

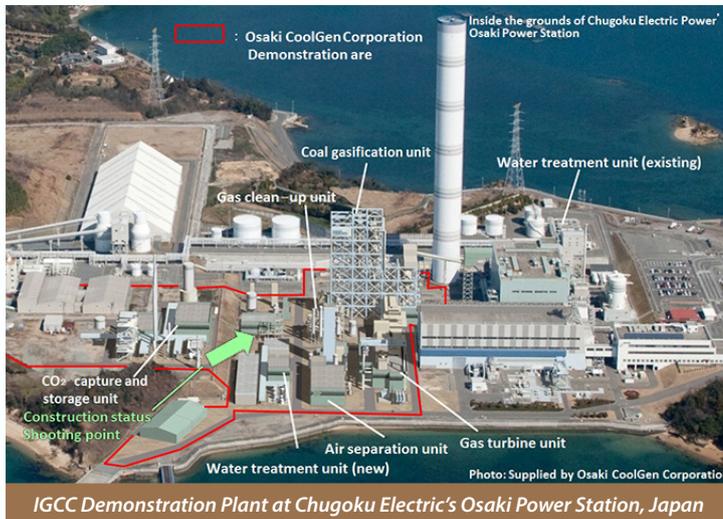
Greenhouse News

• the official newsletter of IEAGHG and its members •

June 2017 • Issue 126

J-Power joins IEAGHG

IEAGHG are pleased to announce that J-POWER has become our latest member. J-POWER has been active in CCS R&D for many years. In 2007 and 2008, J-POWER conducted pilot trials (in collaboration with Mitsubishi Heavy Industries, Ltd.) on post combustion capture at its Matsushima Thermal Power Plant. J-POWER was also a participant in the Callide OxyFuel Project at the Callide A Power Station in Queensland, Australia. This joint demonstration project between Japan and Australia ran from 2010 to 2014.



To complete its activities in capture, in July 2009, J-POWER and Chugoku Electric Power established a new company; Osaki CoolGen Corporation. The Osaki CoolGen Project involved the construction of an oxygen blown IGCC demonstration plant with an output on a scale of 170 MW as a first step in demonstrating CCS on IGCC technology. Phase 2 will involve the installation of an amine based CO₂ capture slipstream. In the third and final step, it is planned to demonstrate IGCC with CO₂-capture, combined with a fuel cell.

As of 2017, the IGCC unit has been constructed, commissioned and is now operating. Installation of the post combustion train will begin in 2018/19. ●

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New IEAGHG Briefing Papers

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The IEA Greenhouse Gas R&D Programme (IEAGHG) is part of the IEA's Energy Technology Network and its role is to assess the potential to mitigate greenhouse gas (GHG) emissions from the use of fossil fuels in the power, oil and gas and industry sectors. The IEAGHG's remit covers all greenhouse gases but we focus on research activities primarily on assessing CO₂ mitigation options. Of the CO₂ mitigation options, Carbon Capture and Storage (CCS) is considered to offer the most potential for CO₂ mitigation from the use of fossil fuels across the sectors we consider. Further details of the activities of the IEA Greenhouse Gas R&D Programme can be found on our website at www.ieaghg.org.

This CCS Technical Status Brief has been prepared to summarise key technical developments on CCS in the last 6 months, identified by IEAGHG providing information for both its members and the broader community. The IEAGHG provides reports and webinars, those directly relevant to this brief are referenced at the end of the document.

CCS is Essential for Europe to Meet the Paris Agreement
The European Zero Emission Platform (ZEP) has modelled the least cost CO₂ reduction pathways across 10 EU countries to assess their ability to meet the Paris Targets! When CCS was not available to the model total emissions in 2050 from the 10 countries modelled were found to be 3 to 4 times higher. Across the European energy system, ZEP's modelling shows that the value CCS to the EU could be in excess of €1 trillion by 2050.

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CCP Annual Review

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New IEAGHG Staff Member: Monica Garcia

Monica Garcia joined IEAGHG in May as a Technology Analyst on Carbon Capture Systems. Previously, she worked as a R&D Project Manager and R&D Engineer in Spain and The Netherlands in several areas within the energy sector, covering projects on cogeneration, biomass gasification, wastewater treatment, advanced materials and production of hydrogen, bioethanol and methanol. She has managed and coordinated multiple consortia and has participated in a cluster of projects.

Monica just submitted her PhD Thesis, focused on novel CO₂ capture solvents, from the University of Surrey and in collaboration with NTNU, where she spent over one year. Her recent research was awarded by UKCCSRC, and the ECCSEL and SCOT projects. She has a Master's degree in Chemical Engineering from the University of Seville (Spain), where she delivered her Thesis on CO₂ Capture systems in Pulverized Coal Power Plants. Currently, she is involved in studies on advanced CO₂ capture technologies, water usage, economic assessments, CCS in industries and impurities. ●



New IEAGHG Briefs: April

An important aspect of the IEAGHG's activities is to ensure that the results of its work are disseminated as widely as possible. IEAGHG has been asked by its members to produce short briefing papers on a 6 monthly basis that inform the broader community of developments in both Greenhouse Gas Mitigation and the Technical Status of CCS.

The first of these briefs were produced in April 2016, and another produced in October 2016 and they will continue to be updated twice yearly.

The GHG Mitigation Brief aims to summarise key climate change science, policy and technology developments, identified by IEAGHG, in a 6 month period and aims to provide information for both its members and the broader policy development community, interest groups and policy makers.

The CCS Technical Status Brief aims to summarise key technical developments in CCS that IEAGHG has identified within a six month period and put these developments into the broader context of what they mean for the deployment of CCS.

Please visit www.ieaghg.org/publications/briefing-papers to download the latest Briefing Papers. ●

CCS Technical Status Brief – April 2017

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GHG Mitigation Briefs – April 2017

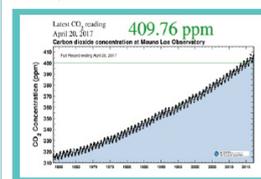
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2016 Breaks all Records

The World Meteorological Organisation (WMO) annual statement on the State of the Global Climate was published in March 2017. Key headlines from the report are:

- 2016 was the warmest on record – a remarkable 1.1°C above the pre-industrial period, which is 0.96°C above the previous record set in 2015.
- Globally averaged sea surface temperatures were the warmest on record, global sea levels continued to rise, and Arctic sea ice extent was well below average for most of the year.
- With levels of CO₂ in the atmosphere consistently breaking new records, the influence of human activities on the climate system has become more and more evident that the WMO conclude.



CO₂ Concentrations in Atmosphere Break Records

Atmospheric monitoring data from the Mauna Loa monitoring station in Hawaii has shown that on April 20th 2017 atmospheric emissions of CO₂ have reached 410 ppm, the highest recorded to date.

CO₂ emissions remain level for 2nd year in a row

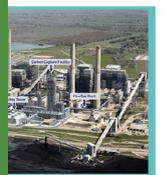
Both the IEA and the Global Carbon Project have reported that energy related CO₂ emissions have not grown significantly for 3 years in a row, which is unprecedented at a time of strong economic growth. However, to meet Paris targets global emissions now need to decrease rapidly, not just continue to stop growing.

The Global Carbon Budget is Being Exhausted

The emissions data published by the Global Carbon Project has been used to estimate the time left to time left until the 1.5°C carbon budget is exhausted. At the 2016 level of 39.0bn tonnes of CO₂, emitted there are just four years and one month left in the carbon budget for 1.5°C. Urgent action to begin reducing emissions is therefore required.

Large-scale CCS projects in operation are 22 projects is around 40 million tonal in 2017.

CCS technologies over the past 20 years. The report emphasises the fact that in Norway has been operational of CO₂ from an offshore natural gas in deep under the seabed.



New IEAGHG Studies

2017-06 Proceedings Of US DOE Workshop: Energy-Economic Modelling Review IEAGHG Manager: Keith Burnard



Integrated assessment models (IAMs) are a key methodological tool for investigating long term trade-offs between the energy system, the climate system and the broader economic system. Such models play an important role in underpinning the scientific debate on climate change mitigation and adaptation. They are developed and operated by a wide range of international, national, academic and industrial organisations.

The US Department of Energy's Office of Fossil Energy (DOE-FE) organised an energy-economic modelling review workshop, which was held on 3rd - 4th April in Washington DC. The aim of the workshop was to review the representation of CCS and advanced fossil technologies in IAMs. IAMs are computer models and can range in the mathematical methods that underpin them, but largely they incorporate representations of the energy system, the economy and earth systems into one IAM.

These computational models are then used at global, national and city scales to gain insights into energy and economic system dynamics under various constraints, e.g. from government policy, from socio-economics and from the environment. IAMs are widely used in energy and climate change mitigation scenario analysis to develop technology roadmaps and inform policy pathways. Their results inform assessments by bodies such as the IPCC and feed directly or indirectly into advice taken up by national and international policy makers and regulators.

The workshop brought CCS technology experts, CCS data providers, CCS process engineers and other relevant stakeholders, together with IAM modellers from policy, industry and academia with the objective to assess the methodologies, inputs, and assumptions of the energy-economic modelling capabilities we use to provide insights to inform policy direction, regulatory processes and program justifications. The desired outcomes of the workshop are a mapping of capabilities, and identification of gaps and opportunities for development. While some CCS and IAM experts came from Europe, workshop attendees were largely based in the United States. This geographic distribution of the attendees gave the workshop more of a US focus from the perspectives of data availability, CCS costs, and the IAMs presented at the workshop. The agenda included highlighting the CCS technology baseline data available from the US National Energy Technology Laboratory (NETL), updates on current CCS demonstration at scale plants (US DOE/IEAGHG), IAM overview presentations from US and global model developers, model inter-comparison projects (MIPs) from the Stanford Energy Modelling Forum (EMF), overview of the IEA Energy Technology Systems Analysis Programme (IEA-ETSAP), the energy system and CCS outlook from the IEA's Energy Technology Perspectives (ETP) analysis, as well as break-out discussion sessions.

Key messages from the workshop are:

- Communication between CCS technology experts and IAM modellers needs to be enhanced. Such communication should include a regular meeting with accessible, open and transparent data-sharing essential.
- NETL have gathered and estimated baseline CCS datasets critical to developing detailed state-of-the-art cost curves for capture, storage and transport that could be used for CCS calibration in IAMs. The data has not yet been widely distributed among IAM teams. It is largely focussed on US data sources but includes in-depth technology information relevant to international locations.
- Many IAMs employed a simplistic representation of CCS transport and storage costs, with a variation in capture costs depending on the CCS technologies represented. Where data is available, IAMs should aim to have cost curves (and, potentially, learning rates) for capture, transport and storage.
- There are numerous IAMs, many of them with CCS represented in them to various levels of detail. For user confidence, it is important to gain an understanding of the assumptions, data and calculations that underpin the models.



Over recent decades, it has become apparent that there is no one single technological solution to solve the problem of reducing anthropogenic greenhouse gas emissions; a portfolio of low-carbon energy technologies needs to be deployed in parallel. Most climate scenarios targeting 2°C or well below 2°C confirm that CCS is an essential element in this portfolio as it significantly increases the probability of reaching the emission reductions required and at least cost. Roadmaps have established that widespread deployment of CCS is needed to deliver this contribution.

The urgency of accelerating the deployment of CCS increases with time. While ambitions have been growing firmer, through developments such as the Paris Agreement, the pace of deployment of CCS has been slow, with only some fifteen large-scale facilities in operation today. The slow pace, however, has not been due to technical or physical limitations of building out the industry; a major barrier has been the absence of market incentives, compounded by the fact that capture projects need access to transport and storage infrastructures, the development of which takes time. With CCS roadmaps showing a steep curve for CCS industry build-out, the question has been raised “Can the CCS industry build out at the rates projected in CCS roadmaps?” To address this question, the study compares the anticipated CCS build-out rates with those achieved in other sectors, where comparable technologies in those sectors have been used as analogues.

The study finds that the rate of build-out in industry analogues has been comparable to the rates now being anticipated for CCS. Considering these analogies, it is shown that, if sufficiently strong incentives for a technology are established, industry can achieve the rapid build-out rates required for the projected scale of deployment. This suggests that CCS development, while requiring substantial growth, may not be constrained by physical limitations in supply chain and industry build-out. However, substantial efforts would be required from both the public and the private sectors to deliver and maintain the anticipated build-out rates over the coming decades. These would include strong market incentives, stable policy commitment, government leadership and public support. While it is recognised that analogies have limitations, this study has shown it to be tenable technically that the anticipated CCS build-out rates can be realised in a supporting environment. ●

New International Energy Agency (IEA) Publications

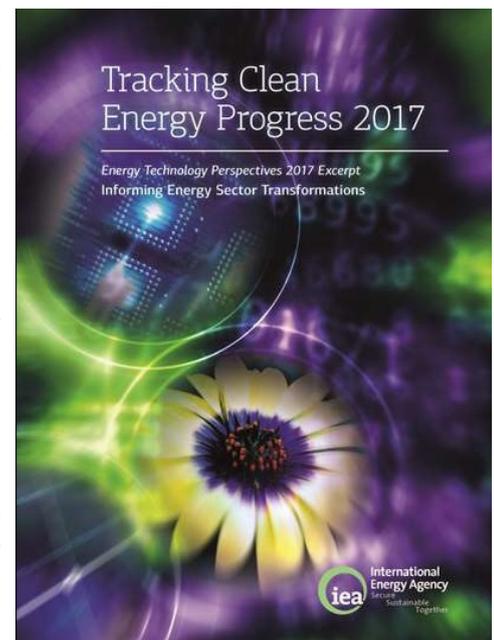
Energy Technology Perspectives 2017

The global energy system is moving closer to a historic transformation. This year’s edition of the International Energy Agency (IEA)’s comprehensive publication on energy technology focuses on the opportunities and challenges of scaling and accelerating the deployment of clean energy technologies. This includes looking at more ambitious scenarios than the IEA has produced before.

Improvements in technology continue to modify the outlook for the energy sector, driving changes in business models, energy demand and supply patterns as well as regulatory approaches. Energy security, air quality, climate change and economic competitiveness are increasingly being factored in by decision makers. Energy Technology Perspectives 2017 (ETP 2017) details these trends as well as the technological advances that will shape energy security and environmental sustainability for decades to come.

For the first time, ETP 2017 looks at how far clean energy technologies could move the energy sector towards higher climate change ambitions if technological innovations were pushed to their maximum

practical limits. The analysis shows that, while policy support would be needed beyond anything seen to date, such a push could result in greenhouse gas emission levels that are consistent with the mid-point of the target temperature range



of the global Paris Agreement on climate change. The analysis also indicates that regardless of the pathway chosen for the energy sector transformation, policy action is needed to ensure that multiple economic, security and other benefits to the accelerated deployment of clean energy technologies are realised through a systematic and co-ordinated approach.

ETP 2017 also features the annual IEA Tracking Clean Energy Progress report, which shows that the current progress in clean energy technology development and deployment remains sub-optimal. It highlights that progress has been substantial where policies have provided clear signals on the value of technology innovation. But many technology areas still suffer from a lack of financial and policy support.

ETP 2017 purchase includes extensive downloadable data, figures and visualisations.

You can download the publication here: www.iea.org/publications/freepublications/publication/tracking-clean-energy-progress-2017.html

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IEA and China Host High-Level Gathering of Energy Ministers and Industry Leaders to Affirm the Importance of Carbon Capture, by Juho Lipponen, IEA



From left to right: Hon Jim Carr, Minister of Energy, Canada; Hon Wan Gang, Minister of Science and Technology, China; Dr Fatih Birol, Executive Director, International Energy Agency; Hon Rick Perry, Secretary of Energy, USA; Hon Terje Søviknes, Minister of Petroleum and Energy, Norway (Photograph: IEA)

The energy ministers of Canada, China, Norway, and the United States, as well as heads of delegation from Australia and the European Commission, along with leaders from the industry and key organisations, were invited by the International Energy Agency and China to review how to increase collaboration in order to drive further deployment of carbon capture, utilization and storage (CCUS).

The meeting was held on Tuesday 6th June, ahead of the 8th Clean Energy Ministerial (CEM8), in Beijing. Ministers and panellists discussed the factors that have attracted investment to current CCUS projects and highlighted the importance of identifying where these factors could converge to replicate recent success with CCUS projects.

The countries represented in the discussion host 19 of the 22 projects currently in operation or construction globally. China, the host of the 8th Clean Energy Ministerial (CEM 8), recently announced the beginning of construction on the country's first large-scale CCUS project in Shaanxi Province. The Minister for Science and Technology of the People's Republic of China, Wan Gang, co-hosted the discussion.

U.S. Department of Energy Secretary Rick Perry said, "I don't believe you can have a real conversation about clean energy without including CCUS. The United States understands the importance of this clean technology and its vital role in the future of energy production."

"We have already seen the success of projects like Petra Nova in Texas, which is the world's largest post-combustion carbon-capture system," Mr. Perry said. "Our experience with CCUS proves that you can do the right thing for the environment and the economy too."

The system at Petra Nova can capture 1.6 million tons of CO₂ each year from an existing coal-fired power plant unit, a capture rate of up to 90 percent from a supplied slipstream of flue gas. By using CO₂ captured from the plant, oil production at West Ranch oilfield is expected to increase from around 500 barrels per day to up to 15,000 barrels per day.

Jim Carr, Canada's Minister of Natural Resources said: "Carbon capture, use and storage holds enormous potential to enable economic growth and create jobs, while ensuring the environment is protected."

"Canada hopes to continue working with domestic and international partners — including through the Clean Energy Ministerial and Mission Innovation — to help us all address the technical and policy challenges around wide scale implementation of this important technology," he added.

The IEA has consistently highlighted the importance of CCUS in low carbon energy systems. "Our analysis consistently shows that CCUS is a critical part of a complete clean energy technology portfolio that provides a sustainable path for mitigating greenhouse gas emissions while ensuring energy security," said Dr Birol.

"Investment has flowed to CCUS projects where there is a confluence of factors which constitute a viable business case," said Dr Birol. "We need to find more such opportunities, where a commercial case for CCS can be built with reasonably modest, well targeted public interventions."

The leaders recognized the importance of CCUS technology as an essential tool in the global effort to achieve deep reductions in carbon dioxide emissions and prevent global temperature rises in future decades.

As a next step, IEA will be working with the key CEM governments to look for suitable ways reactivate CCUS discussions within the CEM process. CEM9 in 2018 will be held in Europe, co-hosted by the European Commission and the Nordic Countries. ●

Paris Agreement News and Reaction, by Tim Dixon, IEAGHG

On the 1st June the US President Donald Trump announced that the US would be withdrawing from the Paris Agreement and reducing US funding to the Green Climate Fund. For his announcement and his curious rationale see www.whitehouse.gov/blog/2017/06/01/president-donald-j-trump-announces-us-withdrawal-paris-climate-agreement.

The Paris Agreement requires a country to give 1 year's notice of leaving, and that can only be given 3 years after the Agreement comes into force by ratification by the threshold number of countries and emissions, which implies the USA would give notice in 2019 to leave in 2020. However, the Paris Agreement will continue without the USA, as it has met its required ratification threshold of 55 countries covering 55% of global emissions.

Reaction from world leaders has been very strong to this announcement and to his rationale. The other two largest emitters, the EU and China, agreed further co-operation to reinforce all the recent UNFCCC-based decisions and agreements, and includes enhancing technology co-operation and collaboration on development and deployment of CCUS technologies. President of the European Commission Jean-Claude Juncker said: "As far as the European side is concerned, we were happy to see that China is agreeing to our unhappiness about the American climate decision. This is helpful, this is responsible, and this is about inviting both, China and the European Union, to proceed with the implementation of the Paris Agreement." See http://europa.eu/rapid/press-release_IP-17-1524_en.htm.

The UN Secretary General released the following statement:

"The decision by the United States to withdraw from the Paris Agreement on climate change is a major disappointment for global efforts to reduce greenhouse gas emissions and promote global security.

The Paris Agreement was adopted by all the world's nations in 2015 because they recognize the immense harm that climate change is already causing and the enormous opportunity that climate action presents. It offers a meaningful yet flexible framework for action by all countries.

The transformation envisaged in the Paris Agreement is already underway. The Secretary-General remains confident that cities, states and businesses within the USA -- along with other countries -- will continue to demonstrate vision and leadership by working for the low-carbon, resilient economic growth that will create quality jobs and markets for 21st century prosperity.

It is crucial that the United States remains a leader on environmental issues.

The Secretary-General looks forward to engaging with the American government and all actors in the USA and around the world to build the sustainable future on which our grandchildren depend." Stéphane Dujarric, Spokesman for the Secretary-General 1 June 2017."

The Secretariat of the UNFCCC released the following statement:

"The Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) regrets the announcement by the President of the United States that his government will withdraw from the Paris Climate Change Agreement.

"The Secretariat also notes the announced intention to renegotiate the modalities for the US participation in the agreement. In this regard, it stands ready to engage in dialogue with the United States government regarding the implications of this announcement.

"The Paris Agreement remains a historic treaty signed by 195 Parties and ratified by 146 countries plus the European Union. Therefore it cannot be renegotiated based on the request of a single Party.

"The Paris Agreement is aimed at reducing risk to economies and lives everywhere, while building the foundation for a more prosperous, secure and sustainable world. It enjoys

profound credibility, as it was forged by all nations and is supported by a growing wave of business, investors, cities, states, regions and citizens. We are committed to continue working with all governments and partners in their efforts to fast forward climate action at global and national levels."

Twenty one Ministers from a range of developed and developing countries, including Germany, France, Norway, Netherlands, Sweden, Switzerland stated *"We are deeply disappointed by the decision. Our commitment to the Paris Agreement is unshakeable"*.

The leaders of France, Germany and Italy issued a joint statement rejecting a renegotiation of the agreement. *"We deem the momentum generated in Paris in December 2015 irreversible and we firmly believe that the Paris agreement cannot be renegotiated, since it is a vital instrument for our planet, societies and economies."*

Environment groups have also responded strongly against his decision. Greenpeace tweeted *"There's no sugar-coating it: The USA withdrawing from the Paris Agreement is bad news. But we can and will move ahead "*.

Business groups also responded strongly ahead of the decision. The International Chamber of Commerce Secretary General John Danilovich said: *"Global business interests are best served by a stable and practical framework to manage climate change risks – which already represent an estimated drain of over US\$1 trillion to the global economy. The Paris Agreement provides a balanced framework to tackle climate change, while providing the long-term certainty needed to support business innovation and growth.*

"We've been clear for years that business can win from the transition to a low-carbon economy. The economics of the Paris agreement are clear: it encourages market-based solutions to achieve emissions reductions at low cost and expands markets throughout the world for new and innovative technologies. The USA economy is well positioned to grow and create new jobs within this flexible, long-term framework.

"What is so important about the Paris Agreement is that it puts the responsibility on every country to play its part. We call on the US to show the confidence and courage to lead the way towards a safe, sustainable and profitable future for all." <https://iccwbo.org/media-wall/news-speeches/icc-deeply-concerned-us-consideration-paris-agreement-withdrawal/>

And after the decision, the World Business Council for Sustainable Development (WBCSD) said *"Yesterday's withdrawal from the Paris Agreement by the US Federal Government is not good news. However, businesses from around the world will not give up and will double down on their commitments to work together, in order to continue to find new and rewarding solutions in all countries of the world.*

The Paris Agreement has made the transformation to a low-carbon economy inevitable. This transition will in the long run be the only way to deliver successful financial results for companies, strong economies with jobs everywhere and a planet that is liveable for all."

Meanwhile, the number of other countries that have ratified the Paris Agreement has reached 146 of the 197 countries. The threshold number for ratification (and hence coming into force) was 55 countries with 55% of global emissions, and this was reached on 5th October 2016, more than a year ahead of anticipated schedule. Irrespective of the USA President's decision, work in developing the rules and mechanisms to operationalise the Paris Agreement continues. ●

Press Release: CCP Publishes 2016 Annual Report

The CCP (CO₂ Capture Project) has published its latest Annual Report covering the key programme activities delivered during 2016. The Report is available in digital format at www.co2captureproject.org.

Having been founded in 2000 to advance technologies for CO₂ capture and geological storage, CCP is currently in its fourth phase of activity. The 2016 Annual Report summarises the main activities delivered by the organisation's Capture, Storage, Monitoring & Verification, Policy & Incentives and Communications Teams. Highlights of the new Report include:



- progress on the novel capture technologies project, including molten carbonate fuel cells and high-pressure solvent absorption
- conclusions of the natural gas treating study
- latest update on the well sealing experiment at Mont Terri
- conclusion of the study into transitioning CO₂ EOR to CO₂ storage.

CCP Chairman, Jonathan Forsyth, comments: "CCP is delighted to publish its Annual Report for 2016, which reflects the busy year we had and the fact that we are now well underway in our fourth phase of activity. Our aim is to orientate our programme to provide our members with what they need in regard to future CCS development in the face of potential societal needs and legislative requirements. I hope that the Report provides all readers with an interesting overview of some of the main projects we have been involved in." ●

What Was Wrong with Boundary Dam 3, and How they Fixed it, by Brian Zinchuk, Estevan Mercury

The Boundary Dam Unit 3 Integrated Carbon Capture and Storage Project (BD3) has had its share of bugs that gathered many headlines since it went online in October 2014, but SaskPower has expended great effort in addressing those issues and sorting out what needed to be fixed. On May 11th, as a part of the Carbon Capture Summit, hosted by the Estevan Chamber of Commerce, the Crown corporation laid out just what some of those issues have been, and what steps they've taken to address them.

David Jobe, who holds a PhD in Chemistry and is licensed as an engineer, gave the presentation on behalf of SaskPower. He's the director of carbon capture and chemical services at Boundary Dam Power Station.

"We are operating very well," he said of the current situation.

He outlined several phases that took place over roughly 2.5 years the plant has been operational. It started out with optimism, when the plant held its grand opening on October 2nd, 2014. But during the commissioning phase, which ran until April 2015, he noted, "It became apparent these were not typical design issues."

In particular, they had issues with fly ash and amine, what is essentially the chemical lifeblood of the capture plant.

"We were getting a lot of fouling and plugging," he said.

One of the key issues was the original design had no redundancy. So when they had to clear fouling from a system, they had to shut the whole plant down every time something plugged. Fly ash related outages accounted for a significant amount of time the plant was down. The plant's steam de-superheater's original design was unable to cool the steam sufficiently, and this affected the amine, causing degradation.

Dirty heat exchangers, without redundancy, meant shutdowns when they needed to be cleaned. There were also component deficiencies. He noted small carbon steel gaskets that needed to be replaced.



Then there was the leaking amine tank, a ceramic brick structure which had tens of thousands of hand-placed tiles lining it. It leaked. They tried a number of fixes, but eventually had to open up the roof and lower in a close-fitting cylindrical stainless steel tank inside the original tank, taking its place.

Overall, ash-related problems resulted in 42.6 per cent of the down times, the CO₂ compressor was 19.2 per cent, construction deficiencies made up 14.9 per cent, and outages with the power generating unit accounted for 13.5 per cent. Miscellaneous items made up the final 4.8 per cent.

Jobe then got to the fixes addressing these issues. It was found that a spray curtain would deal with much of the fly ash. "It was a breakthrough," he said.

The de-superheater was replaced. The amine was purified. Deficient materials and a heat exchanger were replaced. They installed rectifiers on the power plant's precipitators.

For 2015, the plant had a 56 per cent availability as they worked through these issues and captured 426,066 tonnes of carbon dioxide. However, they were able to hit the 3,240 tonne per day nameplate capacity for a period of 72 hours.

The goal for 2016 was to hit 800,000 tonnes of captured carbon dioxide, and 85 per cent reliability. By May and June of that year, there were issues with the CO₂ tower and degradation of the amine, causing foaming like soap. By adding anti-foaming agents, they dealt with that problem.

Activated carbon was added in 2017, and that worked well. Its addition meant a jump in production over the course of four hours from 1,400 tonnes per day to 1,800 tonnes per day. By the end of the year, they had captured 808,263 tonnes of carbon dioxide and had 84 to 85 per cent online availability. This resulted in CO₂ emissions, from the entire system, of 380 tonnes per gigawatt-hour, whereas the regulator limit is 420 tonnes per gigawatt-hour.

Putting in redundant systems should bring availability up to 90 per cent, or more, according to Jobe.

On the agenda is a significant shutdown later this spring which will coincide with a regular maintenance shutdown of the power generating unit. At some point following that, SaskPower intends on running a 720 hour test, capturing more than 3,000 tonnes per day. At 2,800 tonnes per day, the resultant emissions would equate to around 200 tonnes per gigawatt-hour.

"It was a rough and rocky start. We had the privilege of being first." Jobe concluded. ●

Press Release - Acorn: a Seed for the UK CCS Industry

Despite considerable effort, the UK has struggled to get Carbon Capture and Storage (CCS) started. The UK government has run two competitions to select a project but none have made it to construction. The scale of the proposed projects, with capital costs over £1bn, in a new market have prevented public and private sector agreement being reached.

CCS remains vital for the UK, and many other countries, to meet climate change obligations. By capturing CO₂ from industrial sources and existing thermal power stations we can significantly and quickly reduce our emissions. In addition, CCS enables the generation of Hydrogen in bulk which can also be used for low carbon heating and transport.

The best way forwards for CCS in the UK is to initiate CCS with a small scale, full chain project at the lowest possible cost, in the most suitable location for subsequent CCS growth and build out. This is what Acorn is.

Acorn is a small scale full chain project in North-east Scotland. CO₂ is captured from existing emissions at the St Fergus gas terminal, which would otherwise enter the atmosphere. It is then transported offshore and injected deep underground for permanent sequestration in a saline formation.

The project will re-use existing oil and gas infrastructure which is now redundant before it is decommissioned. Re-using existing infrastructure reduces project costs and makes best use of old facilities. On its current timetable the project could be operational before 2022.

Acorn also acts as a seed from which CCS can grow. Additional CO₂ sources can be added, including Peterhead Power station, ship import via Peterhead Harbour and transport via existing pipeline from industrial and power sources in Central Scotland. Additional transport and storage infrastructure can easily be developed, re-using additional oil and gas pipelines and developing storage sites in the Central North Sea, where data exists from our oil and gas heritage and there are many large scale storage reservoirs.

It's time for the UK to deliver its first CCS project. One on a small scale, re-using existing oil and gas infrastructure and ideally placed for subsequent CCS growth. One like Acorn. ●

IEAGHG Information Papers and Blogs Published Since March 2017 Newsletter

IP Number	IP Title	Publication Date	Author
2017-IP14	EU Project to Advance Environmental Monitoring for Offshore CO ₂ Storage Projects	21/03/2017	Tim Dixon
2017-IP15	WMO Statement on the State of the Global Climate	23/03/2017	John Gale
2017-IP16	Impacts of Non-CO ₂ GHGs from Aviation	23/03/2017	John Gale
2017-IP17	PRESS RELEASE: IEA finds CO ₂ emissions flat for third straight year even as global economy grew in 2016	23/03/2017	John Gale
2017-IP18	ETI AUV Harbour Trials	12/04/2017	Tim Dixon
2017-IP19	EU ZEP report on "CCS and Europe's Contribution to the Paris Agreement - Modelling least-cost CO ₂ reduction pathways	12/04/2017	John Gale
2017-IP20	The Global Carbon Budget for 2016 and its implications	13/04/2017	John Gale & Jasmin Kemper
2017-IP21	Methane Emissions continue to increase	13/04/2017	John Gale
2017-IP22	Energy Transition Commission Report: Better Energy, Greater Prosperity	26/04/2017	John Gale
2017-IP23	Hydrogen and CCS	28/04/2017	John Gale
2017-IP24	Society of Petroleum Engineer's CO ₂ Storage Resources Management System	24/05/2017	Lydia Rycroft
2017-IP25	Summary and Background of SPE's SRMS Document	26/05/2017	Lydia Rycroft
2017-IP26	CCUS, Status, Issues and Needs	08/06/2017	John Gale
2017-IP27	Carbon Capture and Storage Decision Time, an Australian Perspective	08/06/2017	John Gale
2017-IP28	Press Release: CCP Publishes 2016 Annual Report	12/06/2017	N/A
2017-IP29	Intensification of CO ₂ Stripping from Amine Solutions by Ultrasonic	19/06/2017	Monica Garcia

Blog Title	Publication Date	Author
Climate Change for kids	13/03/2017	John Gale
New Report: 2016-10 – Techno-Economic Evaluation of Retrofitting CCS in a Market Pulp Mill and an Integrated Pulp and Board Mill.	31/03/2017	Stanley Santos
Advancing Environmental Monitoring for Offshore CO ₂ Storage Projects	31/03/2017	Tim Dixon
Boaty McBoatface meets CCS	12/04/2017	Tim Dixon
IEAGHG 51 st ExCo	12/05/2017	Becky Kemp
12 th CO ₂ GeoNet Open Forum	17/05/2017	Lydia Rycroft
Shell Quest CCS Project Visit	30/05/2017	Keith Burnard, James Craig & Tim Dixon
CTCN Workshop	30/05/2017	Tim Dixon
TCCS-9	15/06/2017	Monica Garcia
Monitoring Network meeting in Traverse City	19/06/2017	Tim Dixon

Conferences & Meetings

This is a list of the key meetings IEAGHG are holding or contributing to throughout 2017. 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 Summer School

17th - 22nd July 2017, Regina, Canada

7th High Temperature Solid Looping Cycles Network (HTSLCN) Meeting

4th - 5th September 2017, Luleå, Sweden

4th Post Combustion Capture (PCCC4) Network Meeting

5th - 7th September 2017, Birmingham, Alabama, USA

IEAGHG CCS Costs Network Meeting (Invitation Only)

13th - 14th September 2017, London, UK



Greenhouse News

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