**No. 55** **May 2009**

# NEWSLETTER

## *of the Coal Research Forum*

### EDITOR'S COMMENTS:

Well here we are moving towards summer - the days are lengthening and the weather is getting warmer, I can hear the irritating buzz of the lawn mower outside and there goes the thwack of leather on willow. Yes, those are the things that you can generally rely on happening at this time of the year but what of the more uncertain and worrying issues? Have we reached the bottom of the recession yet? Will it get any worse? How many more jobs to be lost? Will the Government ever make a decision on the direction of future energy policy? Will Derby County be relegated next season? And perhaps most importantly, can I afford to retire yet? It seems to me that no one knows the answers to these crucial questions - and that really is worrying.

As regular as the things I mentioned earlier is the CRF Annual General Meeting. And sure enough we held our 20th AGM at the University of Leeds on April 22nd. The meeting was held jointly with Coal Combustion and Advanced Power Generation divisional meetings. The event was felt to be a good one and was quite well attended. It is hoped that the presentations from most if not all of the speakers will be posted on the CRF website in due course.

The first organising committee meeting for the next CRF conference, the "8th European Conference on Coal Research & Its Applications" - 8th ECCRIA for short! to be held in September 2010 at the University of Leeds also took place recently. Some of the organising committee from earlier conferences have decided the time is now right to hang up their badges of office so it will be a new team, (well new in parts) for Leeds in 2010!

Finally, it is with some regret that we have to report that the Coal Utilisation Subject Group of the Institution of Chemical Engineering is no more. The CRF has enjoyed a fairly long and very amicable working relationship with the CUSG and it is sad that it has ended rather abruptly and without the consensus of the CUSG officers who were in post at its demise.

### Contact Details:

David McCaffrey,
The Coal Research Forum
P.O. Box 154,
Cheltenham GL52 5YL
Tel: 01242 236973
Fax: 01242 516672
e-mail: mail@coalresearchforum.org
Website:
http://www.coalresearchforum.org

Dr Alan Thompson
The Coal Research Forum
Tel: 01332 514768
or 02476 192 569
e-mail:
alan.thompson5511@btinternet.com

# Brief Report on the 20th Annual Meeting & Meetings of the Combustion and Advance Power Generation Divisions 22nd April 2009, University of Leeds

It was a warm day as the attendees, including the Newsletter editor, walked up the hill from the city centre of Leeds to the Houldsworth Building where the 20th AGM of the CRF was scheduled to take place.

Refreshed with a coffee we were welcomed to Leeds by Professor Mohammed Pourkashanian. The first session was the Combustion Division meeting and comprised four presentations. The theme was "Combustion Modelling and Supporting Measurements" and, in the absence of chairman Jon Gibbins, the session was to be chaired by Professor Pourkashanian. However, as the first paper was to be given by Mohammed, Alan Williams stood in as chairman for this part of the session. The first paper was entitled "Oxy-fuel combustion for coal-fired power generation with $CO_2$ capture - opportunites and challenges"

After the musical chairs session was over the session reverted to its original chairman and continued with papers from Oliver Stein of Imperial College London with his paper entitled "Towards large eddy simulation (LES) of pulverised coal combustion".

The third paper was entitled "Advanced monitoring and characterisation of combustion flames" and was presented by Dr Gary Lu of the University of Kent.

The session was brought to a close by Dr Ravata Seneviratne of Doosan Babcock who presented work describing their Oxt fuel R&D activities.

The second session was the Annual Meeting of the CRF which has been reported separately by Dr David McCaffrey as CRF E-mailshot No.12 of 2009.

After a break for a most enjoyable lunch the meeting re-commenced with the Advanced Power Genaration Meeting chaired by its divisional chairman Peter Sage. Peter opened the proceedings by giving an introduction to current technologies and their status.

Mike Farley then gave the next paper entiltled "Ambitions for near-zero emissions fossil fuel power plant-based on supercritical PC". Mike had also had the opportunity to hear some of the budget speech being given on the day by Alasdair Darling and had been able to create a slide summaruising the Governmnet's current position of new technology developments in cleaner coal.

The second paper of the afternoon session was given by Ken Fergusson of the UCG Partnership entitled "UCG technology overview and UK initiatives".

The final session of the day was given by Grant Budge of Powerfuel Power Ltd. and was entitled "Hatfield 900MW IGCC Power Station with CCS".

Professor John Patrick gave the closing remarks and hoped that the attendees had enjoyed a very varied and interesting day and wished them a safe journey home.

# Brief Report on the Coal Research Forum Session at the British Carbon Group Spring Conference, 31st March/1st April 2009, Manchester

The Coal Conversion Division collaborated with the British Carbon Group (BCG) by organising a session at the BCG Spring Meeting on "Carbon in Health, the Environment and Energy". This event was held at the Manchester Conference Centre from 31st March to 1st April with the CRF sponsoring the Wednesday afternoon session on "Carbon in Energy". This session comprised 5 presentations. The opening invited lecture was given by

Professor Colin Snape (University of Nottingham) with a presentation entitled, "Some Recent Developments in Apportioning Carbon Particulates and PAHs from Coal Utilisation and Assessing their Health Effects". This was followed by four more presentations as follows; "The Nature of Smoke Produced by the Combustion of Biomass and Model Compounds", Emma Fitzpatrick (University of Leeds), "Bio-coke from Upgrading of Pyrolysis Bio-oil as a Feed-Stock for Sustainable Carbon Materials", John Andresen (University of Nottingham), "Aspects of the Calcium Looping Cycle", Paul Fennell (Imperial College), "Performance of a Fluidized Bed Gasifier under Oxy-Fuel Conditions", Nicolas Spiegl (Imperial College). The meeting was well attended with over 50 delegates ensuring some lively discussions in pleasant surroundings.

# Impressions of 7th ECCRIA, Cardiff University,

The Coal Research Forum awarded Emma Fitzpatrick of the University of Leeds £300 as a travel bursary to attend the 7th European Conference on Coal Research & Its Applications in Cardiff in September 2008. These are her impressions of the event.

The 7$^{th}$ European Conference on Coal Research and its Applications (ECCRIA) held in Cardiff (3$^{rd}$-5$^{th}$ September 2008) was a conference of personal firsts. Not only was it my first time attending a "coal" conference, as I come from more of a biomass/co-firing background, but it was also the first conference where I had to make an oral presentation, having only made poster presentations previously, and finally it was my first time in Cardiff!

There were two and a half days of presentations with two sessions running concurrently, as well as an evening poster session on the first day. Some of the topics covered included combustion, pyrolysis and carbonisation, co-firing with biomass and wastes, several types of modelling sessions, and carbon capture. Of particular interest to me were the sessions related to the co-firing coal/biomass, combustion and modelling. There were many noteworthy people, not only from the UK and Europe (Spain, from in my personal experience had a large representation) but there were also delegates from further afield, including South Africa and Japan! It was good to meet some of these people to find out what they're doing as well but also to get feed back on their views of my work. It was also helpful that there were a lot of delegates there from industry, as meeting these people and making contacts is particularly useful to later-stage PhD students.

My presentation *"The Mechanism of the Formation of Soot and Other Pollutants During the Co-Firing of Coal and Pine Wood in a Fixed-Bed Combustor"* gave results of emission measurements from a domestic boiler. These included information on the formation of PAH and O-PAH from biomass using both in-flame/close-to-flame measurements and pyrolysis and oxidative pyrolysis experiments. Reaction pathways, and a possible formation route to naphthalene as well as modelling considerations were discussed. My session was "Emissions from co-firing" session, in the dreaded first presentation, of the morning after the conference dinner! Despite this and the horrendous rain there was a good attendance and I was met with several thought-provoking questions, which I hope I in some way at least, managed to answer.

A few remarks on the venue and location, organisation was generally good although turning the evening. Due largely to a sunny and bright Thursday, the city of Cardiff left a good impression on me, it's a lovely small city with friendly people, a good atmosphere and it's easy to get around. The location of the conference dinner was pleasing and the food was excellent, and there seemed to be no shortage of wine, which pleased colleagues who weren't worried about an early morning presentation! The recommended university accommodation on the other hand, although functional, was not great and not terribly convenient to the lecture venue. (Side note: If used as accommodation in the future, perhaps a shuttle bus service to the venue in morning might be a good idea?).

# Impressions of the 9th International Conference on Greenhouse Gas Control Technologies (GHGT-9)

A number of student bursaries were provided by the Coal Research Forum, RWEnpower plc and the Coal Utilisation Subject Group of the Institution of Chemical Engineering.

The impressions of the bursary recipients are as follows:-

- **Hannah Chalmers:- University of Surrey**

Thanks to the generosity of the Coal Research Forum (CRF), RWEnpower plc and the CUSG of the IChemE, I was one of a group of UK students able to attend the 9th international conference on greenhouse gas control technologies (GHGT-9).

GHGT-9 may have been the biggest conference ever held with a specific focus on carbon capture and storage (CCS) with nearly 1500 delegates in attendance. The bursaries available to UK students made it possible for us to meet fellow students from around the world as well as attending conference sessions and exploring the poster/exhibit hall.

One of the most striking aspects of this conference was its sheer size. By the time I passed through passport control at Dulles airport in Washington DC, the immigration officials already knew about it. In the opening reception there was a wonderful (if noisy) atmosphere as there was an initial opportunity to meet others from the UK and further afield; catching up with some old friends and starting to make some new ones.

As well as a large attendance, GHGT-9 also attracted a record number of abstracts resulting in very high quality programme of technical sessions, supported by some fascinating plenary sessions to set CCS in context. I am funded by the UK Energy Research Centre as a multi-disciplinary student so enjoyed the opportunity to dip into a broad range of presentations that deepened my engineering knowledge of $CO_2$ capture processes but also added to my understanding of the key non-technical issues facing developers of real CCS projects.

Like many other conferences, another highlight was the conference dinner held in the Smithsonian National Air and Space museum. The range of international food available highlighted the diversity of the delegate list. We were free to explore the museum and appreciate the achievements of generations of engineers and scientists. It was amazing to see their success in introducing innovations that are now often seen as unremarkable today.

Perhaps the most important reflection I have brought back with me from GHGT-9 is that although successful deployment of CCS will require a significant science and engineering effort, a large community is developing in response to the challenge. CCS researchers based in the UK, including the group of students sponsored by CRF and RWE, are working hard to contribute to this effort. I hope that in the future we will be able to look back to conferences like GHGT-9 as events where we were able to share our work effectively and forge links with an international community that has successfully developed CCS for global deployment.

- **Maryam Gharebaghi - CFD Centre, University of Leeds**

The ultimate goal of my PhD project is the assessment of the Oxy-fuel combustion (as an alternative process for carbon capture, in CCS applications) and finding the challenges in its application for full-scale power generation plants. This is planned to be achieved through modelling of pilot-scale test facility, using commercial CFD code. Sharing the global concern of the environmental issues, communication with other researchers is very important for the purpose of this project. So far attending GHGT-9 had many potential benefits for my research purposes from the beginning.

More than 1400 participants from 39 countries attended GHGT-9. The number of attendees has been doubled since GHGT-7. I interpreted this increase as the growth of knowledge and interest in CCS applications. The venue was sponsored by well-known

industrial companies and leading universities. This cooperation contributed to the researcher – expert link and provided the space for further international collaborations. Sponsors of the conference were available in the booths in the poster exhibition hall. Beside of the marketing intentions for them, this gave an opportunity to attendees to be directly informed of the on-going projects. In the same hall, large number of posters was demonstrated which were accompanied by the authors in specified times. As a viewer comment, I imagine that the poster session would be more beneficial if it was arranged based on categories (capture/storage) in separate sites. Going through all the posters in a short time and a common space was not an easy task for me.

In general, the conference program covered the major technical and economical aspects of CCS. Being more related to my research interest, I attended almost all the sessions on capture technologies. The presentations were of good quality and sessions timing were excellent. The question and answers at the end of each lecture were beneficial. In addition, conference program was organized in a way that I found the chance to attend number of sessions on economical analysis of capture processes and also storage applications. This helped me to have a collective idea of the CCS state-of-the-art. Finally, there were various talks on novel technologies which were potential topics for discussion in future conferences.

Personally, I believe that postgraduate students are the right messengers for transferring the latest scientific achievements in research groups of universities to industry and actual applications. In pursue of this thought, I attended the student session. I had the chance to communicate closely with other young researchers and experts to exchange ideas and socialize. The speakers in the session shared their various experiences on joining the industry and academics after the graduation, which was quite valuable.

I would rate the social aspect of the conference as high-quality. The dinner in the air/space museum gave me the chance to meet more people in a less formal approach and socialize with them. Being an international student, this experience was priceless for me.

As the conclusion, I would say that the conference was successful in presentation of the up-to-date technologies and advances in CCS. There were emphasizing notes on consideration of the assurance and feasibility of these technologies before application in large scales. Marketing and economy analysis lectures were also useful. I am certain that most of the attendees – including me – are looking forward the next meeting in Amsterdam in 2010.

- **Rudra V. Kapila, School of GeoSciences, University of Edinburgh.**

The 9$^{th}$ International Conference on Greenhouse Gas Control Technologies (GHGT9) took place in Washington DC from the 16$^{th}$-20$^{th}$ of November 2008, and was superbly organised by the IEA Greenhouse Gas R&D Programme (IEA GHG), the US Department of Energy (DOE) and the Massachusetts Institute of Technology (MIT). As a PhD student, I found this to be a great opportunity and privilege to participate in the global gathering of experts, all working towards solutions for climate change. This was an exciting time in Washington; the city had not only become the epicentre of global politics, but the buzz and thrill from the historic election of President Obama were still prevalent throughout the four days of the conference. Delegates could not help discussing what Obama's new strategy was going to be in terms of energy and climate change. Everyday an announcement of a new appointee in government made headlines, and when it was announced during one of the keynote speeches that US Congressman Henry Waxman was going to become chair of the powerful energy committee in the House of Representatives, there was much jubilation from the delegates. This was very good news for the progress of climate change legislation.

The politically charged atmosphere of the conference was highlighted by the excellent lunchtime Keynote addresses that presented the bigger picture along the lines of the future of coal via Carbon Capture and Storage (CCS) technology, including perspectives from developing countries, and the prospects for a post-2012 climate policy. Eminent scientists and engineers gave presentations based on these wide themes, including Dr. Susan Solomon based at the National Oceanic and Atmospheric Administration, who pioneered research into the cause of the Antarctic ozone hole. She gave a talk about the

science of climate change and the whole procedure behind compiling the data for the IPCC reports, giving a great insight into how those pivotal reports were formed, and some of the data presented was quite an eye-opener to the current state of the planet. A Keynote address was also given by Jae Edmonds, chief scientist at the Pacific Northwest National Laboratory, on the potential role of CCS in climate stabilisation. According to Dr. Edmonds, a successful CCS program would lower society's cost of meeting and atmospheric $CO_2$ concentration limit, and that it had to be included into the energy mix for both the developed and developing world. His research for the Global Energy Technology Strategy Program indicated that Bio-CCS (biomass combustion/gasification with carbon capture) may have the most significant role in cutting carbon emissions, but also the take up of this technology will depend heavily on the price of carbon. In particular, he said that there was great promise in Bio-CCS, especially for developing countries, but it was still difficult to predict how rapidly the technology would be taken up because the response to an escalating price of Carbon will vary according to the economy and various industrial sectors.

This was the largest GHGT conference to date, running over 4 days with approximately 270 oral presentations that were divided into the main themes of capture, integrated systems, geological storage and policy. Over 1500 delegates attended and I was one in 400 giving a poster presentation. My poster was on my PhD research, which is looking at suitable sites and policies for geological storage of $CO_2$ in India. Initially, it was a bit daunting to present in a vast hall among hundreds of other people, but surprisingly it was a relaxed setting to talk to industry experts and other researchers one to one. Due to the interdisciplinary nature of my work, I had the opportunity to interact with geologists, policy-makers and engineers all in the context of CCS technology research. It was through one of these conversations that I got asked to take part in a side event hosted by the Bellona foundation of Norway. I, along with a few other delegates from GHGT9, was asked to participate in a roundtable discussion on how to ensure a rapid deployment of CCS technology in emerging economies. Issues on cost and financing CCS projects dominated the discussion with South Africa and India highlighting that their development priorities were on poverty alleviation as well as national infrastructure and construction. Both countries highlighted a huge dependency on coal and that this would continue for a few decades to come. In response, it was argued by a few delegates from industry that if one were building very efficient power plants, then making them CCS-ready could be a good insurance policy against a stranded asset. Other issues raised were the inclusion of CCS under the Clean Development Mechanism (CDM) and how the discussions at Poznan could lead to a possible agreement at Copenhagen. Apparently, a distinct methodology for efficient coal-fired plants exists in the CDM, but currently not for CCS. However it seemed that even though CCS has been put on the agenda for a post 2012 CDM, it is likely that it would get excluded due to running costs being the biggest problem, which could not be supported with the current vulnerable market mechanisms.

Overall, the conference was run very smoothly and efficiently, with a touch of glitz and glamour. On the last evening a gala banquet was held at the Smithsonian Institution's National Air & Space Museum, which is one of the most visited museums in the world. The museum had been booked exclusively for GHGT9 delegates, providing an exquisite range of American cuisine and music, surrounded by giants such as the V-2 missile and the Apollo 11 Lunar Module. It was an incredible evening, the highlight being a chance to enjoy the Einstein planetarium show with colleagues from all over the world. It was truly a great experience, and not to be forgotten.

- **Kali-Stella Zoannou, Cardiff School of Engineering, Cardiff University**

The 9$^{th}$ National Conference on Greenhouse Gas Control Emissions (GHGT9) was held in the Omni Shoreham Hotel in Washington DC, from 16$^{th}$ to 19$^{th}$ November 2008. This conference was organized by MIT in collaboration with the IEA Greenhouse Gas R&D Programme and the US Department of Energy. More than 1400 delegates were registered from 42 Countries. The conference ran with six parallel technical sessions, with major themes including the carbon capture, storage, policy and integrated systems for carbon capture.

I had the opportunity to participate in many interesting oral sessions and update myself on the progress of existing and new technologies in the field of carbon capture and storage.

As my project is in the area of amine scrubbing and I selected the sessions related to the field of carbon capture and was impressed by the high technical content of the presentations. I was rather pleased to find out that some of the presentations were directly relevant to my subject area, so I had the chance to get some interesting ideas to help me with my own work.

During the conference I had also the opportunity to interact with other researchers in the field, to exchange information and to discuss matters of shared interest. For this purpose the organisers had arranged several receptions and a gala held in the Smithsonian Institution's Air and Space Museum. During the lunches and breaks delegates had the opportunity to visit the poster sessions, meet with the researchers and company representatives in order to network in a less formal atmosphere.

Of great interest for me was a student session followed by a reception, in which young professionals talked about their own experiences at the beginning of their careers. Students also raised questions and their concerns in a friendly discussion which gave me a clearer picture of the wide range of job opportunities and career directions in this field. I also enjoyed meeting many students, at the student reception, with whom I shared common thoughts and worries for our PhDs.

Finally, after the end of the conference I was able to attend the separate seminar for $CO_2$ Capture by Aqueous Absorption, organised by the University of Texas, as Dr. Michael Whitehouse managed to seek permission for the UK students to participate. Many students who presented their work, I had met them during a study visit in January 2008 in Texas, so it was great pleasure to reacquaint with them, exchange ideas and discuss about the progress in our work.

For me as a PhD student it was a great personal and professional experience to attend this conference. I had the chance to broaden my technical understanding of the subject and meet and interact with people from all around the world that share common research interests. For this reason I would like to thank the Coal Research Forum, RWEnpower plc., and the CUSG of the IChemE for making this grant available in order for me to attend this highly motivating conference.

- **Rachael Porter, CFD Centre, Faculty of Engineering, University of Leeds**

The 9$^{th}$ International Conference on Greenhouse Gas Control Technologies (GHGT-9) took place in Washington D.C in November 2008. As a PhD student currently in my second year, I found the experience of attending the conference invaluable. The conference was the largest that I have attended so far and had delegates from a wide range of countries, approximately 1500 in total. The technical program was excellent and contained a wide variety of papers and topics.

My interest in particular was in papers on $CO_2$ capture technologies, in particular modelling of oxy-fuel combustion systems and oxy-fuel demonstration projects. For the first session of the conference, there were only three sessions in parallel in the three main topic areas of the conference; $CO_2$ capture, storage and policy. The capture session was very full with the whole room packed with delegates and many people standing in order to hear the speakers. The talks were aimed at giving an overview of the topics in the storage area, with all the speakers having a wealth of experience in the area. I felt this was a very fitting way to start the conference because there was an atmosphere of anticipation for the rest of the conference in the room, and highlighted the huge amount of interest in this area of research.

The same atmosphere prevailed throughout the conference with every session that I attended being very full, with lots of audience participation and questions, indicating a keen interest in the topics being discussed. In general the sessions ran with six technical sessions in parallel, many I attended were on $CO_2$ capture and pilot plant experience of technologies such as post combustion capture and oxy-fuel. I also found topics on international efforts towards CCS, such as in India and China, very interesting, and was one of the benefits of attending an international conference. Some of the papers that attracted a lot delegates and were of great interest to me were the oxy-fuel demonstration updates including companies such as Vattenfall, Doosan Babcock, Babcock & Wilcox, Air

Liquide and Air Products. It highlighted to me the importance of having forums such as the GHGT conferences for companies to share operating experience of new technologies. The talks covered a wide range of oxy-fuel issues from oxygen production through to flue gas cleanup and aspects of the combustion process in between. There were papers on CFD modelling of oxy-fuel combustion and overall process modelling that was informative for my work.

Alongside the very interesting and lively technical sessions, I thoroughly enjoyed the keynote lectures that took place during lunch. I thought having a relatively long break with speakers, gave me a great opportunity to meet people from industry and academia, that I otherwise wouldn't have met. There was a range of lunchtime speakers and I found all the talks interesting however I enjoyed two in particular, from Susan Solomon and David Ropeik. David Ropeik highlighted the urgent need to communicate to the public the issues involved in CCS and Susan Solomon discussed the now undisputed evidence for climate change.

The conference had several evening events that I felt were also very useful and enjoyable. The opening welcome reception was a great success with a large proportion of delegates attending, and I met people from many different areas in industry, from large companies such as BP and Shell, to smaller companies pioneering one technology in particular, for example. Midway through the conference, the students evening was a great opportunity to meet students from other universities working in a wide range of research areas related to CCS and the panel of speakers regarding career development routes were very interesting. I think the panel was selected well and covered people from a wide range of backgrounds and experiences. The relaxed atmosphere and friendliness of the whole conference continued in this session and it helped to enable interaction between students with many jokes and stories being told of our research experiences so far. The highlight of the evening events was the gala banquet held at the Smithsonian National Air and Space Museum. The whole museum was dedicated to the conference attendees for the evening with a dinner of different foods from around the world, and several live bands playing. It was a great evening and being a space travel enthusiast I couldn't have chosen a better venue!

Throughout the conference I enjoyed discussing my work and issues surrounding combustion modelling and oxy-fuel in particular with many people. One opportunity to do this was at the poster sessions, which were very informative and extended for several different periods throughout the conference allowing plenty of opportunity to explore the posters as there were a great number! There were several different oxy-fuel projects for which papers were not presented and therefore the posters were vital. For example, one such poster presented by Jupiter Oxygen Corporation and NETL detailed an oxy-fuel burner with high oxygen concentration and no RFG, that was an interesting contrast to some other papers presented. There were several papers on oxy-fuel in CFB boilers and various methods of oxygen capture and separation, which are all of wider interest to my project. There was a huge range of posters on geological storage issues, and although not directly related to my project I found myself very interested in this issue.

Overall the conference was excellent and had a very friendly atmosphere. The technical presentations were of very high quality and the results presented were useful and helped me to understand some of the operational and wider issues that may affect my project. One major benefit of attending the conference was explaining and discussing my work on oxy-fuel modelling, engaging in interesting discussions with others and receiving feedback on my work. I am very grateful to have received a grant that enabled me to attend this conference, it was a great experience and invaluable to me.

- **Penelope Edge, CFD Centre, Faculty of Engineering, University of Leeds.**

As I have come into the general field of CCS from the technical side of capture, specifically the internal processes occurring within the furnace under oxy-fuel firing, it was very interesting to find out about the status of other parts of CCS development; technical, political, and economical because of course if we don't have all the necessary elements then CCS will not work.

The first session I sat in was "recent developments in capture", chaired by Ed Rubin and Yoichi Kaya. A question was put to the panel - "when and where do you think the first working full-scale CCS plant will be demonstrated?" The majority answer was China, around 2020. Although in retrospect this should not have surprised me, it did because I have never asked myself the same question. And that was probably one of the main points I have taken away from this conference - there's a lot more to implementing CCS than controlling the furnace temperature and flue gas composition and as scientists we need to be aware of the policies and the economics as much as they do us.

On the capture side, the most interest was in PCC (post combustion capture), being closest to implementation. Some interesting ideas were put forward:

Dale Simbeck for SFA Pacific, US talked about an economical model suggesting plants suitable for retrofit options. Most of the worst fossil fuel stations emissions-wise are old inefficient subcritical dirty coal plants in OECD countries – if we could upgrade these to supercritical & retrofit PCC CCS, we could get a significant drop in global emissions without a global efficiency penalty. And Ashleigh Hildebrand at MIT suggested using partial-capture to "phase-in" the technology as the fastest way to economize capture although there are concerns about the public perception.

Most of the PCC presentations considered amine-scrubbing, closest to deployment. However, the session on CO2 separation via absorption by ammonia had the largest audience I saw all week, due in part to controversy over whether it is workable. I attended because I have only vaguely heard of the chilled ammonia process and was interested to see how it works and the current status of research efforts. Basically, it appears that the lower the temperature, the faster the reaction rate and the higher percentage of $CO_2$ which is absorbed into the ammonia. Much faster reaction rates can be achieved with this process compared to MEA adsorption. The main (possibly prohibitive) problem is the energy requirement for chilling the flue gas, and this was a topic for debate.

The Oxyfuel sessions were interesting, looking at the status of pilot projects and the overall potential of the technology. A huge possible advantage comes from the potential to have just one cleanup process: due to the elevated pressure and temperature conditions of the flue gas, potentially NOX, SOX and particulates can be removed in the compression stage by distillation and the "lead chamber concept", providing savings on SCR and FGD. This is being explored at Air Products and Vince White’s presentation showing results from the Oxy-Coal UK program was very interesting.

Both the technical and economical capture sessions gave me a lot of new up-to-date information relevant to my broad area of study and will be invaluable in influencing the path of my PhD, as well as what I choose to do afterwards.

Overall the emphasis was on cost and economics. What is the current (retrofit) and predicted future (purpose-built and optimized) COE and energy efficiency penalty for applying CCS? What price needs to be put on $CO_2$ emissions to make it economical to capture and store $CO_2$ (assuming a "cap and trade" system or a flat $/tonne $CO_2$ penalty cost)? Flexibility requirements and how to operate a CCS PF plant to ensure you are not at the bottom of the dispatch order?

These of course are uncertain due to our inability to predict the future (fuel cost, raw material cost, energy demand...), but we are moving closer to "prediction" from "guess". Compared to GHGT-8, this week we heard higher initial cost predictions due to increased raw materials costs, and potentially lower efficiency penalties (as low as 6% quoted by Air Liquide) due to research efforts, although this greatly depended on fuel prices. What was unanimously agreed and underlined was that we need legislation, now, so that we know exactly what we have to work towards. If the legislation is too harsh it will effectively kill coal as an energy resource, too weak and there will not be enough impact on emissions.

# UK emission cuts of 34% promised but is it enough?

22 April 2009
If the government's pledge to cut global warming emissions by one third in just over a decade can be done it should transform the way the UK economy works. However, critics have warned that the cuts would still not be enough to avoid dangerous climate change, and claimed that other spending pledges were not nearly enough to meet the target.

The Chancellor has now promised to cut greenhouse gases by 34% by 2020 through so-called carbon budgets, which fix binding limits on greenhouse gas emissions over five-year periods. This target is in line with the advice of the government's independent watchdog, the Committee on Climate Change (CCC). "This represents a step change in the UK ambition on climate change," said the budget report.

The budget report said the government "aims" to do this without purchasing controversial carbon credits from cuts made in other countries, but said these "offsets" could be a "fallback option". It also said the target cut would be higher if there was "satisfactory" global agreement on cutting emissions, but stopped short of committing to the higher 42% cut recommended by the CCC in those circumstances.

"These budgets give industry the certainty needed to develop and use low carbon technology – cutting emissions, creating new businesses and jobs," said the chancellor. Nobody expected the government to reject the emissions targets put forward by its watchdog, which are designed to help reach a promised reduction of 80% by the middle of this century. However, the formal announcement makes the UK the first country in the world to set legally binding targets.

Environmental campaigners and business groups commended the government on committing itself to firm targets. However, there were immediate warnings that not enough was being done.

Friends of the Earth, the charity which led a mass public campaign for the Climate Change Act which created the targets, said the 34% cut was no longer enough.

"Setting the first ever carbon budgets is a ground-breaking step - but the government has ignored the latest advice from leading climate scientists and set targets that are completely inadequate," said Andy Atkins, the organisation's executive director. "A 42% cut by 2020 is the minimum required if we are to play our part in avoiding dangerous climate change."

There was also widespread criticism that the rest of the budget did not include enough money for renewable energy like wind and tidal power, and energy efficiency for homes and other buildings. The budget also promised up to four "demonstration" projects for carbon capture and storage for coal and gas power plants, and £60m of new spending on research and development of the unproven technology, but critics said these partial capture schemes were not enough if the government goes ahead with plans for up to eight new coal plants.

James Cameron, vice-chairman of Climate Change Capital, a low-carbon investment fund with more than US$1.5bn (£1bn) under management, said: "The idea of a carbon budget is to be applauded and must become a permanent feature of how we direct our economy. But the reality is that creating a low carbon economy requires more than high-level commitment. The scale of investment required is huge, and thus far the commitments to stimulate the economy and reduce emissions have been small gestures, albeit in the right direction. They have identified the correct areas to be targeting with strategic intervention but the orders of magnitude are much too small."

The budget report said a full strategy on how the targets will be met is due this summer, but that the "latest government modeling" showed it was on course to meet the 2020 and two interim targets.

"The strategy will strengthen the long-term policy framework, taking into account recent consultations on heat and energy saving, renewable energy and zero carbon homes," added the report.
http://www.guardian.co.uk/environment/2009/apr/22/carbon-emissions-budget-20091

# Mobile $CO_2$-extractors - a reality but will they ever be used?

13 April 2009
When you get Klaus Lackner, a scientist at Columbia University, talking about his work, he sounds a bit like a travelling salesman. His product seems at first to be unworkable, but as he describes it, it moves to the possible and then to be a must-have item.

Ten years ago, no one, Lackner included, really believed it could be possible to efficiently capture and remove carbon dioxide directly from the atmosphere. Today, the idea is still widely considered a far-fetched option for addressing climate change. But as emissions climb and as global climate targets look increasingly difficult and expensive to meet, it is, to some, one of the only options that could someday turn back the hands of time. What is needed is a machine that can actually reduce the concentration of greenhouse gases in the atmosphere.

"We are actually the $CO_2$ collector of last resort," explained Lackner. "I'm convinced we will need one." Last week, John Holdren, science adviser to President Obama, echoed those thoughts to the Associated Press when he said that last-resort options to cool the earth using technologies like air capture cannot be taken off the table.

Lackner and Global Research Technologies LLC (GRT), the company that he co-founded to develop the patents and commercialise the process to do this, are now raising capital for a full-scale prototype of their carbon-capture travel pack, which they plan to have up and running, scrubbing carbon dioxide from the ambient air, within three years.

Technology isn't the only way to pull $CO_2$ out of the air; planting or saving a tree will do it, too. So might some rock formations that react with the gas. But the flat slats of Lackner's "atmospheric carbon capture systems" -- often likened to artificial trees -- are designed to be more efficient collectors than real leaves because they can ignore the photosynthesis part.

Lackner has been tinkering with various atmospheric carbon capture methods for years, but his newest design gets around his old nemesis, high energy costs. The key will be the prototype's patented plastic resin material, which GRT has already tested on a smaller scale. When exposed to dry air, it sops up carbon dioxide gas. When wet, it spontaneously releases the gas. Afterwards, it can be dried and reused, a little like a sponge being soaked and wrung over and over again.

In 2007, billionaire Richard Branson upped the ante for this by offering a $25 million prize to the person who can offer a commercially viable free-air capture technology. Today, a handful of research groups are tackling the air capture idea. One, led by David Keith at the University of Calgary, has erected a 20-foot tower that sucks the equivalent of 20 tons of carbon dioxide out of the atmosphere.

Of those involved, Lackner has been at it the longest, ever since the late 1990s, when he convinced himself with a series of calculations that the energy balance sheet to make air capture work was not as daunting as it seemed at first.

That conclusion runs counter to the intuitive notions of most scientists. Atmospheric carbon dioxide, measured in units of parts per million, is more than a hundred times more dilute than the concentration of the gas in a smokestack. Many assumed this fact would make it that much harder to collect. Lackner has since set out to prove that this assumption was wrong.

"I like to look at farther-out options," said Lackner, who began his career as a particle physicist but grew frustrated that his physics theories couldn't be proved right or wrong for another two centuries.

Lackner expects an initial cost of about $200 to collect a ton, a hefty sum by carbon trading standards. It is, however, in the ballpark for industries that actually buy carbon dioxide, such as energy companies that inject it into oil wells or vegetable growers who use it in greenhouses.

"A few tons here and a few tons there," said Lackner. "We can bootstrap ourselves." The ultimate goal, as the company scales up its production, would be to reduce the carbon capture costs to $30 a ton and then store it underground.

But it won't be until scientists develop actual sequestration projects to store $CO_2$ over the long haul that carbon capture of any kind -- whether from the air or from the flue stack of a power plant -- will really get off the ground.

When it does, however, Lackner says, carbon capture from the atmosphere has at least two major advantages over technologies that are wedded to the smokestack. One is that there's no need to modify older power plants or build pipelines to bring the captured gas to sequestration sites.

The other: Unlike the plant with the smokestack, "I'm going to be able to move," he explains. From oil wells to remote sites where carbon may be one day locked away deep in the ground, the ability to go from door-to-door and capture carbon dioxide almost anywhere is one of his main selling points.

Lackner fully admits that his air capture devices will be far from the cheapest option for addressing climate change and says that new power plants would be "foolish" to let their $CO_2$ out for him to capture -- but older power plants, he said, might do well to consider it.
But the idea that air capture and other proposals to alter the Earth's systems to reduce climate warming might allow fossil fuels to be burned as usual is exactly what some its detractors fear.

John Coequyt, with the Sierra Club's global warming and energy program, said he was generally concerned that looking for a "silver bullet" approach could sidetrack renewable energy projects and other nearer-term options for mitigating climate change. He added that the environmental community has mainly left the debate over capture technologies up to the scientists.

Some prominent climate scientists, such as NASA's James Hansen and Columbia's Wallace Broecker, have indeed called for more serious attention be paid to air capture research because they are alarmed at the ever-shrinking timetable left for reducing emissions.

Others, however, have called such proposals a waste of limited resources. Howard Herzog, principal research engineer at the Massachusetts Institute of Technology's carbon capture and sequestration program, called the hype about free-air capture a distraction from the real task at hand in dealing with coal emissions. In 2007, MIT issued a report saying that, in general, carbon capture research is vastly under funded.

And the Intergovernmental Panel on Climate Change (IPCC) summarily dismissed atmospheric capture in its 400-page report on carbon capture and sequestration in 2005. "Their argument is 'We only look at the things that already exist,'" said Lackner.

The Department of Energy, likewise, has been hard to convince. A US DoE spokesman explained that, until recently, its experts thought that the concentration differences and energy requirements were too high. But now the U.S. Climate Change Technology Program is thinking about collaborating on some exploratory work.

Advocates say that while large-scale air capture projects might be a long time away, their economics aren't as bad as everyone assumes. Roger Pielke Jr., a political scientist who studies energy and climate policy at the University of Colorado, conducted a recent study that found that stabilizing greenhouse gas concentrations with air capture using today's

technologies could about equal the costs projected by the IPCC of other ways to deal with warming.

"If climate change really is a definitive problem of our generation, how could we afford not to explore this technology?" asked Pielke. "It seems like we wouldn't want to put all our eggs in the basket of conventional mitigation, even if we are successful beyond our wildest dreams."
http://www.nytimes.com/cwire/2009/04/13/13climatewire-is-there-a-market-for-a-synthetic-tree-that-10510.html?pagewanted=1

# Government warned next Budget will be crunch-time for renewable energy

12 April 2009
Industry leaders have warned that this year's budget will "make or break" Britain's struggling renewable-energy sector.

The Treasury has been flooded with demands for several billion pounds in funds that industry says it needs to stave off the collapse of sectors like wind power and to jump-start fledgling industries such as electric cars and clean coal. Executives fear, however, that chancellor Alistair Darling will disappoint when he reveals the government's spending plans on April 22 because the parlous state of the public purse has left him with little money to plough into the sector.

Nobody has been more ambitious than the promoters of wind power. The British Wind Energy Association, the industry's trade body, has told the government it needs at least £2 billion in tax breaks, increased subsidies or "green bonds" to fund building costs. If they don't get help, power companies have warned that £12 billion of new wind farms, enough to power more than 1.3m homes, will be scrapped.

The predicament of the wind industry is similar to most of the renewable-energy sector. Gordon Brown has called for a green-energy revolution, arguing that it will help to pull the economy out of recession through the creation of thousands of new jobs. The credit crunch, however, has pushed up the cost of financing projects, while the appetite of investors to back new, risky technologies has dropped off sharply. Industry executives argue that it is up to the government to fill that funding gap or risk seeing the revolution die before it is born.

Greg Barker, shadow energy minister, said: "The government has talked about creating a low-carbon economy. Unfortunately they have done next to nothing to deliver on it. Investment is close to collapsing right across the low-carbon sector and all the government seems to do is call for more consultations and host photo opportunities masquerading as 'green job' summits."

He added: "I see no sign that this 'green budget' will be any different. What the UK energy sector needs is less talk and more action."

The government has big decisions to make. Coal is a big issue. The Association of UK Coal Importers (ACI) has told the government it should bring forward its decision on the winner of its clean-coal competition. The government has pledged to fund the building of a pilot carbon capture and storage project, which promises to strip the carbon from emissions at coal-fired power stations and bury it underground. It is seen as a vital piece of the low-carbon energy mix because of the abundance of coal.

The decision, under which the winner will be awarded several hundred million pounds, has been delayed several times and is not now expected until the end of the year at the earliest. The government is also thought to be looking at paying for it with funds from a European Union economic-recovery package rather than using taxpayers' money.

Smaller companies represented by the Renewable Energy Association have said they need £625m in subsidies and grants for an array of small-scale projects like those under the

low-carbon building programme, which helps cover costs for solar-panel installation and micro-generation projects.

This month the government suspended the scheme and said it would return the remaining funds to the Treasury.

Samir Brikho, chief executive of Amec, the engineering firm, said the government should take this as an opportunity to make a "clear statement of their intent". "The chancellor could consider subsidies for wind and tidal power to make them more competitive and provide funding for studies into tidal projects in the Severn estuary and Pentland Firth," he said. "Financial encouragement for environmentally sound biofuel plants, ones that do not divert produce from the food chain, would also be beneficial."

There will be a few green shoots. The government is expected to offer £2,000 grants to encourage motorists to buy electric cars as part of a fresh initiative to stimulate the green economy. It will also reveal the broad outline of a £7 billion plan to install "smart" gas and electricity meters in all of the UK's 26m homes. The meters allow homeowners to monitor their real-time energy usage and have been shown to reduce consumption.
Under the plan, each utility will install meters, and a telecoms group will handle the data.

**What they want**

Wind: £2 billion to build new farms
Low-carbon buildings: £625m for this and other small-scale initiatives
Electric cars: a £2,000 subsidy for buyers of electric cars
Clean coal: several hundred million pounds to build the first plant
Nuclear: new funding to build a long-term nuclear-waste repository
Oil: big tax breaks for North Sea oil drillers
http://www.timesonline.co.uk/tol/news/environment/article6078151.ece

# Geopressure - a useful new power option?

12 April 2009
Great Britain's gas network contains an untapped source of clean energy that Andrew Mercer, a former IT entrepreneur, plans to harness. Mercer's scheme is to tap the high pressure at which gas emerges from underground to drive turbines and generate electricity. Late next year Mercer's "geopressure" company, called 2OC, will generate its first power at a gasworks in Becton, east London.

The plant will be the first project of Blue-Ng, a £300m joint venture between 2OC and National Grid. It will generate 19.5MW, enough to power 50,000 homes. The Becton site will generate more power from an adjoining combined heat and power (CHP) plant that will burn oilseed-rape fuel supplied by nearby farms. Blue-Ng has planning permission for a site in Southall, west London, and has an eye on five other London locations.

Generating power from geopressure is efficient as well as clean, according to Mercer. While a coal-fired power station will typically be 35% efficient and the best gas-turbine power station is about 50% efficient, 2OC claims it can achieve electricity-generation efficiencies of 70%-80%.

If biomass is burnt at the same time in a CHP plant, more than 90% of the heat produced can be recovered and used – in the case of Becton to reheat the gas that gets very cold when it loses pressure.

Mercer said his technology produces better results than wind or wave power. "Power generated by natural gas pressure is available round the clock. It does not require wasteful base-load power to be standing by and it is responsive to demand."

The mini power plants will use existing brown field sites so it should be easy to secure planning permission, said Mercer. "Many of these sites will be in industrial areas so you won't really notice them."

As Britain's gas grid has 12,000 pressure-reduction stations, all of which in theory could be turned into mini power generators, the Blue-Ng venture could help plug the gap emerging in the country's ageing power generation network, said Mercer. "We expect to generate 1GW within five years but we also have a big hairy ambition to reach 10GW by 2020."

By adding 1GW of clean electricity generating capacity to the UK's power supply, 2OC claims it could remove 1m tonnes of carbon from the Earth's atmosphere, equivalent to the National Health Service's carbon footprint.

Mercer has global ambitions, too, and is establishing operations in America, Germany and the Middle East. If exploited worldwide, geopressure technology could add generating capacity of between 100GW and 400GW, reducing carbon emissions by between 100m and 400m tonnes. "The technology can be used anywhere there is a gas grid," he said.
http://www.timesonline.co.uk/tol/news/environment/article6078147.ece

# CBI unhappy with UK climate policy

6 April 2009
Business leaders have delivered a surprise attack on the government's environmental policy, arguing that ministers are not doing enough to cut global warming emissions or make sure the UK does not run out of power. The CBI says billions of pounds of necessary investment will move to the US and China unless the government takes "urgent action".

It comes amid widespread disappointment that the G20 heads of state failed to come up with any real push on green issues as part of a $1.1tn (£743bn) financial aid package for the global economy.

The warning from the CBI follows a series of announcements by major energy companies, including Shell, BP and Centrica, that they would axe or reconsider investment in "low carbon" energy such as wind and solar power and carbon capture for coal-fired power stations.

Richard Lambert, the CBI's director general, said "politics and policy", not the recession, were delaying investment in the UK. He said the government's policies were on the "right path", but companies were "jittery" about investing in the UK because of delays with planning permission, poor National Grid connections, slow funding for new technology, and uncertainty over long-term carbon prices.

The government needs "to get on with it," said Lambert, ahead of today's launch of a new strategy for the energy industry. "If they don't, the risk is that the private capital needed will not come here in the volumes required."

Further evidence of the growing crisis of confidence in the green energy sector is exposed today by a survey which revealed that more than three quarters of Britain's green energy companies were now facing enormous financial difficulties gaining vital access to loans and investment money - a finding that has seriously shaken the industry's parent body.

Out of 39 member companies that responded to a poll by the Renewable Energy Association (REA), 32 said they were suffering from a shortage of cash flow and other problems, while only six said they were not affected at all.

Philip Wolfe, the director general of the REA, said the survey highlighted the need for immediate action by ministers. "Given all the rhetoric on the Green New Deal and Green Tech, it is astonishing that the renewables industry has received no dedicated support - even in areas that don't cost extra money," he said.

"As so little has been done, the last opportunity comes in this month's budget. Other countries have already committed huge stimulus monies to their renewables industries while we have nothing, so the UK industry is now at a serious competitive disadvantage."

Lambert said: "It's a bit of an edgy moment. If we're going to go to where we want to get to by 2020, we need to be moving pretty aggressively on policy."

The CBI's new strategy, one of four "road maps" to a low-carbon economy published today, will call for immediate and short-term actions, including clear planning guidance to fast-track investment in offshore wind farms and nuclear power stations and an upgraded National Grid. Ministers also need to make a quick decision about a promised trial of carbon capture and storage, and fund at least one other, says the business group.

The Department for Energy and Climate Change said there were "clear signals that there's an appetite for investment in nuclear energy" and this month it had increased the incentive for offshore wind power by 50%.

"The government has been working to ensure that the short, medium and long-term environment for energy investment remains healthy in Britain and that any barriers identified are swiftly removed," the department said.
http://www.guardian.co.uk/environment/2009/apr/06/cbi-environment-climate-change

# Research confirms underground water a safe haven for $CO_2$

6 April 2009

Water deep below ground has safely trapped carbon dioxide for millions of years and may one day help absorb emissions of the greenhouse gas to help slow climate change, researchers have said.

The finding shows that such carbon capture and storage is possible provided scientists find an area where the geology is suitable, said Chris Ballentine, a researcher at the University of Manchester, who worked on the study.

This means locating ancient deep water systems thousands of metres below the surface to ensure gas doesn't escape back to the surface and into the atmosphere, he told Reuters.

"Clearly we want to bury carbon dioxide in the ground, that is a no-brainer," Ballentine said. "The big question is when we put carbon dioxide into the ground, how safe is it?" The world is looking to limit emissions of greenhouse gases like $CO_2$ as climate scientists warn that their elevated global levels will lead to higher temperatures, rising seas, drought, and cause floods, heat waves and stronger storms.

Many governments see carbon capture and storage as a key weapon in the fight against global warming because it captures the emissions from fossil fuel burning power stations and buries them underground, in a process which could keep up to a third of all carbon emissions out of the atmosphere.

However, the technology is untried at a commercial scale and will initially be very expensive, at around 1 billion euros per power plant, making it unattractive for individual companies to undertake without support.

But the prize for the winner is potentially vast, with China on its own opening one coal-fired power plant a week and global reserves of coal which could last hundreds of years. Ballentine and colleagues analysed how carbon dioxide dissolved into water and another technique to see if it reacted with the rocks at nine natural gas fields in North America, China and Europe filled with the greenhouse gas thousands or millions of years ago following volcanic eruptions.

They found that underground water was the major carbon sink in these gas fields and had been for millions of years, potentially offering vast areas to store the greenhouse gas one day, the researchers said.

While other studies have shown that certain rocks below the surface soak up carbon, the findings published in the journal Nature found that most rocks do not store the greenhouse gas and the water instead keeps it safe.

http://www.dailytimes.com.pk/default.asp?page=2009%5C04%5C06%5Cstory_6-4-2009_pg14_5

# New gasification process for London's waste

18 March 2009
A bid to use plasma gasification technology to generate energy from London's 21 million tonnes of waste has been made by Waste2Tricity, a company set up just four months ago. The company's expression of interest answers a call from the London Waste & Recycling Board for an energy-to-waste management solution for the capital.

Waste2Tricity has proposed using gasification along-side AFC hydrogen fuel cells to convert rubbish into electricity. LWRB will make a decision on the proposals this year. If successful, the bid could lead to a £135 million 250,000 tonne a year commercial processing plant for the capital.

Waste2Tricity lead consultant Howard White explained that the technology is already used in Japan at a "commercially sized" 50,000 tonne capacity plant. "Going up to 250,000 tonnes capacity is the leap of faith the consortium [backing Waste2Tricity] is taking. It shows their confidence in the technology," White said. He added that investors had also conducted due diligence procedures.

He said the increased fuel production efficiency of the gasification process compared favourably with incineration based energy from waste technologies.

"With incineration, to produce 1 megawatt you need to use 25,000 tonnes of waste. But with plasma gasification you only need 8,000 tonnes to produce 1MW. And with the added efficiency of the fuel cells this is reduced to 5,000 tonnes to produce 1MW," he said. White also said that gasification combined with fuel cells achieves 60% efficiency compared with 30% energy generation efficiency achieved by internal combustion technologies.

The Waste2Tricity consortium includes AFC Energy plc, Alter NRG, and WSP Environmental. GDF SUEZ has expressed an interest in purchasing the electricity produced. http://www.mrw.co.uk/page.cfm/action=Archive/ArchiveID=10/EntryID=5235

# Claims made against UK government carbon targets

17 March 2009
Official advice being used to set Britain's first carbon budget is "naïvely optimistic" and will not stop dangerous climate change, experts from the Tyndall Centre for Climate Change Research say.

Proposed government carbon targets are too weak to prevent dangerous levels of global warming, according to a new analysis by leading scientists. Ministers are poised to introduce strict limits on UK carbon pollution when they announce Britain's first carbon budget next month. But experts from the Tyndall Centre for Climate Change Research warn today that official advice used to set the budget is "naïvely optimistic" and will not stop dangerous climate change.

It comes after scientists at a global warming conference in Copenhagen last week warned that emissions are rising faster than expected, and that climate change could strike harder and faster than predicted.

The Tyndall Centre report analyses the conclusions of the Committee on Climate Change (CCC), which said in December that ministers should aim to cut UK carbon emissions 34% by 2020, as part of worldwide efforts to limit temperature rise to 2$^{O}$C.

The Tyndall scientists say the committee's report is "inevitably and significantly compromised" because it focuses on limiting temperature rise to 2$^{O}$C above pre-industrial

levels, which the EU defines as dangerous. The committee was forced to use "highly optimistic and sometimes unclear assumptions" to hit the $2^{O}$C target, they say.

Chief among these, they say, was that global emissions of greenhouse gases would peak in 2016, despite little evidence that such a U-turn in soaring emissions within seven years is "in any way viable". A peak of emissions in 2020, which the Tyndall Centre says is more realistic, would leave governments facing an impossible challenge to hit the $2^{O}$C target, it adds.

"The CCC's first report is therefore inevitably and significantly compromised by its implicit need to deliver demanding but nonetheless politically palatable conclusions in line with the 2C threshold," the scientists say. "Peaking in 2020 would recast the agenda as much more radical and urgent, and well beyond the ability, even if applied stringently, of orthodox policies to deliver the necessary mitigation and adaptation."

The government should aim to cut emissions 42% by 2020 - the most stringent scenario in the CCC report - the Tyndall Centre says, and must make the cuts at home rather than buying offsets abroad. These proposals are backed by more than 90 Labour MPs – including four ministerial aides – in a parliamentary petition.

Kevin Anderson of the Tyndall Centre said: "At a time when the message from Copenhagen is for urgent action and leadership, paying poorer communities elsewhere to make the reductions for the UK risks undermining seriously the government's hard-earned reputation as leading the international climate change agenda."

The findings of the report, commissioned by Friends of the Earth, will be presented at a special meeting of the Environmental Audit Committee today. Andy Atkins, Friends of the Earth's executive director, said: "This advice from one of the world's leading climate research centres cannot be ignored. If we are to play our part in avoiding dangerous climate change, the government must commit the UK to cutting its greenhouse gas emissions by at least 42 per cent by 2020 without buying pollution 'offsets' from abroad. The UK has one of the best renewable energy potentials in Europe. Investing in green power and cutting energy waste can create tens of thousands of jobs and help lead this country out of recession."

The CCC said: "The choice of peaking year was more determined by what we thought might be possible if a global deal was achieved in 2009. The CCC analysis drew upon, and cited, a number of studies which suggested that global emissions could peak around 2016 if the world dedicated sufficient intellectual and material resources towards solving the problem." http://www.guardian.co.uk/environment/2009/mar/17/uk-climate-budget-advice-weak

# Wood torrifaction - has it a future?

18 March 2009
Is wood the new coal? Researchers at North Carolina State University think so, and they are part of a team working to turn woodchips into a substitute for coal by using a process called torrefaction that is greener, cleaner and more efficient than traditional coal burning.

Environmental organizations have raised concerns for decades about the environmental impact of the burning of fossil fuels – particularly coal – for energy. The combustion of coal contributes to acid rain and air pollution, and has been connected with global warming.

During torrefaction, woodchips go through a machine – almost like an industrial-sized oven – to remove the moisture and toast the biomass. The machine, called a torrefier, changes more than just the appearance of the woody biomass. The chips become physically and chemically altered – through heat in a low-oxygen environment – to make them drier and easier to crush.

The torrefied wood is lighter than the original woodchips but retains 80 percent of the original energy content in one-third the weight. That makes them an ideal feedstock for

electric power plants that traditionally use coal to generate energy for businesses and residential neighbourhoods.

While the process of torrefaction is nothing new, NC State's particular torrefier machine, called the Autothermic Transportable Torrefaction Machine (ATTM), is field portable and self-heated. Traditional torrefier machines are bulky and immobile, but the ATTM lends itself to field-based operations, which reduces the cost of transporting tons of woody biomass to and from the combustion facilities. The ATTM is also largely self-powered, producing a large energy return while also removing carbon from the atmosphere.

"This process could help us build a bridge to more energy independence," says Chris Hopkins, a doctoral student in forestry at NC State and developer of the torrefier machine.

Woodchips are abundant in North Carolina while coal is all imported from other states. More importantly, woodchips are a carbon neutral source of energy. For a state that spends more than $4 billion a year importing coal, use of torrefied wood could result in an economic windfall.

Hopkins explains that nearly half of the state's forests are not adequately thinned because landowners lack a market for small diameter trees, rotten or unusable trees and logging residue. That land could be producing more valuable wood products if it was managed more effectively, he says.

If woodchips were collected and sold to help fire North Carolina's energy generating plants, the state's tax base could be increased by nearly $400 million a year, Hopkins estimates. Since the torrefier machine is small enough to transport, it could be set up close to forest-clearing operations, making the process even more efficient.

NC State's Office of Technology Transfer (OTT) announced an exclusive license agreement with AgriTech Producers, LLC of Columbia, S.C. to commercialize this technology, called "Carolina Coal".
http://www.sciencedaily.com/releases/2009/03/090311134802.htm

# Hope of new level of interest in CCS in the USA

19 February 2009
Carbon capture and storage (CCS) has received a fillip from the US, with $3.5 billion earmarked in President Barack Obama's stimulus package for demonstration projects and growing support at the state level.

The extra money for CCS in the $787 billion federal stimulus package increases US funding for projects by 70%, to more than $8 billion, according to Emerging Energy Research (EER). And the Cambridge, Massachusetts-based analysis company notes that several states have passed legislation to incentivise CCS. Illinois, for example, has passed a Clean Coal Portfolio Law, which requires utilities to source 5% of the state's electricity supply from coal-fired power stations which capture and store the carbon dioxide (CO2) they emit, when such plants are built.

Alex Klein, research director at EER, said: "The fact that individual states have begun to take the lead in CCS policy creates an even greater mandate for these demonstration projects." Governments worldwide have set aside more than $20 billion for CCS demonstration plants, EER said in a report published last week. This includes $11.6 billion in funding promised by the EU.

Nearly 120 large-scale demonstration plants are in development, with activity concentrated in Western Europe, the US, western Canada and Australia. The funding available could support more than 30 large-scale projects, but Klein is expecting a high drop-out rate, with only 10-20 out of the current pipeline being built.

A number of projects have already been cancelled "and that's going to continue, unquestionably", Klein added. Although some cancellations are due to companies proposing projects that they do not have the resources to carry out, some cancellations are due to technical and practical reasons.

For example, he said, the BP and Rio Tinto collaboration Hydrogen Energy put forward five projects over two years, and has cancelled three, then proposed another two, as the venture encountered problems including potential sequestration sites and locations. On its website, Hydrogen Energy said: "We have faced substantial challenges to do with financial incentive and regulatory framework issues, as well as the technology. These are the growing pains of a new industry and we see ourselves as pioneers in this exciting new area."

"If coal is to maintain its share in the global power generation mix over the next two decades, its carbon emissions must be mitigated through the capture of $CO_2$," said Klein.

"Carbon sequestration is finding its way into power generation strategies as energy companies across the value chain wrestle with the likelihood of impending carbon regulations, continuing natural gas price volatility, potential capacity shortfalls and the need to retire existing coal plants," he added.
http://www.environmental-finance.com/onlinews/0219ana.html

# CCS studies initiated at EPRI

27 January 2009
Five electric utilities in the United States and Canada will host studies of post-combustion carbon dioxide ($CO_2$) capture systems at existing coal-fired power plants, the Electric Power Research Institute (EPRI) said on Tuesday.

As global demand for electricity increases and regulators worldwide look to reduce $CO_2$ emissions, post-combustion capture for new and existing coal units could be an important option, EPRI said in a release.

Coal generates about half of the electricity used in the United States and is now much cheaper than other fossil fuels like natural gas. At the current production rate, the United States has enough coal to last more than 150 years.

But a coal plant produces about twice as much $CO_2$ as a natural gas-fired plant, and $CO_2$ is a greenhouse gas associated with global warming. A 1,000 MW coal plant produces about six million tons of $CO_2$ per year.

Retrofitting existing plants presents "significant challenges," EPRI noted, including limited space for new equipment, limited heat and water needed to run the system and potential steam turbine modifications. EPRI expects to conduct the studies in 2009.

The five stations include Edison International's 1,536-megawatt (MW) Powerton in Illinois, Great River Energy's 1,100 MW Coal Creek in North Dakota, Emera Inc's two 160 MW units at Lingan in Nova Scotia, Intermountain Power Agency's 950 MW Intermountain in Utah and FirstEnergy Corp's 176-MW Unit 1 at Bay Shore in Ohio.

EPRI is already working on post-combustion carbon capture systems using chilled ammonia designed by French engineering firm Alstom SA at stations owned by Wisconsin Energy Corp in Wisconsin and American Electric Power Co Inc in West Virginia and Oklahoma.

U.S. greenhouse gases in 2007 were close to 7.3 billion tonnes of CO2 equivalent, according to the federal Energy Information Administration. Burning fossil fuels, like natural gas and coal, to generate electricity is the single largest source of greenhouse gas emissions in the United States, representing about 40 percent of greenhouse gas emissions.

EPRI is a not-for-profit organization that conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public.
http://www.reuters.com/article/rbssIndustryMaterialsUtilitiesNews/idUSN27461836200901 27

# Capture costs - how low can you go?

20 February 2009
Colorado start up company Ion Engineering says it has devised a cheaper way to clean contaminating gases from natural gas – and it's seeking investment and stimulus funding to extend that to capturing carbon dioxide from coal-fired power plants.

Ion Engineering says its new technology could cut the costs of capturing carbon dioxide from coal-fired power plants to as low as $20 a ton – a price that could get the attention of companies and governments looking to spend tens of billions of dollars on reducing greenhouse-gas emissions over the coming years.

But the Boulder, Colo.-based startup founded by University of Colorado researchers will first set its sights on a market that actually exists today – cleaning $CO_2$ and other contaminant gases from natural gas, CEO Alfred Brown said Friday.

Ion's breakthrough is in using ionic liquids – molten salts – in place of water in the amine solutions now used in so-called "gas sweetening," Brown said. Processing "sour" natural gas to remove CO2, hydrogen sulfide and other contaminating gases is a $12 billion-a-year business in the United States, and possibly as large as $50 billion worldwide, Brown said.

Using ionic liquids, which don't evaporate like water-based solutions and react with contaminating gases at a much higher rate, could lead to 30% to 40% reductions in those processing costs, he said. "That alone addresses a huge market," Brown said, noting that cheaper sweetening processes could also open up "sour" gas fields now viewed as too expensive to develop. Ion – founded six months ago with funding from its founders and the University of Colorado – is seeking to raise about $5 million to develop that business, he said.

But the next step for Ion's technology – capturing carbon dioxide emitted from coal-fired power plants and other large-scale sources – will take a lot more money. "You could be talking $30 million to $40 million there," he said. And for that, Ion is looking to partnerships with companies and institutions doing carbon capture pilot projects, as well as the federal stimulus money aimed at promoting them.

The stimulus package signed into law by President Barack Obama on Tuesday adds $3.5 billion to the federal Fossil Energy Research and Development program, which includes carbon capture and storage funding, bringing the program's total funding to more than $8 billion.

The US DoE said in 2007 that current technology's costs are about $150 per ton of $CO_2$ captured – enough to increase the cost of electricity by 2.5 cents to 4 cents per kilowatt hour.

Mark Trexler, director of EcoSecurities Consulting, said at the Clean-Tech Investor Summit in Indian Wells, Calif. last month that recent technology improvements have brought costs of carbon capture down to $50 to $100 a ton.

Ion's $20-per-ton carbon capture cost would place it among the cheapest being promised, though Brown cautioned that the figure was based on "very preliminary" estimates. "Obviously, we are trying to get into a small pilot situation as quickly as we can to validate these assumptions," he said. "Both gas and coal-fired power plants are what we're looking at. We're putting together partnerships right now." But, of course, carbon that's captured needs to be stored somewhere – the other half of the carbon capture and storage, or sequestration, equation.

"The variable here is, sequestration hasn't been figured out yet," he said. While several projects around the world inject captured carbon into oil and gas wells or underground caverns, it's unclear whether that method will be effective for large-scale carbon storage.

Ion is exploring other uses for the $CO_2$ it captures, including providing it to algae-to-biofuel companies that could use the gas to speed growth of the plants they want to turn into fuel at commercially viable costs, Brown said.

The company's founders are Jason Bara and Dean Camper, two University of Colorado scientists with a long history in research into using ionic liquids for carbon capture. Their research has been published by the American Chemical Society and in other peer-reviewed journals.
http://www.greentechmedia.com/articles/carbon-capture-on-the-cheap-5766.html

# Is geothermal power really competitive?

2 March 2009
Although the environmental benefits of burning less fossil fuel by using renewable sources of energy—such as geothermal, hydropower, solar and wind—are clear, there's been a serious roadblock in their adoption: cost per kilowatt-hour.

That barrier may be opening, however—at least for one of these sources. Two recent reports, among others, suggest that geothermal may actually be cheaper than every other source, including coal. Geothermal power plants work by pumping hot water from deep beneath Earth's surface, which can either be used to turn steam turbines directly or to heat a second, more volatile liquid such as isobutane (which then turns a steam turbine).

Combine a new U.S. president pushing a stimulus package that includes $28 billion in direct subsidies for renewable energy with another $13 billion for research and development, and the picture for renewable energy—geothermal power among the options—is brightening. The newest report, from international investment bank Credit Suisse, says geothermal power costs 3.6 cents per kilowatt-hour, versus 5.5 cents per kilowatt-hour for coal.

| LCOE scenario analysis | High case ($) | Base case ($) | Low case ($) | Minimum ($) | Difference ($) |
|---|---|---|---|---|---|
| Solar PV (crystalline) | 201 | 153 | 119 | 119 | 82 |
| Solar PV (thin film) | 180 | 140 | 110 | 110 | 71 |
| Fuel cell DG | 117 | 90 | 72 | 72 | 46 |
| Solar thermal | 126 | 90 | 69 | 69 | 57 |
| Coal | 66 | 55 | 46 | 46 | 19 |
| Natural gas (CCGT) | 64 | 52 | 40 | 40 | 25 |
| Nuclear | 64 | 62 | 35 | 35 | 29 |
| Wind | 61 | 43 | 29 | 29 | 32 |
| Geothermal | 59 | 36 | 22 | 22 | 38 |
| Efficiency | 30 | 15 | 0 | 0 | 30 |
| Source: Credit Suisse | | | | | |

LCOE = levelised cost of electricity

That does not mean companies are rushing to build geothermal plants: There are a number of assumptions in the geothermal figure. First, there are the tax incentives, which save about 1.9 cents per kilowatt-hour. Those won't necessarily last forever, however—although the stimulus bill extended them through 2013.

Second, the Credit Suisse analysis relied on what is called the "levelized [*sic*] cost of energy," or the total cost to produce a given unit of energy. Embedded within this figure is an assumption that the money to build a new geothermal plant is available at reasonable interest rates—on the order of 8 percent.

In today's economic climate, that just isn't the case. "In general, there is financing out there for geothermal, but it's difficult to get and it's expensive," Geothermal Energy Association director Karl Gawell told *ScientificAmerican.com* recently. "You have to have a really premium project to get even credit card interest rates." That means very high up-front costs. As a result, companies are more likely to spend money on things with lower front-end costs, like natural gas–powered plants, which are cheap to build but relatively expensive to operate because of the cost of the fuel needed to run them.

"Natural gas is popular for this reason," says Kevin Kitz, an engineer at Boise, Idaho–based U.S. Geothermal, Inc, which owns and operates three geothermal sites. "It has a low capital cost, and even if you project cost of natural gas to be high in future, if you use a high [interest rate in your model] that doesn't matter very much."

Natural gas, which came in at 5.2 cents per kilowatt-hour in the analysis, is also popular because it can be deployed anywhere, whereas only 13 U.S. states have identified geothermal resources. Although this limits the scalability of geothermal power, a 2008 survey by the U.S. Geological Survey estimates that the U.S. possesses 40,000 megawatts of geothermal energy that could be exploited using today's technology. (For comparison, the average coal-fired power plant in the U.S. has a capacity of more than 500 MW.)

There's another significant issue: finding geothermal resources. In that way, the geothermal industry has the same challenges as the oil and gas industry. The Credit Suisse analysis doesn't factor in exploration costs, which can run hundreds of thousands of dollars for per well. "The United States Geological Survey estimates that 70 to 80 percent of U.S. geothermal resources are hidden," Gawell says. "You can't see it on the surface, and we don't have the technology to find it without blind drilling. ... Geothermal hasn't had the breakthroughs in geophysical science that the oil industry had in 1920s. We are still looking for where it's leaking out of the ground."

Despite these caveats, the new analysis is backed up by earlier ones, such as a 2006 Western Governor's Association (WGA) report on geothermal resources in the U.S. Southwest. Using nearly the same economic model, but assuming a higher cost of capital than the one used in the Credit Suisse analysis—in other words, the interest rate that is so troublesome in today's economy—the WGA found that geothermal could be produced from existing resources, using existing technology, for around 6.5 cents per kilowatt-hour, once a 1.9 cent per kilowatt-hour tax credit furnished by the federal government is included.

Although the WGA did not compare the cost of geothermal with coal directly, applying their assumptions to other forms of energy would boost prices across the board, especially for coal-fired plants, which are assumed to last for upward of 50 years. (The assumed 50-year life of a coal-fired power plant allows planners to spread the cost of their construction across an even longer period of time than geothermal plants, which are assumed to last less than half that long.)

Another potential stumbling block is reliability. Both the Credit Suisse and WGA studies assume that geothermal power plants are producing electricity virtually 24 hours a day, seven days a week. Larry Makovich, vice president and senior power advisor at Cambridge Energy Research Associates, believes this is an exaggeration. "They're assuming that if you put a megawatt of geothermal capacity in you're going to run over 95 percent of the hours in the year," Makovich says. "Here's the catch: if you look at actual electric production of geothermal in the U.S., it runs 62 percent of the time."

Other sources dispute this number—Glitnir bank, a financier of geothermal in Iceland and elsewhere, claims that geothermal plants are operational up to 95 percent of the time, and a 2005 paper (pdf) by academics in the field claims that in aggregate, geothermal plants in the U.S. produce power about 80 percent of the time.

What prevents geothermal plants from running continuously is the sometimes harsh nature of the steam on which they depend. "When you take steam out of the Earth it is different from taking steam out of a boiler from a coal or natural gas plant," Makovich says. "It's got a lot of other stuff in it." That "stuff" can include everything from silica and heavy metals to ammonia, depending on the source.

Geothermal advocates hope that many of these caveats become moot. A tax on the carbon emitted by power plants that rely on fossil fuel, for example, could increase the cost of coal so much that geothermal's issues become unimportant. A carbon cap-and-trade system similar to the one used in Europe would do the same. And state mandates that a certain percentage of energy come from green and renewable sources already seem to be having an effect. "It's been great to see a change in the market—the enthusiasm," says Kitz, who has been an engineer on geothermal projects since he graduated from college in 1985. "Five years ago I said everyone wants green power as long as it's not one one-thousandth of a cent more expensive than coal. Now people just want renewable power, period—It's nice to be loved."
http://www.sciam.com/article.cfm?id=can-geothermal-power-compete-with-coal-on-price&offset=2

# Straw biomass a bad performer claims EA

14 April 2009
The Environment Agency has attacked certain forms of biomass power generation for emitting "more greenhouse gas emissions overall than using gas". A report published by the Agency today identified straw-fired power stations as among the worst performers in achieving carbon emission cuts compared to fossil fuel use.

The government's pollution watchdog was calling for new rules requiring biomass schemes to report publicly on their emissions, including the production and transport of fuel to their plants. But in a report already inspiring national headlines suggesting "Biomass Worse Than Fossil Fuels" and **"Biomass Power Could Be Harmful"**, the Agency highlighted concerns about biomass projects shipping fuels in over long distances, and the use of nitrogen fertilisers in growing energy crops.

The report, entitled *Biomass: Carbon sink or carbon sinner*? was assembled by consultants at AEA Technology on behalf of the Agency, and is now being carefully digested by the renewable energy industry.

It said energy crops and waste materials "could play an important role" in meeting UK renewable energy and climate change targets, and concluded overall that: "Greenhouse gas emissions from energy generated using biomass are generally, but not always, lower than those from fossil fuels," the report states.

But, while it suggested using short rotation coppice chips to generate electricity could save between 35-85% fewer emissions than fossil fuel power stations, it added that straw-fired power stations could "in some cases" produce 35% more emissions than a combined cycle gas power station.

The best projects would save 98% of the equivalent emissions of a coal power station, it said, but projects shipping in energy crops grown thousands of miles away can reduce emissions savings by up to half.

Excessive use of artificial fertilisers in growing energy crops also has a "major impact" on biomass plants' carbon footprint, warns the report, as does using previously fallow land for energy crop cultivation.

The Agency wants the government to require biomass generators to publicly report greenhouse gas emissions from producing, transporting and using biomass fuels. But while its report recommends mandatory standards be developed for both large-scale and small generators, the Agency said standards should only be brought in if a sustainability reporting scheme fails to encourage good practice.

Such reporting systems are already being introduced in the biofuels sector under the supervision of the Renewable Fuels Agency, and are now being considered for biomass fuels by lawmakers in Europe.

The biomass sector already has a tool to help them calculate and minimise their emissions, called the **Biomass Environmental Assessment Tool**, available from the Biomass Energy Centre website.

"We want to ensure that the sector's growth is environmentally sustainable and that mistakes made with biofuels are avoided." said Tony Grayling, Environment Agency. More than three million tonnes of carbon dioxide emissions could be saved by encouraging good practice among the biomass sector in fuel production, processing and transport, the Agency's report concluded. Tony Grayling, head of climate change and sustainable development at the Agency, said: "We want to ensure that the sector's growth is environmentally sustainable and that mistakes made with biofuels are avoided, where unsustainable growth has had to be curbed.
"Biomass operators have a responsibility to ensure that biomass comes from sustainable sources, and is used efficiently to deliver the greatest greenhouse gas savings and the most renewable energy." Mr Grayling added: "The government should ensure that good practice is rewarded and that biomass production and use that does more harm than good to the environment does not benefit from public support."

As well as sustainability reporting, the Environment Agency also wants the government to bring in greater incentives for plants to make use of waste heat through combined heat and power (CHP) systems, perhaps through the forthcoming Renewable Heat Incentive or the existing Renewables Obligation.

The report suggests that if biomass power plants are not designed with the capability of at least retrofitting CHP systems in future, they risk becoming "stranded assets within 20 years".

Co-firing - the use of biomass fuels within coal power units - was seen by the report as a "good short-term measure" to reduce emissions, but that unless carbon capture and storage technology is deployed, "it does not have a long-term role". By 2030, the report predicted that the carbon intensity of the national grid would mean that "even with co-firing of biomass, coal-fired power stations will have to have carbon capture and storage operational".

The report predicts that 80 TWh (80 million MWh) of renewable electricity generation will be required from biomass power stations by 2020, just under a third of the UK's efforts in meeting its European renewable energy target for that year. http://newenergyfocus.com/do/ecco.py/view_item?listid=1&listcatid=32&listitemid=2501&section=Bioenergy%20%26%20Waste

# Student Bursaries for 2009-2010

Up to 6 travel and subsistence bursaries for up to £300 are on offer to bona-fide full-time students wishing to attend appropriate National and International coal-related conferences, such as the "8th European Conference on Coal Research and its Applications" to be held at University of Leeds in September 2010, (please see the Calendar of Coal Research Events for details of both this and other events at the end of this Newsletter). To apply, please send the abstract submitted to the conference with a brief supporting letter from your supervisor to:

Prof. J.W. Patrick
School of Chemical & Environmental Engineering
The University of Nottingham
University Park
Nottingham NG7 2RD

The bursaries come with no obligations to the recipient other than to supply a short essay about his or her impressions of the conference to the Newsletter for inclusion in the next edition.

# Update on new Research Fund for Coal & Steel (RFCS) Projects

The annual feature on new RFCS projects continues to be absent from this newsletter as previous sources of information are no longer available to the editor. If any reader is able to provide a source of the information the newsletter editor would be pleased to hear of it.

# CALENDAR OF COAL RESEARCH MEETINGS AND EVENTS

| Date | Title | Location | Contact |
|---|---|---|---|
| 31 May - 4 June 2009 | Clearwater coal conference: 34th International Technical Conference on Coal Utilization & Fuel Systems | Clearwater, FL, USA | Barbara Sakkestad, Coal Technology Association, 601 Suffield Drive, Gaithersburg, MD 20878, USA<br>Tel: +1 301 294 6080<br>Fax: +1 301 294 7480<br>email: Barbarasak@aol.com<br>www.coaltechnologies.com |
| 1-2 June 2009 | Coal: an answer to energy insecurity? | London, UK | Royal Institute of International Affairs, Conference Unit, Chatham House, 10 St James's Square, London SW1Y 4LE, UK<br>Tel: +44 20 7957 5753 Fax: +44 20 7321 2045 Email: conferences@chathamhouse.org.uk<br>Internet: www.chathamhouse.org.uk/coal |
| **11 June 2009 (Postponed due to clash of dates with an IPPC Meeting in Brussels)** | **The Integrated Pollution Prevention & Control Directive, (IPPC)** | **British Sugar plc, Holmewood Hall, near Peterborough** | **Dr Michael Whitehouse, 01793 894 118 e-mail micahel.whitehouse@rwenpower.com** |
| 7-10 July 2009 | 10th International Conference on Energy for a Clean Environment | Lisbon, Portugal | Instituto Superior Técnico, Mechanical Engineering Department, Av. Rovisco Pais, 1049-001 Lisbon, Portugal<br>Tel: +351 21 841 7378<br>Fax: +351 21 847 5545<br>email: cleanair@ist.utl.pt<br>rgesd.ist.utl.pt/cleanair |
| 21-24 September 2009 | 2009 International Pittsburgh Coal Conference | Pittsburgh, PA, USA | Conference Secretary, International Pittsburgh Coal Conference, University of Pittsburgh, 1249 Benedum Hall, Pittsburgh, PA 15261 USA<br>Tel: +1 412 624 7440<br>Fax: +1 412 624 1480<br>email: ipcc@pitt.edu<br>www.engr.pitt.edu/pcc/index.htm |
| 26-29 October 2009 | 15th International Conference on Coal Science & Technology (ICCS&T) | Cape Town, South Africa | Mrs Angelique Freyer, Syngas and Coal Technologies, Sasol Technology Research and Development, 1 Klasie Havenga Avenue, PO Box 1, Sasolburg 1947, South Africa<br>Tel: +27 16 960 4505<br>Fax: +27 11 219 1095<br>email: angelique.freyer@sasol.com<br>www.iccst.info |
| **November 2009 Date to be Announced** | **Coal Preparation Divisional Meeting Joint with the Mineral Engineering Society Southern Group and the South Midlands Institute of Materials, Minerals and Mining, (IoM3)** | **The Coal Authority, Mansfield, Nottinghamshire** | **Mr Andrew Howells E-mail : hon.sec.mes@lineone.net** |

| | | | |
|---|---|---|---|
| **September 2010 (Provisional)** | **8th European Conference on Coal Research & Its Applications** | **University of Leeds** | |