# Newsletter

No 76 August 2013

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# Andrew Minchener joins IEA CCC as General Manager

On 1 July Dr Andrew Minchener OBE joined the IEA Clean Coal Centre as General Manager. Members of staff enjoyed lunch in the office meeting room on Andrew's first day, as a chance to welcome him, hear his vision for the future of the Centre and socialise. Andrew is well-known to most of the staff as he has written various reports for the IEA CCC over the years. His most recent work, *Gasification in developing countries* is currently available in draft for comment and will be published later this year.

Andrew has over 35 years experience in the coal industry. He has expertise on developing fossil fuel and biomass/waste utilisation systems, on policy and regulatory analysis, on techno- and socio-economic analysis, on training and capacity building, technology transfer and international business development. This includes considerable involvement in clean coal and carbon capture and storage (CCS) related activities in Europe and the Far East. He has undertaken numerous overseas assignments, including over 140 missions to the People's Republic of China and a further thirty to Eastern Europe. In recent years he has worked with a number of organisations besides the IEA CCC, including the UK Department of Energy and Climate Change, the World Bank, the Asian Development Bank, the International Energy Agency and the European Commission.

Dr John Topper remains as Chief Executive of the Operating Agency for the IEA CCC and the IEAGHG, in a part-time role. He will be travelling extensively in the coming months as part of his work for the Centre.









The IEA Clean Coal Centre Newsletter is available free from
> http://www.iea-coal.org

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# Forthcoming coal conferences

***3rd oxyfuel combustion conference***
*Leon, Spain, 09-13 September 2013*
*IEAGHG, Orchard Business Centre, Stoke Orchard, Cheltenham, Gloucestershire GL52 7RZ, UK*
*Tel: +44 1242 680753*
*Fax: +44 1242 680758*
*Email: mail@ieaghg.org*
*Internet: www.ieaghg.org/index.php?/20120814317/3rd-oxyfuel-combustion-conference.html*

***9th European coal conference***
*Gliwice, Poland, 10-14 September 2013*
*Łukasz Gawor, Silesian University of Technology, Faculty of Mining and Geology, Akademicka 2 Street, 44-100 Gliwice, Poland*
*Tel: +48 32 237 28 48*
*Fax: +48 32 237 22 90*
*Email: Lukasz.Gawor@polsl.pl*
*Internet: www.ecc9.polsl.pl*

***2nd post combustion capture conference***
*Bergen, Norway, 17-20 September 2013*
*IEAGHG, Orchard Business Centre, Stoke Orchard, Cheltenham, Gloucestershire GL52 7RZ, UK*
*Tel: +44 1242 680753*
*Fax: +44 1242 680758*
*Email: mail@ieaghg.org*
*Internet: www.ieaghg.org/index.php?/2nd-post-combustion-capture-conference.html*

***Power plants 2013 conference and technical exhibition***
*Maastricht, The Netherlands, 25-27 September 2013*
*Marthe Molz, VGB PowerTech eV, Klinkestrasse 27-31, 45136 Essen, Germany*
*Tel: +49 201 8128 211*
*Fax: +49 201 8128 350*
*Email: marthe.molz@vgb.org*
*Internet: www.vgb.org/en/hv_2013.html*

***3rd IEA Clean Coal Centre network workshop on underground coal gasification***
*Brisbane, Qld, Australia, 7-8 November 2013*
*John Kessels, IEA Clean Coal Centre, Gemini House, 10-18 Putney Hill, London SW15 6AA, UK*
*Tel: +44 20 8246 5250*
*Fax: +44 20 8780 1746*
*Email: John.Kessels@iea-coal.org*
*Internet: ucg3.coalconferences.org*

*An extended list of coal meetings and conferences is available on the IEA Clean Coal Centre website (www.iea-coal.org)*

# IEA CCC reports

## Recently published

*Coal and gas competition in global markets, £100**
*Upgrading and efficiency improvement in coal-fired power plants, £100**

* These prices apply to purchasers in non-member countries of IEA Clean Coal Centre. Purchasers in member countries and employees of sponsoring organisations can download the report for free, when registered. Six months after publication reports are freely available to all.

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Reports can be downloaded from our website.

## Next webinar

*Techno-economic analysis of PC versus CFB combustion technology* is the subject of the next webinar. Toby Lockwood presents it on Wednesday 4 September at midday (UK time).

*Status of advanced ultra-supercritical coal-fired power plant* will be presented as a webinar by Kyle Nicol on Wednesday 9 October at midday (UK time). The webinars can be viewed live, or any time after the event at our webinar page, after a one-off registration http://www.iea-coal.org/site/2010/news/webinars.

## Soon to be published

*Recent operating experience and improvement of commercial IGCC*
*Co-utilisation of renewable energy with coal*

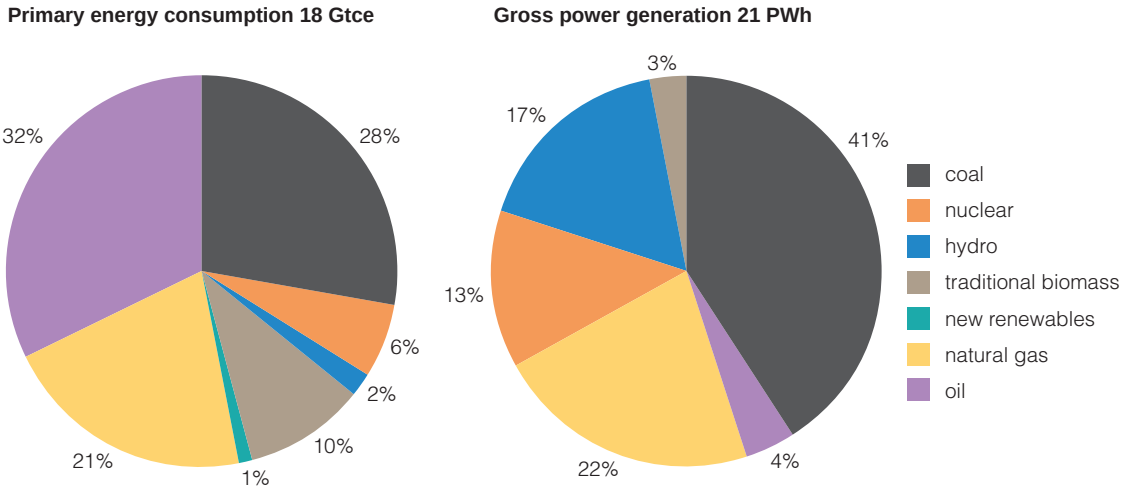
## Available to members in draft

*Quantifying emissions from spontaneous combustion*
*Challenges and opportunities for coal gasification in developing countries*
*Techno-economic analysis of PC versus CFB combustion technology*
*Status of advanced ultra-supercritical coal-fired plant*
*Advances in multipollutant control*
*Sustainability of biomass for cofiring*
*Coal prospects in Botswana, Mozambique, Zambia, Zimbabwe, and Namibia*

## In progress

*Management of waste products from coal combustion*
*Impacts of climate change on power generation from coal*
*Mid- to long-term outlook for the utilisation of coal under environmental and resource restrictions*
*Coal sampling and analysis*
*Recent developments in modelling & simulation of coal gasification*
*An economic assessment and life cycle analysis of drying technologies for low rank coal*
*Blending of coals to meet power station requirements*
*Global outlook for coal derived products*
*Coal prospects in Turkey*
*Operating experience with ultra-supercritical coal-fired power plant*
*HELE coal-fired power plant as a precursor to CCS*
*Developments in oxy-combustion technologies*
*Programmes for clean coal technology R&D worldwide*

# Coal and gas competition in global markets




*Global primary energy mix and global power generation by primary energy source, 2010*

It is estimated that there are over 847 Gt of proven coal reserves worldwide. At current production rates, this equates to ~118 years availability. Proven gas and oil reserves are equivalent to around 59 and 46 years, respectively, at current production levels. Coal reserves are available in almost every country in the world, with recoverable reserves in about 70 countries. The largest reserves by region are in North America, the former USSR, China, Australia, India and Germany.

In 2011, coal production reached a record level of 7.678 Mt increasing by 6.6% over 2010. Global hard coal trade amounted to over 1 Gt, about14.8% of world coal production. Two thirds of all coal produced worldwide is delivered to power plants, or 90% in the case of lignite.

Global production of natural gas in 2011 amounted to >3000 billion $m^3$. Unconventional gas in the form of shale gas and coalbed methane is expected to account for 63% of North American production by 2030. Outside North America, unconventional gas is currently in its infancy but likely to play a growing role in the long term as current technical and regulatory hurdles recede. In Europe, major unconventional production before 2020 is not expected. The decline in conventional supply implies a growing import requirement for Europe, up by more than 60%, from 0.77 $m^3/d$ in 2010 to 1.19 $m^3/d$ in 2030. In China, gas production is expected to grow at 6.1%/y. Although coalbed methane and shale gas are expected to contribute 46% to growth, an increasing need for imports is forecast. These are expected to be met by expansion of liquid natural gas and pipeline projects.

Coal met 45% of the rise in global energy demand between 2001 and 2011, growing faster even than total renewables. The main driver was the strong growth in non-OECD countries, particularly China and India. Coal fuels more than 40% of the world's electricity, and is expected to remain the backbone of global electricity generation mix, regardless of climate change policy. Despite the increase in coal consumption in absolute terms, coal's share in the world's electricity generation is expected to decrease gradually as many governments are set to promote generation from renewables, nuclear and natural gas. Demand for natural gas has been following a consistent upward trend since the mid-1980s except for a dip in 2009. Again, non-OECD countries have largely contributed to the growth, which overtook OECD countries in aggregated gas demand since 2008. Natural gas provides around 22% of the world's electricity, and use for power generation will be the major driving force for future growth in gas demand worldwide. Nevertheless, its share in the electricity generation mix is expected to increase only slightly due predominantly to high prices.

Historically, natural gas has been more expensive than coal on an energy equivalence basis. The price of both fuels has been more volatile over the last decade. Worldwide, coal prices have rebounded strongly after a collapse in 2009, following the historic high levels seen in the summer of 2008. In contrast, gas prices only rebounded markedly in Europe and Asia Pacific, while remaining low in North America. There has been a convergence between domestic and international coal markets, in which domestic coal prices are linked to international prices. Consequently, demand from China and, potentially, India may cause large swings in international coal prices. In the natural gas market, it emerges that gas prices are divorced from those of oil and instead are linked to spot gas prices at trading hubs. This change in the pricing mechanism will certainly increase the volatility of gas prices, but may also lead to lower gas prices provided that ample supplies are available.

In summary, coal remains the main fuel for electricity generation globally and its use is forecast to continue to rise in absolute terms. However, its share of total generation is expected to fall while the share of gas is expected to increase, especially in North America.

*Coal and gas competition in global markets*
Herminé Nalbandian and Nigel Dong
CCC/220, ISBN 978-92-9029-540-2, July 2013
£100 non-member countries
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# International Conference on Mercury as a Global Pollutant (ICMGP), Edinburgh, Scotland

*A piper greets delegates at ICMGP (photograph courtesy of Douglas Kurn)*

The 2013 ICMGP was held at the Edinburgh International Conference Centre from 26 July to 2 August in the heart of Edinburgh, Scotland, with Dr Lesley Sloss of the CCC in the role of Conference Chair. The conference, held every two years, was attended by over 900 delegates from more than 60 countries. The conference covered all issues relating to mercury and its potential negative effects on the environment and comprised a record seven parallel sessions running twice a day all week. New expert panel sessions to promote open dialogue on the most controversial issues relating to mercury were well attended. As the second largest source of mercury emissions from human activities, coal combustion featured in several sessions including


*Delegates at ICMGP (photograph courtesy of Douglas Kurn)*

those relating to emission sources and control technologies. The theme of the conference was *Science informing global policy* in order to promote the event as a launching pad for the new UNEP Minamata Convention on Mercury, drafted in Geneva earlier this year. Many of the papers and posters concentrated on how the text of the new convention could be moved into practice through research and development activities.

The conference began on Sunday 26 July with a public open day followed by a press conference, highlights of which can be viewed at: http://www.youtube.com/watch?v=XyVvXhYNHyQ

The conference itself was launched with welcoming addresses from Mr Paul Wheelhouse, Minister for the Environment and Climate Change in Scotland; Mr Anders Flanking (via Loic Viatte), Secretary of State for Energy in Sweden; and Mr David Piper, Department Head, UNEP Chemicals Branch.

In addition to an exceptional scientific agenda, the conference delegates enjoyed a week of entertainment and networking including cocktails at the castle, whisky tasting, rock and roll bagpipes and even an indoor funfair.

Although there are no papers published, several Journals such as Science of the Total Environment and several Royal Society of Chemistry publications have offered to run special issues based on the most relevant and innovative papers. To view the full selection of abstracts for the conference please follow this link http://www.mercury2013.com/login/ with the username: icmgp2013 and password: icmgp2013.


*Lesley Sloss presents at ICMGP (photograph courtesy of Douglas Kurn)*

# Upgrading and efficiency improvement in coal-fired power plants

**Potential efficiencies from plant improvements in APEC countries**

| Category | Area of improvement | Net efficiency gain (percentage points) |
|---|---|---|
| Combustion system | Pulveriser and feeder upgrades | 0.3 |
| | Air heater repair or upgrade | 0.25 |
| | Sootblower improvements | 0.35 |
| | Excess air instrumentation and control | 0.2 |
| Steam cycle | Feedwater heater repairs | 0.4 |
| | Heat transfer tube upgrades | 0.6 |
| | Steam turbine blades | 0.5 |
| | Cycle isolation | 0.5 |
| | Condenser repairs | 0.4 |
| O&M | O&M training | |
| | Computerised maintenance and management systems and reliability centred maintenance | Included in combustion and steam cycle gains. Efficient operation realised over the long term |
| | Distributed control systems | |
| Combined total | | 3.5 |

Improving the efficiencies of the large number of older coal fired power plants operating around the world would give major savings in $CO_2$ emissions together with significant other benefits. This could be achieved by improvements to operating and maintenance practices and through more major activities (retrofits).

The efficiencies of coal-fired plants decrease over time as components suffer deterioration with age and use. The losses that develop in the earlier part of the life of a plant are generally containable by employing good operating and maintenance practices. However, after about 25–30 years of operation, performance and reliability will usually have decreased to the extent that substantial works may be merited, in order that the unit may be restored to operating efficiently and economically. The lower performance of older plants also stems from the limitations of the prevailing technology at the time of plant design. Retrofitting offers the opportunity to incorporate technology advances made in the period since the unit was built.

Retrofits will increase efficiency significantly, by up to as much as 2–3 percentage points, and may compensate completely for loss of performance from addition of environmental control equipment after a plant was first commissioned. As an example of the latter, the annual average efficiency in 1982-83 of the first three units of Drax power station in the UK with no FGD was 39% LHV. Recent turbine retrofit work has now increased the efficiency to almost 40% LHV even with FGD. Major plant upgrading involving conversion of subcritical to supercritical or ultra-supercritical (USC) could raise efficiencies more substantially, but has seldom progressed beyond studies because of the high cost.

The impact of plant ageing on efficiency tends to be most significant in countries where financial resources for maintenance are limited, such as in the non-OECD countries of southeast Asia. Unfortunately, a warmer climate and, sometimes, higher ash coals also restrict the efficiencies of coal-fired units in parts of the latter region (even for new plants). These influences combine to make it particularly important to maximise efficiency of old units as much as possible by carrying out retrofitting works. This often needs to be conducted on all main areas of the plant, not just the turbine area, as will frequently largely suffice on many units in OECD countries.

Major boiler and turbine retrofits are the main subject of this report, but optimisation of the combustion process can give valuable benefits in efficiency and costs. The gain may typically be about 0.1–0.15% in fuel cost saving, efficiency and $CO_2$ emissions. Improvements in combustion efficiency can be achieved in parallel with other improvements, for example, reductions in primary NOx production from replacement burners and new air supply arrangements. Intelligent sootblowing systems can improve boiler efficiency by 1% or more and reduce the incidence of outages from fouling.

Lignites with inherent moisture contents as high as 50–65% are used for power generation in some countries. The conventional systems that use these coals restrict generation efficiency. Lignite pre-drying would give a potential efficiency advantage of about four percentage points if a boiler designed for the dryer feed were used. Retrofitting a pre-dryer to treat a maximum of about 25–30% of the fuel feed to an existing boiler would be possible, and would give a worthwhile one percentage point efficiency gain. Such dryers are at the point of commercial availability.

Overall, this report shows that environmental and economic benefits are routinely achievable from plant modernisations and that the potential gains are now very considerable. Expertise is widely available, and progress is being made to realise these gains through projects at increasing numbers of plants. Technology sharing between all countries will be valuable in increasing the benefits.

*Upgrading and efficiency improvement in coal-fired power plants*
Colin Henderson
CCC/221, ISBN 978-92-9029-541-9, August 2013
£100 non-member countries
free member countries

# News from the IEA Greenhouse Gas Programme

**IEAGHG 2nd Post Combustion Capture Conference (PCCC2) 17-20 September 2013, Bergen, Norway**

*Test plant at Mongstad (photograph courtesy of Helge Hansen)*

Following the success of the 1st Post Combustion Capture Conference in Abu Dhabi, 2011 and the 12th International Post Combustion Capture Network workshops held from 2000 to 2009, IEAGHG is proud to announce the PCCC2 Conference to be held on 17-19 September 2013 at Hotel Grand Terminus, Bergen, Norway. The PCCC conference series is an important gathering for post-combustion capture experts to share their knowledge, findings and expertise. PCCC2 aims to continue the forum to discuss the various issues related to post-combustion capture technologies status and development.

There will be a special session on 17 September known as the 'Milestone Mongstad' to mark the first anniversary of Technology Centre Mongstad (TCM) $CO_2$ Capture Demonstration projects.

Keynote Lectures at PCCC2 include:

- The Mongstad experience – The importance of R&D in CCS, by Mr Tore Amundsen (CEO, Gassnova, Norway)
- Addressing the challenges for PCC in the Australian context, by Dr Paul Feron (Research Program Leader, CSIRO, Australia)
- Current status and future trends of the post-combustion carbon capture technologies: views from North America and Asia, by Dr Paitoon Tontiwachwuthikul (Professor, University of Regina, Canada).

The conference concludes with a site visit to Technology Centre Mongstad (TCM) on 20 September. Registration and more information about the event can be found at: http://www.ieaghg.org/index.php?/2nd-post-combustion-capture-conference.html.

**3rd Oxyfuel Combustion Conference (OCC3) and the 3rd Oxy-FBC Workshop 9- 13 September 2013, Leon, Spain.**

OCC3 is organised by the IEAGHG in partnership with Ciudad de la Engenia (CIUDEN) and Foster Wheeler (FW). The event includes keynotes presentations by Arto Hotta (Foster Wheeler) and Pedro Otero (CIUDEN) on the development of Oxy-CFB combustion and their experiences in operating the largest oxy-CFB pilot plant in the world; Ken Humphreys (FutureGen Alliance) on the activities of FutureGen2 leading the demonstration of Oxy-PC combustion; Prof Chuguang Zheng (HUST) on the large scale oxyfuel combustion pilot demonstration activities in China; Dominique Copin (TOTAL) on the storage dimension of the Lacq and Rousse Project; and Monica Lupion (MIT/CIUDEN) on the importance of public acceptance.

The conference has: two plenary sessions, two workshops on High Temperature Corrosion and Oxy-FBC Combustion, one special session on industry application of oxyfuel combustion with CCS, and twenty-two technical sessions covering all aspects of R&D activities in the development of oxyfuel combustion technology.

A total of 125 oral and 50 poster presentations will be delivered over the three days in four different parallel sessions. The meeting will conclude with a panel of distinguished experts. Finally, there is an opportunity to visit the Technology Development Platform of CIUDEN demonstrating the various facilities covering 20 MWth oxy-PC, 30 MWth oxy-CFB, 3 MWth gasifier and transport rig.

The organising committee would like to thank the sponsors – Vattenfall, Alstom and Air Liquide – for their generous support and contribution to the success of this event.

With more than 260 participants registered - don't miss out to the world's largest gathering of Oxyfuel Combustion Community! Further information can be found at http://ieaghg.org/index.php?/20120814317/3rd-oxyfuel-combustion-conference.html.

**Understanding the Techno-Economics of Deploying $CO_2$ Capture Technologies in an Integrated Steel Mil**l

This report presents a reference document illustrating the techno-economic evaluation of deploying $CO_2$ capture technologies in an integrated steel mill. This study defines the mass and energy balances, steel mill's gas and electricity network, the direct $CO_2$ emissions of individual processes that comprise iron and steel production, and the breakdown of the CAPEX and OPEX for a conceptual integrated steel mill without and with $CO_2$ capture producing 4 Mt/y of hot rolled coil (HRC).

Two different cases were evaluated:

1 $CO_2$ capture from the flue gases of the hot stoves and the steam generation plant (post-combustion $CO_2$ capture using MEA solvent) achieving 50% $CO_2$ avoidance;
2 Deployment of oxy-blast furnace with top gas recycle and $CO_2$ capture using MDEA solvent achieving 47% $CO_2$ avoidance.

An increase of 50-80 $/t of HRC produced from the steel mill with $CO_2$ capture compared with the reference case was found. Thus the cost of $CO_2$ avoidance for a steel mill with OBF and MDEA $CO_2$ capture is strongly linked to the price of the coking coal (as coking coal price increases, the $CO_2$ avoidance cost decreases). This relationship is attributed to the decrease in coke consumption by the blast furnace when equipped with OBF and top gas recycle.

The study concluded that post-combustion $CO_2$ capture (capture of $CO_2$ from different flue gases of the

*continued on next page*


The 3rd IEA Clean Coal Centre Network Workshop on Underground Coal Gasification takes place on 7-8 November 2013 in Brisbane, Australia.

The workshop will cover all the topical issues around underground coal gasification including:

- commercialisation;
- site characterisation;
- risk mitigation;
- UCG development;
- legislation and regulatory issues.

The workshop comprises two days of presentations at the Stamford Plaza Hotel, Brisbane, followed by a technical site visit to Linc Energy's Chinchilla and Carbon Energy's Bloodwood Creek operations. The registration fee is €300 which includes refreshments, lunches and the workshop dinner kindly sponsored by Linc Energy. The registration fee will increase to €350 on 7 October 2013. The technical site visit is limited to 50 participants at an additional cost of €80 and will take place on 9 November.

The draft programme for the Workshop on Underground Coal Gasification is now available at the workshop website http://ucg3.coalconferences.org. To see the programme, click on 'Enter conference system', then 'Conference Programme'. To view the session contents, click on the small arrows to the right of the session title. For more information contact John Kessels at John.Kessels@iea-coal.org.

*Chinchilla UCG plant, focus of site visit (Linc Energy)*

## IEA GHG (continued)

different combustion processes) could be cost prohibitive due to:

- significant increase in energy demand of the steel mill;
- a larger amount of $CO_2$ must be captured to achieve a similar level of $CO_2$ avoidance compared with the OBF case. This means there is more $CO_2$ to be transported and stored;
- it does not gain any upside cost benefit when coking coal price increases.

For the full report, please contact Stanley.Santos@ieaghg.org.

For other IEAGHG publications, please contact becky.kemp@ieaghg.org and visit the website http://www.ieaghg.org.

## Nigel Dong completes his Masters degree


Nigel S Dong, a technical author and energy strategy researcher at IEA Clean Coal Centre, recently completed his executive MSc degree in Finance at the London School of Economics and Political Science. Trained as a chemical engineer at Tsinghua University and Imperial College London, Nigel joined the Clean Coal Centre with high academic credentials. As his research interests extend into techno-economic analysis, there was a need for training in financial economics to complement his engineering background. The new qualification gives him knowledge of energy projects financing and budgeting, which are key skills for understanding and analysis of complex energy projects in the current challenging economic climate.

Nigel's most recent report is *Coal and gas competition in global markets* which was co-authored with Herminé Nalbandian. He is currently working on an assessment of drying technologies for low rank coals.

# Korean members visit IEA CCC

On 6 August, a Korean delegation visited the IEA CCC offices in Putney, London for a discussion on gasification and pre-combustion capture. Seong Jegarl, Principal Researcher at KEPCO Research Institute, Korea has a management role in Korea's IGCC and CCS development programmes. He gave a wide ranging presentation on Korea's extensive $CO_2$ capture R&D programme and an overview of their intended gasification deployment project, which is based on Shell technology. There are ambitious plans to scale up post-combustion capture, testing both advanced amine solvents and solid sorbents on 10 MW demonstration unit streams on coal power plants in Korea. There are plans for a 500 MW commercial prototype demonstration after 2018. For IGCC, the schedule includes trials on a 1 MW unit to be followed by scale up to a 10MW pilot unit from 2017. There is also associated development work on hot gas clean-up and on catalysts for use in the shift reaction process. Plans for a 100 MW oxyfuel demonstration plant have been put on hold due to funding limitations. They are also starting work on chemical looping combustion.

Geoff described the work of the Clean Coal Centre, with some emphasis on topics of interest to Korea. Robert then spoke about pre-combustion capture options. Both presentations were well received and generated much discussion.

*The Korean delegation to IEA CCC*

*Seong Jegarl, Principal Researcher, KEPCO Research Institute*
*Kwang Yun Choi, Deputy Director, Korea CCS R&D Centre*
*Yu Hee-Yol, Professor, Pusan National University*
*Chang Ha Lee, Professor, Yonsei University*
*Oh Min, Professor, Hanbat National University*
*Andrew Minchener*
*Geoff Morrison*
*Robert Davidson*


The IEA Clean Coal Centre was established in 1975 under the auspices of the International Energy Agency (IEA). Its aim is to provide an impartial and objective information and assessment service on all aspects of coal-related technologies and economics.

IEA Clean Coal Centre is a collaborative project established in 1975 involving member countries of the International Energy Agency (IEA). The service is governed by representatives of member countries (Australia, Austria, Canada, Germany, Italy, Japan, Poland, South Africa, the Republic of Korea, the UK and the USA), the European Commission, and industrial sponsors (Anglo American, South Africa; Banpu, Thailand; Beijing Research Institute of Coal Chemistry, China; BHEL, India; Coal Chemistry Coal Association NZ; Danish Power Group; EPPEI, China; Eletrobrás, Brazil; SUEK, Russia; Xstrata, Switzerland).

The IEA Clean Coal Centre programme of work contains studies of considerable significance for all countries involved in the use or supply of coal.



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