered a lot of ground in the past 10 years, we've started a lot of projects, we've built an edifice of scientific knowledge that's substantial – and all of that is positive. The flip side of that is we're still not doing anywhere near enough to really curb global GHG emissions, and so we need to re-double our efforts to make the kind of progress that we know we need to be effective.

How do you feel that CCS is moving forward in your own mind?
I'm actually quite optimistic. A lot of people have commented to me at this conference that they think it's important to hear positive messages – and I'm surprised; it seems like there's so much positive going on that that is unnecessary. We're seeing countries around the world and govts around the world trying to embrace this, not only in the US, but in Canada, in Japan, in the UK – there are many countries that are being strongly proactive in the carbon capture and storage space. I see a lot of financial institutions trying to think about new ways to finance things. I see innovation in business models; innovation in capture technologies; dramatic reductions in costs; emergence of regulatory frameworks – all of these things are the critical steps needed to develop CCS as a global enterprise.


Julio Friedmann talking at GHGT-12, Austin, Texas

What more do we need to do to get CCS recognised more globally as a key option?
Somehow or another, we've failed at a fundamental piece of communication, which is that CCS is an environmental technology that's part of a global solution. We really need to increase our communications to many, many groups along these lines; to businesses, to governments, to the environmental community – there are groups that are simply not convinced. We need to show them the goods, show them the progress, and make clear that we see this not as some panacea, or some 'sop' (??) to extended the life of a dying industry, but rather we really see CCS as a critical component of what is necessary to achieve an energy-rich, low carbon future.

What messages do you think that this conference delivers and to whom?
I think this conference – more than any other – delivers two things: one, the best technical information that there is. This is the conference where I as a researcher would go to really learn things from the global community of scientists. This is as good as it gets. But the other thing that this conference delivers is a sense of scale; of the size of the enterprise, the depth of the knowledge and the breadth of the undertaking, and it is my hope actually that this continues to grow in public awareness; that media around the world and decision makers around the world gain the knowledge they need and learn about CCS as an enterprise here at this conference.

Signs of Stress Must not be Ignored, IEA Warns in its New World Energy Outlook

Energy sector must tackle longer-term pressure points before they reach breaking point.

Events of the last year have increased many of the long-term uncertainties facing the global energy sector, says the International Energy Agency's (IEA) World Energy Outlook 2014 (WEO-2014). It warns against the risk that current events distract decision makers from recognising and tackling the longer-term signs of stress that are emerging in the energy system.

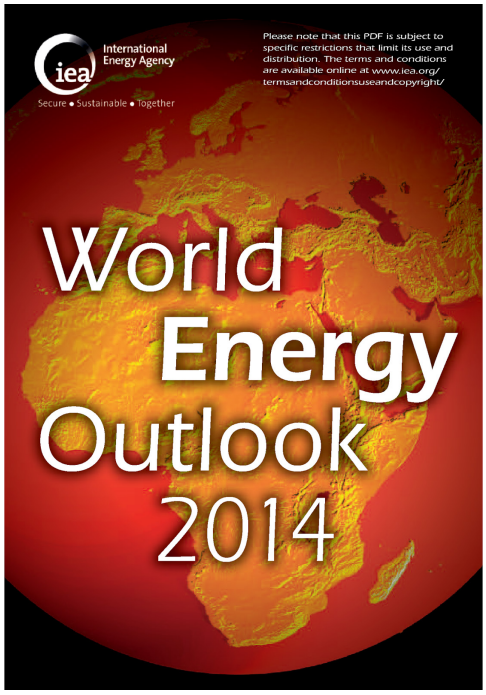
In the central scenario of WEO-2014, world primary energy demand is 37% higher in 2040, putting more pressure on the global energy system. But this pressure would be even greater if not for efficiency measures that play a vital role in holding back global demand growth. The scenario shows that world demand for two out of the three fossil fuels – coal and oil – essentially reaches a plateau by 2040, although, for both fuels, this global outcome is a result of very different trends across countries. At the same time, renewable energy technologies gain ground rapidly, helped by falling costs and subsidies (estimated at $120 billion in 2013). By 2040, world energy supply is divided into four almost equal parts: low-carbon sources (nuclear and renewables), oil, natural gas and coal.

In an in-depth focus on nuclear power, WEO-2014 sees installed capacity grow by 60% to 2040 in the central scenario, with the increase concentrated heavily in just four countries (China, India, Korea and Russia). Despite this, the share of nuclear power in the global power mix remains well below its historic peak. Nuclear power plays an important strategic role in enhancing energy security for some countries. It also avoids almost four years' worth of global energy-related CO_2 emissions by 2040. However, nuclear power faces major challenges in competitive markets where there are significant market and regulatory risks, and public acceptance remains a critical issue worldwide. Many countries must also make important decisions regarding the almost 200 nuclear reactors due to be retired by 2040, and how to manage the growing volumes of spent nuclear fuel in the absence of permanent disposal facilities.

"As our global energy system grows and transforms, signs of stress continue to emerge," said IEA Executive Director Maria van der Hoeven. "But renewables are expected to go from strength to strength, and it is incredible that we can now see a point where they become the world's number one source of electricity generation."

The report sees a positive outlook for renewables, as they are expected to account for nearly half of the global increase in power generation to 2040, and overtake coal as the leading source of electricity. Wind power accounts for the largest share of growth in renewables-based generation, followed by hydropower and solar technologies. However, as the share of wind and solar PV in the world's power mix quadruples, their integration becomes more challenging both from a technical and market perspective.

World oil supply rises to 104 million barrels per day (mb/d) in 2040, but hinges critically on investments in the Middle East. As tight oil output in the United States levels off, and non-OPEC supply falls back in the 2020s, the Middle East becomes the



major source of supply growth. Growth in world oil demand slows to a near halt by 2040: demand in many of today's largest consumers either already being in long-term decline by 2040 (the United States, European Union and Japan) or having essentially reached a plateau (China, Russia and Brazil). China overtakes the United States as the largest oil consumer around 2030 but, as its demand growth slows, India emerges as a key driver of growth, as do sub-Saharan Africa, the Middle East and Southeast Asia.

"A well-supplied oil market in the short-term should not disguise the challenges that lie ahead, as the world is set to rely more heavily on a relatively small number of producing countries," said IEA Chief Economist Fatih Birol. "The apparent breathing space provided by rising output in the Americas over the next decade provides little reassurance, given the long lead times of new upstream projects."

Demand for gas is more than 50% higher in 2040, and it is the only fossil fuel still growing significantly at that time. The United States remains the largest global gas producer, although production levels off in the late-2030s as shale gas output starts to recede. East Africa emerges alongside Qatar, Australia, North

America and others as an important source of liquefied natural gas (LNG), which is an increasingly important tool for gas security. A key uncertainty for gas outside of North America is whether it can be made available at prices that are low enough to be attractive for consumers and yet high enough to incentivise large investments in supply.

While coal is abundant and its supply relatively secure, its future use is constrained by measures to improve efficiency, tackle local pollution and reduce CO_2 emissions. Coal demand is 15% higher in 2040 but growth slows to a near halt in the 2020s. Regional trends vary, with demand reaching a peak in China, dropping by one-third in the United States, but continuing to grow in India.

The global energy system continues to face a major energy poverty crisis. In sub-Saharan Africa (the regional focus of WEO-2014), two out of every three people do not have access to electricity, and this is acting as a severe constraint on economic and social development. Meanwhile, costly fossil-fuel consumption subsidies (estimated at $550 billion in 2013) are often intended to help increase energy access, but fail to help those that need it most and discourage investment in efficiency and renewables.

A critical "sign of stress" is the failure to transform the energy system quickly enough to stem the rise in energy-related CO_2 emissions (which grow by one-fifth to 2040) and put the world on a path consistent with a long-term global temperature increase of 2°C. In the central scenario, the entire carbon budget allowed under a 2°C climate trajectory is consumed by 2040, highlighting the need for a comprehensive and ambitious agreement at the COP21 meeting in Paris in 2015.

The World Energy Outlook is for sale at the IEA bookshop (please follow this link: **www.iea.org/W/bookshop/477-World_Energy_Outlook_2014**). Journalists who would like more information should contact **ieapressoffice@iea.org**.

Projects Selected for Safe and Permanent Geologic Storage of Carbon Dioxide

The U.S. Department of Energy (DOE) announced the selection of 13 projects to develop technologies and methodologies for geologic storage of CO_2.

CCS research is focused on developing technologies to capture industrially generated CO_2, and safely and permanently store it in underground geologic formations, in order to reduce the amount of CO_2 being released into the atmosphere.

The projects selected by DOE will develop technologies, methodologies, and characterization tools to improve our ability to predict geologic storage capacity, understand geomechanical processes, and add to the safety of geologic storage.

The total value of the projects is approximately $17.6 million over three years, with $13.8 million of DOE funding and $3.8 million of non-federal cost sharing.

Managed by the Office of Fossil Energy's National Energy Technology Laboratory, the selected projects have been awarded in two areas of interest: "Geomechanical Research" and "Fractured Reservoir and Seal Behavior."

Geomechanical Research

University of Wyoming, Laramie, Wyo. — The project will study the effects of CO_2 storage on geomechanical, petrophysical, and other reservoir properties through rock experiments, analyses of existing data sets, and simulations representing conditions and processes at the Rocks Springs Uplift, Wyoming. A geomechanical workflow will be developed to predict changes that could affect geomechanical properties and reservoir responses during injection and post injection. (DOE share: $1,091,187; recipient share: $309,068; duration: 36 months)

Clemson University, Clemson, S.C. — This research will evaluate the feasibility of measuring and interpreting, the physical state and properties of rock formations under stress to assess geomechanical processes. Additionally, Clemson researchers will develop and test a removable borehole tool to measure geomechanical properties in wells. (DOE share: $1,244,738; recipient share: $311,185; duration: 36 months)

The University of Texas at Austin, Austin, Texas — The study aims to develop a geomechanical screening tool for reservoirs to assess geomechanical processes and conditions related to CO_2 storage including faults, fractures, and caprock flaws. Geomechanical rock experiments and computational methods using modeling, simulations, history matching, and uncertainty quantification will be conducted for two field demonstration sites to generate and validate a geomechnical screening tool. (DOE share: $1,035,354; recipient share: $258,848; duration: 36 months)

Northern Illinois University, DeKalb, Ill. — The project will develop a risk assessment for a simulated industrial-scale CCS injection project at the Big Sky Regional Partnership Phase II,

Wallula basalt project site. This includes a study of pressure-induced fracture expansion, fracture propagation, and the formation of new fractures. (DOE share: $433,497; recipient share: $119,485; duration: 24 months)

Battelle Memorial Institute, Columbus, Ohio — This research will evaluate the stress-strain setting of the midwestern United States using regional geologic and laboratory data. Methodologies will also be developed to evaluate and predict stress at CO_2 storage sites based on rock cores, geophysical logs, and modeling. (DOE share: $1,171,266; recipient share: $300,000; duration: 36 months)

The Pennsylvania State University, University Park, Pa. — The project will study the geophysical and mineralogical controls on fracture failure in induced seismic events. Relationships between permeability changes and the potential for caprock breaching will be investigated. (DOE share: $1,068,962; recipient share: $267,310; duration: 36 months)

Sandia Technologies, LLC, Houston, Texas — The study aims to develop geomechanical characterization methodologies by combining laboratory rock core testing with downhole tools that determine the strength of rock formations. Data from these tests will be used to model the behavior of caprocks encountered in the Newark Basin in New York. (DOE share: $1,386,261; recipient share: $446,661; duration: 26 months)

Montana State University, Bozeman, Mont. — Researchers will study the geomechanical conditions at the Big Sky Regional Partnership Phase III Kevin Dome large-scale field project to develop and validate an integrated monitoring approach using data from satellites and microseismic monitoring. Numerical modeling will be used to study the interactions between large-scale geologic carbon storage activities and the subsurface geomechanical state. (DOE share: $1,000,000; recipient share: $250,000; duration: 36 months)

Colorado School of Mines, Golden, Colo. — The study will use laboratory rock analysis and models to develop an approach to understand and predict geomechanical effects from large-scale CO_2 injections. Researchers will use the results to develop tools to assess and validate CO_2 flow, storage potential, and the risk of leakage in rock formations. (DOE share: $1,199,408; recipient share: $312,112; duration: 36 months).

Fractured Reservoir and Seal Behavior

Princeton University, Princeton, N.J. — The project will develop new modeling capabilities for simulation of CO_2 and brine migration in fractured reservoirs. Flow interactions between fractures and rock composition will be investigated to model and better predict the CO_2 distribution within a storage reservoir. (DOE share: $800,000; recipient share: $200,000; duration: 36 months)

Colorado School of Mines, Golden, Colo. — Researchers will develop tools to identify damaged shale caprock along with a method to determine CO_2 migration through the caprock. Acoustic methods will be used for detecting damaged CO_2-saturated caprock through laboratory and in-place experimental studies of shale. (DOE share: $1,411,278; recipient share: $450,000; duration: 24 months)

Washington University, St. Louis, Mo. — The project will advance the understanding of fractured basalt reservoirs and the impact basalt structure and chemistry has on flow and mineral trapping of injected CO_2. The project will perform laboratory experiments on rock cores, and integrate geomechanical and geochemical data to understand fracture structure and changes of carbon-trapping mechanisms over time. (DOE share: $996,951; recipient share: $287,750; duration: 36 months)

The University of Texas at Austin Austin, Texas — The study aims to develop and validate geomechanical models based on chemical-mechanical interactions to evaluate fracture growth at the reservoir-caprock interface. Researchers will develop predictive models for top-seal failure via fracture growth by calibrating field observations with experimental rock fracture data under chemically reactive conditions representative of CO_2 storage reservoirs. (DOE share: $991,417; recipient share: $250,154; duration: 36 months)

http://energy.gov/fe/articles/projects-selected-safe-and-permanent-geologic-storage-carbon-dioxide ●

IEAGHG 46th Executive Committee Meeting,

by Becky Kemp, IEAGHG

The most recent biannual IEAGHG Executive Committee ('ExCo') meeting was held in Austin, Texas prior to this year's GHGT event – see page 1 for more on the GHGT-12 conference. The ExCo meeting was kindly hosted by the U.S. Department of Energy (DOE) at the stunning Radisson Hotel in downtown Austin.

This meeting is held twice yearly, at different locations across the world each time, to give IEAGHG an opportunity to provide their Members and Sponsors with programme progress, an update of recently completed and on-going activities and to approve any future work to be undertaken. It also gives Members a chance to report back to the Programme on their activities over the last 6 months and any activities planned for the near future.

The election of the new Vice Chairperson was undertaken, due to Sven-Olov Ericson (Sweden) choosing to stand down after many years of loyal participation in the IEAGHG ExCo. The IEAGHG Programme are saddened to see Sven-Olov step down but are very pleased to welcome Åse Slagtern from Norway to her new position as Vice Chair for the Executive Committee.

Recent studies reported on included our Operating Flexibility of CO_2 storage and transport report, Hubs and Clusters, and an update on the status of two studies on Oil refining Pulp and paper. The CO_2CARE (CO_2 Site Closure Assessment REsearch) project conclusions were also presented which was a project IEAGHG were invited by the EC to be involved with. Feedback was also given on a number of recent IEAGHG events, including the 8th International CCS Summer School, meetings of the Monitoring and Modelling Networks, an update on GHGT-12 and also plans for the future 3rd Post Combustion Capture Conference (PCCC3).

Make sure to follow IEAGHG on LinkedIn, Twitter and Facebook for regular updates on all of our activities and studies. ●

IEAGHG Member Update: Norway

What new CCS activities have been undertaken this month?

EUROPEAN RESEARCH COOPERATION

In order to succeed in commercialising CCS technology, we require extensive R&D in parallel with construction of pilot and demonstration plants. International cooperation is vital in this connection.

The European Commission launched the ERA NET Cofund scheme. This concept entails that several European countries cooperate on joint announcements within R&D and demonstration. The European Commission has indicated that it may be willing to contribute additional financing.

Cooperation Generates Value

Together with Germany, Norway has taken a leading role in establishing an ERA NET Cofund within CCS. The Research Council of Norway and Gassnova are working together to get this started.

The concept now being developed has been named Cofund CCS. A comprehensive dialogue with other European countries is currently ongoing to establish a platform for the cooperation. So far, Norway, Germany, Italy, Switzerland and Romania have agreed to take part in the application. The UK, Netherlands and Greece have given positive signals regarding participation, but not final confirmation. Discussions are also ongoing with several other countries.

Major Joint Announcement

The goal is to get five to ten countries to join, which will contribute EUR 30-40 million overall. An application will then be submitted to Horizon 2020, with the application deadline in May 2015 for ERA NET Cofund (LCE18). If the application is approved for support, the European Commission will provide additional financing corresponding to 50 per cent of the countries' contributions.

If Cofund CCS is realised with support from the European Commission, it will have a pool of EUR 45-60 million. The majority will be allocated to a major joint announcement which will be published at the end of 2015.

What new CCS research has been carried out this month?

POSITIVE RESULTS FROM NORCEM IN BREVIK

Test phase I of the major CO_2 capture project in the cement industry is in its final stages. The project management team at Norcem is eagerly anticipating the results from the various tests.

"Progression in the project is very good. We are on track, and have the finances in check. We can already see at this stage that we will be able to capture CO_2 from the cement production," says Liv

Project manager Liv Bjerge (left) and site manager Camilla Solheim in Norcem are very satisfied with the results in the CO_2 capture project. Photo: Claude R. Olsen

Bjerge in HeidelbergCement Norcem.

Bjerge heads the extensive project where four technologies are being tested to see which is best suited for capturing CO_2 in the flue gas in cement plants. Norcem is the project manager with HeidelbergCement and European Cement Research Academy (ECRA) as industry partners. The project is supported by CLIMIT Demo.

Two of the technologies have progressed quite far in terms of development. Aker Solutions and Alstom are therefore completing their test programmes this autumn. The two immature technologies - solid absorbent (RTI) and membranes (Norwegian University of Science and Technology, Yodfat Engineers, DNV GL) - must undergo two test phases. RTI has finished test phase I and is planning test phase II, while the membrane consortium will complete test phase I later this autumn.

Three of the four test plants are located in Brevik where they are supplied with flue gas directly from the cement production. The flue gas, which contains 17-20 per cent CO_2, as well as SO_2, NO_x, dust and water vapour, is a very corrosive mixture when the water condenses. It was challenging for Norcem to design the process so that the test plants would be supplied with flue gas at the correct rate and temperature. They also had to choose suitable materials which could handle the flue gas. Both issues were solved earlier this year.

www.climit.no/en/Pages/Positive-results-from-Norcem-in-Brevik.aspx

COMPLETELY NEW CO_2 CAPTURE CONCEPTS

Four projects with entirely new concepts for CO_2 capture have been granted funding from the CLIMIT programme.

CLIMIT R&D carried out a completely new evaluation procedure in its last announcement. The goal has been establishing projects that will research completely new CO_2 capture concepts. More emphasis than usual has been placed on the technology's potential, which also means that a much higher risk level is accepted in the research than what is normal. This is to promote new innovative technology for CO_2 capture with considerably improved efficiency and reduction of CO_2 capture costs.

The evaluation took place in two steps. Fifteen applications were received in response to the announcement and international experts have evaluated the scientific qualities of the applications. Eight projects made it through to the final round where the project managers presented their concepts to an international evaluation panel consisting of industry experts who assessed the technology's potential. Another goal of the announcement was to reach young scientists and research groups that do not traditionally submit CO_2 capture projects to CLIMIT.

The four approved projects show that CLIMIT was successful with regard to all of the goals in the announcement.

Project no.	Title	Institute
239778	Capture of CO_2 in Confined Surfactant Geometries	NTNU
239787	Magnetic separation of CO_2 through sorption on magnetic hybrid nanoparticles	SINTEF
239789	3rd generation solvent membrane contactor	NTNU
239802	Combined fixed bed processes for improved energy efficiency and with low penalty for CO_2 capture	SINTEF

What reports on CCS have been published this month?

CO_2 TECHNOLOGY CENTRE MONGSTAD PRESENTED RESULTS FROM ITS MEA CAMPAIGN

A large group attended the technology session where TCM's MEA results were presented during the GHGT 12 conference in Austin, Texas. Four papers were presented, and they are now available via the conference's website at www.ghgt.info.com.

Any other comments/activities regarding CCS?

CLIMIT SUMMIT 2015

10 years of CCS research –what's next? The CLIMIT SUMMIT has become an established meeting place for the CCS community. In 2015, this event is scheduled for 24th - 25th February 2015 at the Soria Moria Hotel and Conference Centre in Oslo.

Ten years have passed since CLIMIT started its work, and this is certainly a cause for celebration.

While we will be taking a look at our past during this year's SUMMIT, the main focus will be on what MUST be done in the time ahead. As in previous years, this year's programme will feature international speakers and presentations from CLIMIT's project portfolio, and we have allocated plenty of time for networking – we can promise you an interesting and educational Summit.

150 - 200 participants are expected from research, industry and public institutions at this year's CLIMIT SUMMIT.

More information: www.climit.no/en

RECORD NUMBER OF INTERNATIONAL CAPTURE PROJECTS

Cooperation across borders yields results. The CLIMIT programme has noted growing interest from projects with international content.

CLIMIT's programme plan for 2013 - 2020 places greater emphasis on innovation, internationalisation and communication.

The intention is faster progression in innovative solutions that make CCS more affordable. The industry sector has also joined in the effort and CLIMIT has several projects with exciting goals that will promote new technology.

"The challenges related to commercialisation of CCS can best be solved through international cooperation. This yields far better results than if each country only works at a national level on separate things. CLIMIT has helped develop a broad portfolio with recognised international players," says Hans Jörg Fell, head of the CLIMIT secretariat.

Cooperation enhances quality

One of CLIMIT's goals is to maintain high quality research, and to let Norwegian researchers be challenged by others, thus promoting development. We want Norwegian research communities to also work towards the EU. When researchers learn from each other, this will contribute to raising the level of research, yield better results and better equip research groups to join even more EU projects. Joint announcements make it easier for researchers to work together, and this is a way to ensure cooperation between groups that complement each other and work toward common goals.

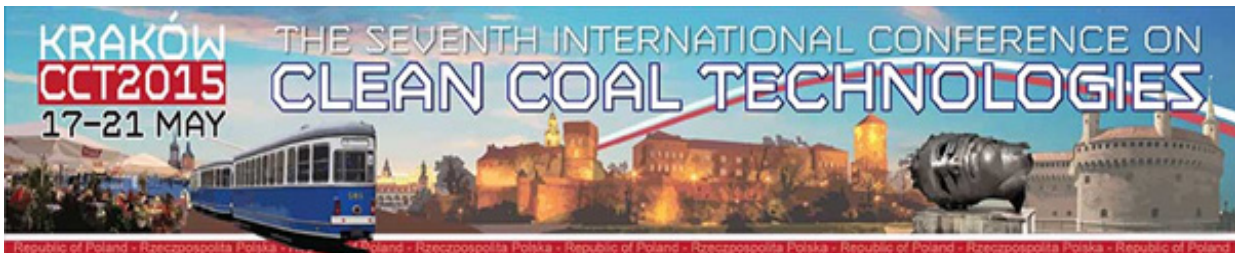
The CLIMIT portfolio illustrates that many groups have already made great progress within international cooperation. As many as 70 per cent of the CLIMIT R&D projects currently include some form of international cooperation.

Would you like to learn more about cooperation with the CLIMIT programme?: post@climit.no

Contacts: Åse Slagtern, asl@rcn.no and Hans Jörg Fell, hjf@gassnova.no

News from the IEA Clean Coal Centre,

by Debo Adams, IEA CCC



The Seventh IEA CCC Conference on Clean Coal Technologies (CCT2015) takes place on 17th - 21st May 2015 in Kraków, Poland.

Organised by the IEA Clean Coal Centre and the Central Mining Institute of Poland (Główny Instytut Górnictwa), CCT2015 is a leading international forum for research into clean coal technologies, including:

- high efficiency, low emissions plant
- developments in carbon capture
- air pollution control
- low rank coal utilisation

With strong international participation from both the coal power industry and research institutes, the conference represents an ideal platform for networking within the global coal research community.

The venue for CCT2015 is the Auditorium Maximum of the Jagiellonian University in the heart of Kraków, and the conference includes a visit to the world's first supercritical circulating fluidised bed boiler at Łagisza power plant.

Visit www.cct2015.org for details.

Contact Debo Adams (Debo.Adams@iea-coal.org) to discuss opportunities for sponsorship.

Delegates at the Energex wood pellet plant

4th Cofiring biomass with coal workshop

The cofiring workshop was held in State College, PA, USA on 4th - 6th November and was attended by delegates from thirteen countries and a range of organisations – utilities, engineering companies, torrefaction companies, research organisations and universities. The workshop began with a site visit through the beautiful forests of Pennsylanvia to the start-up commercial torrefaction facility of Terra Green Energy LLC. It was an excellent start to the workshop.

Solid biomass fuel for cofiring with coal and for biomass conversion is a dynamic area of research – progress is being made on torrefaction, pellet making, characterising biomass, gasification and on a range of materials to use as fuel. As well as wood, there is work underway on straw, miscanthus, microalgae and others. A number of full-scale bioconversions of coal-fired plant are underway.

How can we increase the flexibility of coal to fit in with the intermittency of renewables?

Renewable energy sources provide varying, often unpredictable, amounts of electrical power, so coal-fired power plants are becoming increasingly important in balancing power grids. In this role, the coal-fired plant has to be highly flexible so it can ramp up quickly, for example to cover for when the wind drops.

Unfortunately, coal-fired power plants in the past were generally designed to provide a fairly constant output. Rapid changes in output or frequent shut-down and start-up operations were avoided as far as possible, as they increased the stresses on a plant, shortened component life, increased costs and reduced efficiency.

However, developments by the suppliers have resulted in features that give the flexibility required with much less adverse impact on the plant.

Dr Colin Henderson of the IEA Clean Coal Centre has reviewed how recent coal-fired plants and future advanced coal-fuelled technologies can be designed to achieve this (Increasing the flexibility of coal-fired power plants, Colin Henderson, IEA CCC, Sept 2014). Dr Henderson points out that the importance of having flexible fossil-fired plants on power grids is not widely recognised by people at large: "Increasing the amount of renewable power plants makes electricity grids more unstable, threatening blackouts. Keeping coal-fired units with fast responses on the grid is an essential part of ensuring reliable electricity supplies."

There are means for increasing flexibility in all the main plant equipment areas: boiler firing, boiler pressure parts, emissions control systems, turbine and water-steam systems, control systems, auxiliary plant.

The flexibility aspects of the turbine and water-steam systems of CFBC (circulating fluidised bed combustion) plants are essentially similar, although the different boiler system means that start-up times can be longer.

Existing IGCC (integrated gasification combined cycle) systems were not designed specifically for high flexibility, but it could be improved by providing facilities for storage of syngas or oxygen. Polygeneration (multi-product) IGCC systems would allow greater load range. If IGCC plants start to be ordered in large numbers, designing for flexibility will become more important and new approaches to achieving it may emerge.

Manufacturers and utilities are working to achieve efficiencies of about 50% (LHV basis) by using steam conditions of 700°C and above in advanced ultra-supercritical (A-USC) plants. Providing the capability to operate flexibly could be limited by properties of the nickel alloys that will be used in such plants.

If necessary, it may be possible to design plants incorporating CO_2 capture to have similar flexibility to that of their non-capture equivalents, but cost considerations would influence the extent of flexibility realised in practice.

The report shows that potential damage mechanisms from plant cycling are known, and the technical means exist for conventional combustion-based plants to achieve the flexibility required without unacceptable effects on equipment life, thermal efficiency or costs. The importance of having flexible fossil-fired plants on power grids cannot be overemphasised in

ensuring the reliability of electricity supplies.

The report, Increasing the flexibility of coal-fired power plants, CCC/242 by Dr Colin Henderson (57 pp, September 2014) is available for download from the IEA Clean Coal Centre Bookshop http://bookshop.iea-coal.org.uk/site/uk/clean-coal-technology-research-reports?LanguageId=0 ●

CCS a reality as Construction Rolls Out, Report Finds

A global report launched on the 5th November in Abu Dhabi finds that the only low-carbon technology option for industrial and many power applications, carbon capture and storage (CCS), is now on the cusp of widespread deployment.

Brad Page, CEO of the Global CCS Institute, said: "CCS in the power sector is now a reality with the world's first large-scale CCS project operating at Boundary Dam, Canada. With eight major CCS projects anticipated to go live in a range of industries worldwide by 2016, this low-carbon technology is reaching the critical mass necessary for widespread deployment."

The Global CCS Institute's annual Global Status of CCS: 2014 report finds there are now 22 projects in construction or operation worldwide, a 50% increase since 2011. The report details progress on CCS over the past year, providing a raft of recommendations for decision makers.

It found the industry is poised to move through its most active construction period to date, extending across a diverse range of sectors such as iron and steel, natural gas and power. The report details nine CCS projects under construction with investments totalling billions of dollars. Eight of these are expected to become operational by 2016.

"These diverse and large-scale projects demonstrate that CCS is active, operational and viable. An important point is that the projects currently under construction are the result of visionary policy decisions made around five years ago.

"We simply can't have an effective response to tackling climate change without CCS. Decisions and actions are required now to lay policy, legal and infrastructure foundations for wide-scale deployment post 2020," said Mr Page.

Mr Page called for "a year of action" on policy and deployment for CCS, saying, "Now is the time for decision makers to take stock of what has been achieved and build on these solid foundations so that CCS can make major contributions to reductions in greenhouse gas emissions."

The report found there are 14 CCS projects in advanced planning stage, including nine in the power sector, expected to be in a position to make a final investment decision in 2015. Calling for financial and policy support structures to transition this portfolio of planned projects to actual projects by 2020, Mr Page warned that CCS technology would not become widespread without policy parity with other clean technologies.

By 2016, CCS will be in operation in high carbon-emitting sectors such as chemicals and iron and steel. The world's first commercial-scale chemical and bio-CCS plant at the Illinois Industrial CCS Project in the United States (US) plans to be operational in 2015. The Abu Dhabi CCS Project in the UAE, planned for operation in 2016, is the world's first large-scale project in the iron and steel sector.

"We need to be clear that CCS is the only technology that can achieve large reductions in carbon dioxide (CO_2) emissions from industries such as iron and steel, chemicals and cement which together emit 20% of the world's CO_2. In fact, it is just as important to use CCS on industrial processes as in the electricity sector, which is currently the world's largest CO_2 emitter, accounting for up to 40% of emissions," concluded Mr Page.

Article continues overleaf...

Key findings:

- The world's first large-scale CCS project in the power sector went live at Boundary Dam in Estevan, Saskatchewan, Canada on October 2nd, 2014.
- The Abu Dhabi CCS Project in the UAE (expected to come on in line in 2016) will be the world's first large-scale CCS project in the iron and steel sector.
- There are 22 large-scale CCS projects in operation or construction around the world, with the capacity to capture up to 40 million tonnes of CO_2 per annum, equivalent to taking 8 million cars off the road.
- The next two large-scale CCS projects in the power sector are planned to come online in the US: Southern Company's Kemper County Energy Facility in Mississippi (2016), and the Petra Nova Carbon Capture Project in Texas (2016).
- CCS projects in the UK are progressing with both the Peterhead CCS Project and the White Rose CCS Project receiving funding to begin advanced engineering studies, while its policy makers are developing mechanisms to support CCS in the power and industrial sectors.
- There are another 14 large-scale CCS projects in advanced planning stages, including 9 in the power sector, many of which are anticipated to take a final investment decision during the next year.
- The US, Canada and China lead the world in the development and deployment of CCS projects. These countries are not only major sources of CO_2, but also have a vast potential to store CO_2.
- The data revealed two areas requiring more attention from policy makers: the lack of CCS projects in non-OECD economies (outside of China) and the lack of progress in CCS technology development in high carbon-intensive industries such as iron and steel and cement.

Please click the link to download the full report: **www.globalccsinstitute.com/publications/global-status-ccs-2014-summary-report**

Conferences & Meetings

This is a list of the key meetings IEAGHG are holding or contributing to throughout 2015. Full details will be posted on the networks and meetings pages of our website at www.ieaghg.org.

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

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

IEAGHG and IEA IETS Workshop on CCS in Process Industries - Current State of the Art and Future Opportunities

10th - 11th March 2015; Lisbon, Portugal

6th High Temperature Solid Looping Cycles Network (HTSLCN) Meeting

1st - 3rd September 2015, Milan, Italy

PCCC3

8th - 11th September 2015, Regina, Canada

Environmental Impacts and Risk Management Networks Meeting

28th September 2015, Southampton, UK

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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