GHGT-12

Conference Summary

12th International Conference on
Greenhouse Gas Control Technologies

5th - 9th October 2014
Austin, Texas

Entertainment at the Welcome Reception from the Ballet Folklorico dancers / Lake Austin (formally Lake McDonald), a water reservoir on the Colorado River in Austin, Texas

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IEAGHG would like to thank all those who worked on this publication.

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GHGT-12 Highlights

The latest conference in the long standing GHGT conference series was held in the vibrant city of Austin, Texas, in October 2014. With some 1160 delegates from 35 countries presenting the latest research on carbon capture dioxide (CO_2) and storage (CCS), the series is truly the largest international conference in the world on CCS.

The development that added a new vibrancy to the audience was the announcement that Boundary Dam 3 was now operational. No longer can detractors say that CCS has not been demonstrated at scale in the power sector. We should also draw attention to developments in Texas, where the Air Products Carbon Capture Demonstration project has now been operating for over one year and has delivered around 1 million tonnes of CO_2 for EOR operations.

Aerial Photo of SaskPower's Boundary Dam Project near Estevan, Saskatchewan

Aerial view of Air Products' existing steam methane reforming facility at Port Arthur, Texas, with new carbon-capture units and central co-gen and CO_2 product compressor

| Photo courtesy of Air Products and Chemicals Inc |

"This has been a good decade for CCS. We've accomplished a lot."; Julio Friedmann, US Department of Energy

Such demonstration achievements invigorated the audience at GHGT-12. Coupled with the infectious enthusiasm of Julio Friedmann, US Department of Energy, in his keynote speech and the knowledge that there is a flow of demonstration projects coming on board in the next few years, it is clear that CCS is now moving forward and the CCS communities realisations are finally being achieved.

Compared to other low carbon technologies, CCS is not as mature and we need to develop a process that is cost effective and able to take its place in the market place without subsidy. However, it is reassuring that cost reductions can be achieved when Mike Monea of SaskPower announced from the podium at GHGT-12 that having built Boundary Dam 3, they had identified that the next units for Boundary Dams 4 and 5 could be built at 30% lower capital costs – and with 20% lower operating costs with existing capture technologies.

It is also heartening to see that some governments are prepared to go to lengths to support the long term deployment of CCS. The UK government is one, who have reformed the UK energy market and introduced what are called "contracts for difference" that give investors a positive long term price signal for low carbon technology whilst providing a stable electricity price for consumers.

Bill Spence of Shell in the closing panel made reference to Roger Bannister who broke the four minute mile way back in 1954. The message he was conveying was that whilst Roger took the headlines, there was a whole team working behind him to make that possible. In the case of CCS, demonstration projects will grab the headlines but it is the underpinning research, underway for the last 20 years, that has assisted these demonstrations. The researchers presenting their work at this (and earlier) GHGT conferences have all contributed to these headline successes that are now coming to the fore.

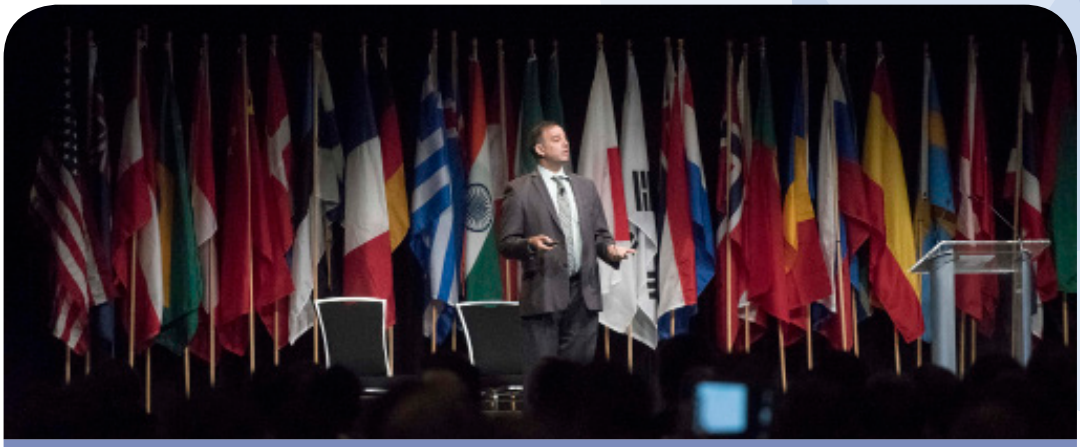
With over 874 papers presented both orally and as posters it is difficult to pick out success stories and highlight individual papers. However, one overwhelming conclusion from the closing panel was that we know a lot more now than we did in 2005, at the time of the IPCC Special Report on CO_2 capture and storage, and this needs to be documented to show just how far our knowledge base has come.

We can look forward to the next conference in the series (GHGT-13, Lausanne, Switzerland, in November 2016) with renewed interest. At this event we should be discussing more new projects coming on stream like the Shell Quest project in Canada, the Gorgon project in Australia, Kemper County project in Mississippi, USA, Petra Nova in Texas, USA and the Abu Dhabi CCS project to name just a few. When you look at this, the coming two years are going to be very exciting and will set us up for a great next conference in the series.

Top Left: Austin, Texas, Capitol Building (View of the front left oblique); Top RIght: The Flag of Texas; Bottom Left: A Texan Sunset; Bottom Right: Austin Texas Skyline

GHGT-12 Conference Summary

Background



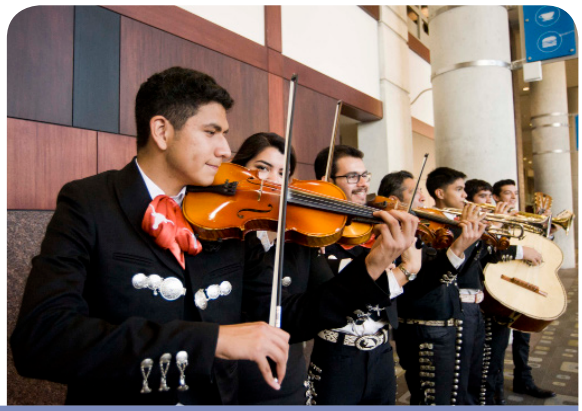
Julio Friedmann (US DOE) addresses the audience in front of the flags which represented the 35 countries in attendance

The GHGT-12 conference is the latest in this long standing conference series, which began in 1990. This conference was hosted by The University of Texas, Austin, USA. The University of Texas is one of the key centres of excellence on amine capture in the USA and through its Bureau of Economic Geology also is a world renowned centre of expertise on CO_2 storage and CO_2-EOR. Who better then to host the conference this time around in the USA?

Of course the USA probably has the largest active demonstration programme and R&D portfolio on CCS in the world. It was also therefore fitting that the USA was the country host for GHGT-12. The United States Department of Energy was the lead sponsor for GHGT-12 and Dr Julio Friedman, Deputy Assistant Secretary, Clean Coal and Carbon Management, gave the opening key note speech.

The GHGT-12 conference was attended by 1160 delegates from 35 countries making it a truly international technical event. In total 874 papers were presented, in 7 parallel oral sessions and 2 poster sessions.

Each conference in the series, whilst it has it technical core, is always culturally different and Austin was no exception. IEAGHG are the guardians of the series and provide a continuity and support across the conferences but it is the host that adds the personality. We had a Mexican Mariachi band and dancers at the opening ceremony and a Texan style barbeque and hoedown at the world famous Salt Lick BBQ.



Left: The famous Texan Longhorns at the Salt Lick BBQ, Texas; Right: Entertainment from a traditional mariachi band at the Welcome Reception

General Conference Outcomes

Given the numbers of technical papers presented across the wide technical breadth of CCS it is difficult to single out the best specific technical developments or issues. However we can make some general points:

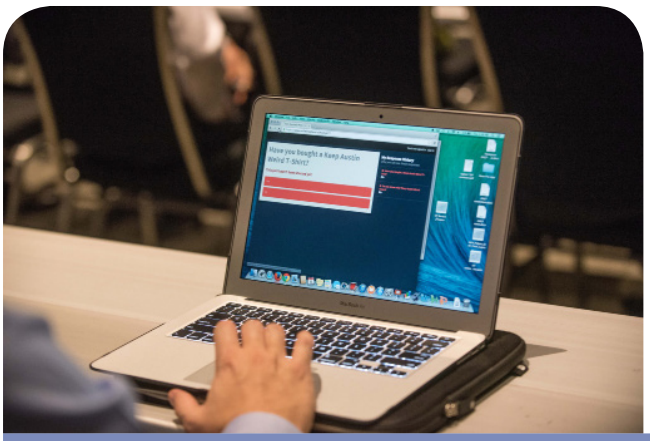
- Geological storage and capture account for 63% of the papers presented.
- There were more technical papers on 2nd and 3rd generation capture technologies than in previous conferences. This reflects the growing research activity in this area, through activities like the USDOE Carbon Capture Program.
- There were double the attendees at BioCCS/BECCS sessions than at previous conferences indicating a growing interest in this topic.
- There was one new technical stream on the energy/water nexus, this is an area that will likely expand in the future
- There was a significant increase in the numbers of papers on monitoring, reflecting the developments and growing experiences in the field from projects.
- As a topic there were fewer papers on social science research on CCS at this conference but more papers on educational activities.
- We had the 1st delegates ever to attend from Trinidad & Tobago
- The first pigeon attended the conference (sorry you had to be there to appreciate that one!)

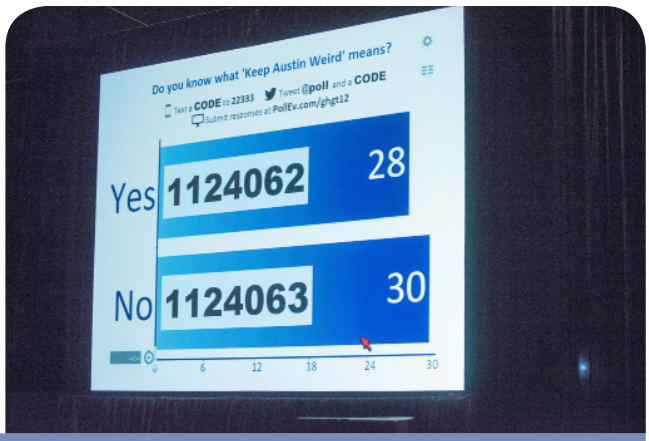
We always try something to improve the experience for the attendees:

- This time there was an interactive closing panel session to get more direct audience participation and feedback. The software did finally work!! It was also very evident that we needed a moderator to assist the chairman in picking questions to direct to the panel – a steep learning curve but we will improve and bring this element back at GHGT-13
- The first use of 'Poster in my Pocket' app – with 189 authors embracing the addition it was well received by both authors and delegates so will continue!
- We developed a new conference app – apologies that it was wrong at the start but once this was rectified the app was downloaded and used by almost half of the delegates. With a wish list of improvements and a plan to roll out much earlier in the future, it is becoming a valuable tool.

ANDROID APP ON Google play

Download on the App Store





All different types of technology including laptops, notebooks, smartphones and tablets were used at the interactive closing panel session at GHGT-12

Conference Discussion Points

As well as the technical content, which will be published in early 2015 as an open access online proceedings, Energy Procedia et al., there were a lot of other issues covered at the conference in either plenary presentations or discussion panels.

"CCS is ready, willing and able to tackle the challenges of climate change" Kelly Thambimuthu, Chairman of the IEAGHG Executive Committee

CCS, the UNFCCC and Climate Change

There was a general feeling at the conference that the time was right for an international high level agreement on greenhouse gas mitigation. As Chairman of the IEAGHG programme, who are custodians of the GHGT-12 conference series, **Kelly Thambimuthu** welcomed delegates to the conference. He recognised the US and Canada's significant role in the development of the CCS technology and likened CCS to a fully grown adolescent child, requiring only the guidance of a responsible parent – in this case a global climate change protocol – to unleash its full potential in the battle against climate change.

Despite the failures in Copenhagen and Durban to reach such a protocol, Kelly remains hopeful that UNFCCC conference in Paris, 2015 will see the world agreeing to limit greenhouse gas emissions.

"The political prospcts for meaningful agreements is the brightest for many years."; David Victor, the University of California

David Victor was one of the Keynote Speakers and added a little spice of controversy to the opening session which went down well with the attendees. David was hopeful that there would be an agreement on greenhouse gas emissions reductions in Paris 2015. However he noted that the impact of the Kyoto Protocol was diminishing. At the original signature of the Kyoto Protocol in 1997, the agreement covered some 59% of global emissions. Only 13% of global emissions are covered by the Kyoto Protocol. His optimism that some form of agreement could be reached was based on recent discussions between the two main polluters; China and the USA.

Since the conference, the IPCC published its Synthesis Report of the 5th Assessment Report, and this provides very strong messages on the role of CCS in mitigating emissions in the future, more so than for any other technology. The messages from this and from GHGT were carried into COP-20 in Lima, and we were pleased to see that the COP resulted in a framework to enable a future climate agreement at COP-21 in Paris in 2015.

The Current Status of CCS Demonstration and Post Combustion Capture

The leading speech that made the GHGT-12 audience well and truly sit up was that from **Mike Monea from SaskPower**. Mike announced to the audience that the Boundary Dam CCS Project was now operational and that the CO_2 pipeline was fully charged and they were sending CO_2 to Cenovus as he spoke. He showed a picture of a gauge indicating the CO_2 had a purity of >99.9% far higher than they expected.

The project was first considered in 2000 but it has taken until 2014 to bring to reality. Why coal? Mike indicated that, in Saskatchewan, there are hundreds of years of coal reserves which he can predict the price of for years to come. The other option to meet Canadian emission requirements for new power plants is natural gas. However, Mike concluded that the price volatility of natural gas made it difficult to make long term cost estimates, which meant coal was first choice.

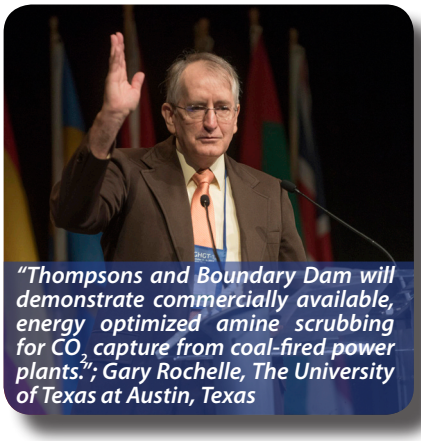
The captured CO_2 is transported to the Weyburn oil field for CO_2-EOR purposes; the sulphuric acid is sold for fertiliser production and the fly ash for concrete production. As well as reducing CO_2 emissions by 90%, SO_2 is down 100%, PM10 emissions are down 90%, PM2.5 down 70% and NO by 27%.

"Build more, build them bigger and they will get cheaper"; Mike Monea, SaskPower

In terms of costs they have identified savings in building Boundary Dam 3 that can reduce the cost of coal with CCS by 20 - 30%, making it competitive with NGCC and nuclear, and more competitive with biomass and wind in a Saskatchewan context. There is, however, no solar option in Saskatchewan.

What next? SaskPower are looking at retrofitting Boundary Dam units 4 and 5 in the future. They are committed to post combustion capture and have invested in a capture test facility at the Shand Power plant and an Amine Chemical Laboratory to help them test and develop advanced solvents.

Another key speech came from **Gary Rochelle of the University of Texas at Austin** - our Host and Conference Co-Chair. His presentation provided a technical review of the progression of the commercial amine technologies, starting with the Lubbock gas plant in 1983-84 and ending with the new WA Parrish CO_2 Capture Project (Petra Nova) in Thompsons, Texas, 2014. The talk focused on the technology and how it has improved over the intervening 30 years. One point Gary made was that the Mitsubishi Heavy Industry post combustion capture technology at WA Parrish, demonstrates the need for patience during what can be a very time consuming scale up process. The progression of energy consumption and other performance results and the improvement of processes and solvents was outlined with Prof. Rochelle concluding that amine scrubbing is, has been, and will be the technology of choice – was there ever any doubt that would be his conclusion?!



"Thompsons and Boundary Dam will demonstrate commercially available, energy optimized amine scrubbing for CO_2 capture from coal-fired power plants."; Gary Rochelle, The University of Texas at Austin, Texas

CO_2-EOR

Supply CO_2 for EOR operations is proving to be a great benefit for CCS demonstration projects in North America. The financial return to projects for their CO_2 is helping to financially de-risk CCS projects in North America. Boundary Dam 3 is one such project that is supplying CO_2 for EOR operations. The Air Products Carbon Capture Demonstration project has now been operating for over one year and has delivered around 1 million tonnes of CO_2 for EOR operations to a pipeline owned by Denbury Resources.

Greg Schnake of Denbury Resources said that CO_2 Enhanced Oil Recovery (EOR) is a proven process, and one of the most effective tertiary oil recovery methods." The US federal government notes that CO_2 is a pollutant, and recognises the role of CO_2 EOR in CCS. This technology has the potential for storing significant volumes of CO_2 emissions and increasing domestic oil production. Estimates show that next generation CO_2-EOR can provide 137 billion barrels of additional oil, and can offer a technical storage capacity of 45 billion metric tons.

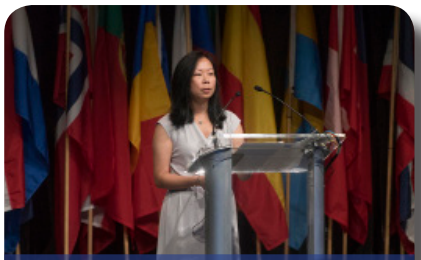
"CO_2 Enhanced Oil Recovery is a proven process, and one of the most effective tertiary oil recovery methods", Greg Schnake, Denbury Resources

For Greg the the bottom line is that "CO_2-EOR is a viable, economical and technologically feasible way to encourage CCS of anthropogenic CO_2 in a safe and secure manner under a known and proven regulatory system".

Whether CO_2 supply for EOR operations outside North America will provide the same financial support for CCS projects in the foreseeable future is as yet unclear, which is a shame as it is certainly acting as a stimulus for CCS deployment in North America.

"I think this conference – more than any other – delivers two things: one, the best technical information that there is. 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", Julio Friedmann, USDOE

CCS Developments Outside the USA



"The UK Government is committed to supporting the commercialisation and cost reduction of CCS alongside the efforts of industry and governments internationally"; Suk Yee Lam, DECC

Suk Yee Lam from The Department of Energy & Climate Change gave an interesting talk on the UK's CCS market. She explained how the UK has launched a £1bn CCS Commercialisation Programme; is developing a market for low carbon electricity through its Energy Market Reform programme and has committed to a £125m, 4 year, cross-Government R&D programme to support CCS development.

The UK's commercialisation programme involves the provision of £1bn of capital funding with additional operational support available through Contracts for Difference and the £100m award to 2 FEED studies for the White Rose and Peterhead CCS demonstration projects. The Final Investment Decisions for these projects will be made around the end of 2015. The UK government is working closely with stakeholders to address and support CCS deployment and engaging internationally engagement to share knowledge and experience.

The UK is looking beyond demonstration to commercialisation of CCS technology. It has published a document: Next Steps in CCS: Policy Scoping Document which sets out the areas further policy development is required to support CCS deployment at scale. It has set out a series of high-level principles for government intervention to support CCS: reducing levels of support through a transition phase after demonstration leading to full commercialisation. Its ultimate aim is to develop a cost-competitive CCS industry in the UK. By 2030 the UK has set a target of up to 13 GW of CCS deployed with a levelised cost of electricity of <£100/MWh.

"With a strong emphasis on the U in CCUS, China is moving ahead with a program for reducing air pollution"; Dr. Xu Shishen, China Huaneng Group Clean Energy Research Institute

Dr. Xu Shishen from the China Huaneng Group Clean Energy Research Institute spoke on China's new policies which were aimed at reducing CO_2 emissions. These policies include an "Energy Revolution" and a national program for mitigating climate change, including several pilot emissions trading schemes.

China has constructed the GreenGen project – a near zero emission coal fired power plant using pre-combustion CO_2 capture with EOR and storage. This is a 3 stage project; with stage 1, the IGCC component, beginning operation at the end of November 2012. Stage 2 involves the R&D for the key technologies to improve IGCC technology, with stage 3 being the demonstration of the IGCC plant fitted with the CO_2 pre-combustion capture technology.

In addition to GreenGen, Dr Shishen provided details of 4 post combustion and 2 oxy combustion capture projects currently underway in China as well as details of the 30,000t of CO_2 stored through the Shenua CCS project which will use future captured CO_2 for EOR.

CCS for Gas-fired Power Generation

"Gas with CCS is a necessity"; Juho Lipponen, IEA

Juho Lipponen from the IEA's CCS Unit told us that gas-fired power generation is increasing and this reduces emissions compared to coal power generation. The role for this fuel switching was mentioned in the IPCC AR5 WGIII Mitigation report in terms of limited expansion of natural gas-fired power generation in the near-term. However the IPCC AR5 states that all unabated fossil fuel power, coal and natural gas, will need to be phased out by 2100. IEA analysis reinforces this message, showing that such fuel switching is only of short-term benefit, gas power generation will still need CCS to reduce its emissions further, and also that this can be a competitive option. Further, gas with CCS supports variable renewables in the grid with its flexible power generation. The top regions for gas with CCS include North America, Europe and the Middle East. The IEA suggests more attention be given to Gas-CCS, to include it in technology development and deployment programmes.

Progress on CCS R&D

There was universal agreement among the organisers and attendees that since the Intergovernmental Panel on Climate Change 'Special Report on Carbon Dioxide Capture and Storage (IPCC 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.

Delegates attending one of the 77 technical sessions held throughout the week

On the capture side:

- 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.
- As a result of research activities and pilot scale testing we 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
- Oxy combustion technology is now proven and awaits scale up. FutureGen 2.0 in the USA and White Rose in the UK are the next steps in demonstrating oxy capture.

On the storage side:

- 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.
- As was expected, experience with industrial scale and pilot projects indicate 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.
- Tremendous progress has been made with respect to understanding and quantifying the importance of secondary trapping mechanisms in 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.
- Country-specific estimates of storage capacity have now been completed in many regions of the world. Harmonization of capacity estimation methods from teams around the world has significantly 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.
- 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 and a range of techniques for near-surface CO_2 fingerprinting and developments towards large-area leak detection.
- 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.

On Social Science and Public Engagement:

The social science achievements have included the development of communication guidelines, production of materials and methodologies to address gaps in knowledge and operation of community engagement programmes at projects, and the development of social site characterisation guidelines. Research has shown that ENGO's and scientists are the most trusted and that trust impacts on social acceptance – it is therefore important to consider the perceived operational motives of a project.

"Social science research will be important for the deployment of CCS."; Emma ter Mors, Leiden University

The role of community host compensation has been studies and it has been found that its effectiveness is limited if the project is considered to be risky. It could be used in public communication plans for future projects – but it must be relative to the perceived risks and burdens of the project.

Comments on the IPCC AR5 WGIII Summary for Policy Makers

The closing panel discussed a number of issues raised in the IPCC Fifth Assessment Report's Report from Working Group III on Mitigation, which were considered in the summary to be barriers to the long term deployment of CCS. The closing panel addressed many of these issues with reference to the IPCC Special Report on CCS (IPCC SRCCS), published in 2005, and by drawing on what we know now compared to then.

Sally Benson, former IPCC SRCCS Co-ordinating Lead Author for Chapter 5 on storage, commented on the issue of storage security identified as a barrier to long term CCS deployment in the WGIII summary for Policymakers by stating that the fundamental processes underpinning storage security are now very well researched and understood compared to the time of the IPCC SRCCS. This knowledge has developed due to the large amount of research on primary and secondary sealing mechanisms that have occurred in the last 18 years and reported at conferences like the GHGT series.

Another barrier identified was that of operational safety and transport risk. The panel pointed to the extremely well-documented 20 years of operational history of CO_2 pipelines in the USA, which clearly demonstrates that transports risks/safety are not a barrier to deployment.

Experience from industrial and pilot scale projects has identified the biggest risk associated with any injection project, be it CO_2, waste water or for fracking, is wells. There is considerable information in the literature that suggests that well completions are the biggest source of integrity loss or contamination. Providing the well completion process is well performed, risk from CO_2 seepage should be minimal.

The Closing Panel (from left to right): Olav Bolland, NTNU; Sally Benson, Stanford University; Sean McCoy, IEA; John Gale, IEAGHG; Kelly Thambimuthu (Chair); Jonas Helseth, Bellona; Bill Spence, Shell

Sally Benson also commented on the issue of 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. Sally felt that there is no evidence to support this theory, but there is plenty of evidence to suggest it is not the case.

On the issue of environmental impacts of leakage - there are now some 10 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 the CO_2 that migrates to the surface is dispersed quickly and that the environmental impacts of CO_2 leakage are very localised.

One point that should be made is that we do not criticise in any way the IPCC or its assessment reports, rather the CCS community applauds them for the very detailed work they do. We also note that the overall Summary for Policy Makers for AR5, which was published subsequent to the conference, does not contain references to the aforementioned issues or barriers, which is good because there was a general feeling at the conference that these issues were not reinforced by the experience from the CCS research community, quite the opposite.

CCS Regulations

Covered in this final panel as well as throughout the conference, there have been very many significant developments in legal and regulatory aspects since the IPCC SR, with CCS-specific regulations now in place in many countries and regions. Since GHGT-11, the biggest achievements have been the first three projects to be permitted under these CCS-specific regulations, and the learnings from these which have been shared in this conference.

BioCCS and negative emissions

"BioCCS is not science fiction, it is science fact". Jonas Helseth, Bellona

BioCCS 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 delay in taking collective action to reduce emissions. This role has since been strongly emphasized further by the IPCC AR5 reports.

The first integrated BioCCS project is operating Illinois Basin - Decatur Project (IBDP) in Illinois, which couples bioethanol production with CCS. This project injects around 1000 tCO_2/d and, as part of a second phase under construction, is being expanded to inject around 3000 tCO_2/d

Biofuels production can generate a relatively pure CO_2 stream, and thus be a relatively low-cost capture option. Barriers to the introduction of BioCCS are generally not related to technology, but rather policy. Policies are needed that not only drive operators to avoid emissions of CO_2, but also reward the atmospheric emission reduction from BioCCS, along with incentivizing improve sustainability of biomass supply. BioCCS is not incentivized in the EU Emissions Trading System (ETS), for example.

Comparing low carbon technologies

This topic was raised by the attendees in the closing panel session and sparked a lot of debate between the panel and the floor. The panel felt that it: is very easy to compare energy technologies in a simplistic way but, in most cases, such simple comparisons are not meaningful. For example, coal- or gas-fired generation with CCS is often compared to other generation options on the basis of a single attribute (e.g. levelised cost of electricity) while ignoring other important attributes such as supply capacity and societal preferences. In reality, if we are going to significantly reduce global CO_2 emissions, technologies will face radically different competitive pressures than they do today that will vary from region to region just as much – if not more – than they do today. This means that one energy or environmental technology will not save the day: many technologies, including CCS, will play a collective role.

The costs for CCS plant that we have at this stage are from first-of-a-kind plants, whereas many other technologies are more mature and further down the learning curve. Thus, comparisons of cost are often not like with like. Because many decision makers want to see competitive costs before supporting a project that, itself, is needed to move CCS down the learning curve, cost estimates of early stage technologies (and not only CCS) often end up on the low-side.

A conclusion drawn was that the kind of comparisons that are needed today are those that look at the role for technologies from a systems perspective. Such analyses can highlight the different roles that CCS could play in different sectors and, thus, the needs for technology R&D. System level assessments can help to inform policy makers of the policy needs, and in turn, they can inform better outcomes. In addition, the results can help identify areas where current market structures may not deliver desirable outcomes (e.g., underbuilding of power generation capacity). One example of this kind is expected soon from the European Zero Emissions Platform and we await its publication with interest.

On the need for a carbon tax?

The issue of the need of a carbon tax was also raised during the panel discussion and debatedby the closing panel. The panellists agreed that a carbon tax would help the deployment of CCS and other low carbon technologies because it sets a clear price signal that will drive investments in the right direction in the long term. However, carbon taxes (and other similar pricing mechanisms) won't move technologies through the "valley of death", so targeted support will be needed. Future investments in technology should be informed by the system type approach advocated earlier, to avoid driving up societal costs.

Is CCS a greenwash for the fossil fuel industry?

Another challenging question that was raised for the closing panel to debate. The panel felt that CCS was not a green wash in the sense that it can substantially reduce emissions from use of fossil fuels and biomass (and combinations of both), as promised by early analysis and being proven in the first wave of projects. Moreover, most technology rich models of the global energy system show fossil fuels being a significant part of primary energy supply for many years to come even in low-stabilization scenarios and, thus, deploy substantial amounts of CCS. Without CCS (and thus BioCCS), the rate of change in the energy system – both in-terms of the decline in fossil fuel use and growth of low-carbon technologies – is difficult to envision. So, all signs point to the substantial and important contribution that CCS will need to make in future.

CCS issues and concerns

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 to trade-offs between emissions reduction options and the broader framing of CCS in society.

In closing

Not content with providing just a forum for presentation, the conference produces a proceedings. 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 59 issues including this and 2 more GHGT's. IEAGHG 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,

Attendees enjoying traditional Texan entertainment at the famous Salt Lick BBQ

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. The proceedings are on course for publication at the end of December 2014.

During his welcome address, Kelly also took the opportunity to mark the 10 year anniversary of the IPCC Special Assessment on CO_2 Capture and Storage and to reflect upon the significant learnings that have taken place in those 10 years with the announcement of the preparation of a definitive publication in a forthcoming special edition of the IJGGC. He called to the CCS community to re-double efforts to convince the policy makers that CCS does not lack technical maturity only the maturity of policy.

And then the next one!!!

Gunter Siddiqi from Switzerland announcing the exciting venue for the next conference - GHGT-13!!

With GHGT-12 now 'put to bed' our thoughts turn to GHGT-13. For those of you at the conference, you will know this will be held in Lausanne, Switzerland. The series has previously been to Switzerland but this was Interlaaken in 1998 and there have been a few developments since then! Despite Europe not being a hotbed of large-scale CCS project activity at the moment, there will still be plenty to report, including updates on new projects such as the Quest project in Canada, the Gorgon project in Australia, Kemper County in Mississippi USA, the Abu Dhabi CCS project, and Petra Nova project in Texas. Also will the international community reach a climate change agreement in Paris next year? Either way, you can guarantee the conference will consider the implications.

The conference aside, Lausanne is simply a beautiful place to visit, easily accessible from Geneva, nestled on the shores of Lake Geneva itself and the Olympic Capital of the world. The conference will be held in École Polytechnique Fédérale de Lausanne's (EPFL's) brand new purpose built venue with all the latest flexible modular accommodation and technical features. A research partnership between EPFL and Induct who have developed a driverless electric shuttle means the Navia shuttle can be seen roaming the square, although it won't be required by delegates as the conference centre is just a few metres from the nearest metro stop.

And so CCS and the GHGT conference series rolls on, we hope you enjoyed GHGT-12 and very much look forward to seeing you in Lausanne, 13th - 18th November 2016.

Lausanne, Switzerland; the stunning location for the next Greenhouse Gas Technologies Conference in November 2016

The Greenman Award


IEA GREENHOUSE GAS R&D PROGRAMME

PRESENTED TO

In Recognition of Contributions Made to The Development of Greenhouse Gas Control Technologies

THE GREENMAN AWARD

Signed on behalf of IEA Greenhouse Gas R&D Programme: John Gale

Signed on behalf of IEAGHG Executive Committee: Kelly Thambimuthu

The Greenman award is given to an individual in recognition of a significant contribution to the development of the GHGT conferences series, or for services to the development of knowledge and understanding of the issues involved with CCS and Greenhouse Gas Control Technologies.

Though no-one knows for sure the real meaning of the Greenman, everyone who sees him understands that he stands for something very profound. He represents the union of the human and the green world and shows us a possible way forward in helping to put right some of the damage caused.

Hallvard Svendsen (NTNU) Winner of the prestigious Greenman Award for his significant contribution to the field of CO_2 removal, storage and utlilisation. The Greenman was chosen to represent these achievments as it is an ancient archetype of a human face peering through growing foliage which is often depicted on building, churches and cathedrals. It symbolises the mysteries of creativity, compassion, healing, new beginnings, and especially our connection with nature and the power of humankind working together with nature, the cycles of creation and "man and the forest".

Special Thanks

Putting on a conference of this size requires a huge effort and IEAGHG would like to thank The University of Texas at Austin for hosting and along with CLEE doing all the hard work. The Sponsors who enable us to maintain the low conference fees and to subsidise students and without whom we would not be able to finance the event. There are also the large number of people who willingly give their time to assist with the abstract review and selection process, although we cannot name those here, they are all recognised on the website www.ghgt.info. In addition to the sponsors listed we would like to acknowledge :

- Dell: donated computers for the technical sessions and the Internet Cafe
- The Center for Lifelong Engineering Education
- The Austin Convention Center
- The Austin Convention & Visitors Bureau
- Erika Rich (The University of Texas at Austin) for the photographs provided throughout the conference

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