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NEWSLETTER

of the Coal Research Forum

A Happy New Year to All Our Readers

EDITOR'S COMMENTS:

Well, here we are in 2007 and, if it isn't too late, a Happy New Year to you all. So what do we think of it so far? What about the weather? Not only is the human race bemused by the unseasonably mild weather at this time but so are the animals and plants. 'Shall we hibernate or not?' say the squirrels, 'Is it spring yet?' say the daffodils, butterflies and flowers are still around and shops are overstocked with windscreen de-icer!! Whatever your views about the causes of climate change no one can doubt that, for whatever reason, it is happening. What can, and perhaps in my view more importantly, what should we be doing about it. On a personal note I feel that the evidence of mans impact on global warming is sufficiently convincing for it to be real. Although my heart says we should try to do something my head says 'But will it work?' A truly vast amount of money will be needed, not to say international commitment and co-operation, to halt the increase in greenhouse gas concentrations. And for what benefit? To preserve the status quo? I have to say I found myself, rather surprisingly, in agreement with someone interviewed by Mark Austin in ITV's 'The Big Melt' new feature last week who said that he felt that the costs would outweigh the benefits and could we not do better things with the money. I found it hard to disagree. That's not to say that we should ignore what is happening but if we think we can halt, let alone reverse, the onset of man-made global warming then I really have to admire their optimism.

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Meeting on "Low Carbon Economy"

The Coal Research Forum, together with the Coal Utilisation and Energy Conversion Technologies Subject Groups of the IChemE, is supporting a two day Conference on "Low Carbon Economy", being organised by the Environmental Protection Group of the IChemE.

This Conference has been arranged to take place at the Dunchurch Park Hotel, near Rugby on Wednesday 25th and Thursday 26th April 2007.

The Conference will review the latest Thinking and Knowledge over a range of inter related topics including meteorology, agreements and treaties, law and regulation, energy management processes, energy supply, techniques for electricity generation, carbon capture, hydrogen as fuel, transport developments, bio fuels, renewables and demonstrated low carbon successes.

Speakers include senior personnel from the IEA Greenhouse Gas Programme, the Energy Institute, the Electricity Generators, the Large Equipment Designers and Suppliers, Academia and Experts in Specialist Fields.

Attendance Charges have been kept down to offer maximum opportunity to attend. Members of any of the three groups (as described above, including the CRF), may register for one day at £95 plus VAT or for both days at £185 plus VAT.

Further information and registration forms are available from Gemma Jones at the IChemE., (Tel : 01788 578214), or from the Organiser, Clive Hadfield (Tel : 01455 552999, E-mail : chadfield@tiscali.co.uk).

2007 International Conference on Coal Science & Technology, (ICCS&T)

28th-31st August 2007
University of Nottingham

The Coal Research Forum is pleased to announce that the 2007 International Conference on Coal Science & Technology has been arranged, at relatively short notice, to take place on 28th-31st August 2007 at the East Midlands Conference Centre of the University of Nottingham. The Coal Research Forum strongly supports this conference and five Members of the CRF Executive Committee have been invited to join the Organising and Programme Committee for this event. The Coal Research Forum hopes that its Members will be able to attend this prestigious conference which has not been held in the UK for many years, where it was last held in the UK in Newcastle in 1991.

As for previous conferences in this series, all aspects of Coal Science and Technology will be covered, with special emphasis on clean coal and CO_2 capture. Conference headline topics are, Coal Structure and Characterisation; Coal Preparation and Beneficiation; Clean Coal Technologies and CO_2 capture; Pyrolysis, Carbonisation-Iron Making and Direct Liquefaction; Co-processing of coal with biomass, waste energy sources and plastics; Environmental Issues; High Value Products and By-products; Plant Impacts; Modelling; Sensors and Instrumentation and Coal and Society.

To register your interest in attending and for more information please visit: http://www.2007iccst.org/index.html

Student Bursaries for 2007

Up to 7 travel and subsistence bursaries of up to £300 each are on offer to bona-fide full-time PhD students of Coal Research Forum Members wishing to attend appropriate coal-related conferences. This funding will be provided equally from the Coal Research Forum and from the Coal Utilisation Subject Group of the IChemE. In particular, the Coal Research Forum wishes to encourage applications for these bursaries for attendance at this year's 2007 International Conference on Coal Science and Technology, (ICCS&T), to be held at the University of Nottingham on 28th-31st August 2007, (please see above). To apply for one of these bursaries, please send the abstract submitted to the conference with a brief supporting letter from your supervisor to:

Prof. J.W. Patrick
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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.

6th European Conference on Coal Research & Its Applications 5th – 7th September 2006

The early attendees for the 6th conference began to assemble at the University of Kent campus on a sunny afternoon in early September. The more energetic ones set off from Canterbury town centre on foot, the slightly less so, including your editor I have to say, opted for the comfort of a taxi! Well it was uphill and I did have a suitcase! Once settled into our rooms and having begun to find our way around the campus we were then encouraged to attend a welcome reception hosted by the University of Kent and Professor Yong Yan who was the conference the local organiser. The event proved to be excellent and all of those who arrived early were pleased they had done so.

The 6th was to be the first conference in this series where parallel sessions were to be used and the organising committee had this as an extra cause for concern over and above the usual organisational worries! In hindsight it must be said that our fears proved, by and large, to be groundless and this was in no small part due to the support from Professor Yan's team of helpers.

The formal proceeding began on Tuesday 5th in the Grimond Building where the delegates were welcomed by Professor Yan and Professor John Patrick, the Conference Chairman. The opening address was given by Mr Brian Ricketts, formerly of UK Coal and now resident in Paris and working at the IEA. It was entitled "Coal, Clean Coal and CO_2" and because I believe it to be an excellent summary of a vital topic, I have, with Brian's agreement included it almost verbatim and it is as follows:-

"The last twenty years have been pretty tough for coal in the UK. We witnessed a devastating, year-long strike in 1984/85, the demise of British Coal, the "dash-for-gas" during the 1990s, declining output as mine closures continued following privatisation at the end of 1994, and, more recently, environmental legislation designed to force the closure of older, coal-fired power stations. And I read last week that a band of environmentalists were hell bent on closing Drax, Western Europe's largest coal-fired power station. But perhaps most frustrating of all is the almost complete lack of public awareness about coal in the UK. After all, who cares where the electricity comes from – just so long as it comes out from somewhere behind our walls at home.

A rather different picture is emerging today. High gas prices mean that coal is back in the equation, underpinning over half of the UK's electricity generation last winter and a number of new, coal-fired generation projects have been announced. However, it is the global situation that interests us most at the International Energy Agency, so I'll not dwell on the UK scene.

First, a few words about the Agency itself, which celebrated its 30th anniversary in 2004. It was born out of the oil shock of 1973 – when oil prices quadrupled in less than three months following the Arab oil embargo, imposed by Saudi Arabia and others in response to Israel's swift and decisive victory over Egypt in the Yom Kippur war.

Not wishing to be ever again at the mercy of OPEC, members of the Organisation for Economic Co-operation and Development set up the International Energy Agency. Its key role remains the preparation of oil market information and "emergency preparedness". The latter includes the co-ordinated release of oil stocks following oil supply disruptions, where these exceed 7% of a member country's supply. Stocks are held by each of our 26 member countries who have all committed to having the equivalent of 90 days net imports at their disposal.

The IEA frequently tests its emergency response measures, but has rarely had to use them in anger. However, last year, following Hurricane Katrina, we did release 60 million barrels in response to the massive disruption to US oil supplies. This was just one of the many notable events to hit the IEA over the last year as energy ministers, presidents and prime ministers took a long, hard look at energy – for two reasons: the growing realisation that policies on climate change are not delivering, and because of high energy prices. After a decade or more of cheap energy, the spectre of the 1970s has returned to haunt us.

In real terms, oil prices have returned to the levels of the mid-70s, having quadrupled since the beginning of this new millennium; but, the circumstances today are very different and certainly more complex. Given this rather worrying picture, there is a renewed interest in coal which has many benefits.

Firstly, there is little concern about the availability of coal – it is abundant, relatively cheap, easy and safe to transport and store; and, in modern power stations, coal can be used cleanly to generate electricity.

Brian then presented a chart, which showed coal reserve data is shown coal resource data from the German Federal Institute of Geosciences and Natural Resources. The data it showed was for the top eleven countries in terms of coal reserves and helped to explain why certain countries of the world will continue to depend very heavily on their indigenous coal. For example, with its 96 billion tonnes of proven reserves, China has enough coal to last for 50-60 years at

current production levels and has vast resources that may be exploited in the future – resources second only to Russia in size. In total, the global reserve-to-production ratio is about 170 years, compared with 65 years for gas and just 40 years for oil. There is much to worry about in the future supply of oil and gas – reserves are concentrated, supply routes limited and demand rising quickly. 62% of the world's oil reserves lie in the Middle East and 73% of the world's gas reserves lie either in the Middle East or the Former Soviet Union. To meet growing energy demand, oil and gas producers in the Middle East and elsewhere must make significant upstream investments, yet there is no certainty that these investments will be made – a message that the IEA repeats to producing countries who need to become more open to foreign investment.

Moving back to coal; with so much of it easily available, it is perhaps not surprising that coal demand is rising quickly. Yet the magnitude of this growth and the environmental consequences should be of great concern to us. The IEA's World Energy Outlook provides many of us with a point of reference. The Outlook is based on two scenarios. In the Reference Scenario, essentially a business-as-usual scenario, world primary energy demand grows by one half between now and 2030 [an average rate of 1.6% per annum]. Fossil fuels meet most of the additional demand [83%]. Oil remains No. 1 – the single largest fuel, meeting the world's insatiable demand for transport fuels. Coal use is forecast to grow at 1.4% per year, from 4,000 mtce to 5,300 mtce by 2030, continuing to account for around one quarter of the world's energy supply. In the second scenario, or the Alternative Policy Scenario, energy and environmental policies currently under consideration in OECD countries are implemented and developing countries are assumed to adopt more energy efficient technologies.

However, the picture that is emerging is of a world where the polices assumed in the Alternative Scenario are not being adopted in the Western world; moreover, developing countries are following energy-intensive growth paths. The result … rapidly rising coal demand. Current demand already exceeds the Alternative Policy Scenario's figure for 2030, and growth rates over the last few years are substantially higher than anticipated. Since 2001/02, coal demand has risen steeply, at over 3x the rate of the previous 30 years. Unless something dramatic happens to the global economy, or population, coal demand is set to continue rising.

High oil and gas prices are, of course, helping to drive this demand for coal. But it isn't only economics; there are renewed concerns about the security of energy supplies. Once again, coal-to-liquids looks attractive as an alternative source for transport fuels. We see incentives for this in the USA; and, by 2020, China wants to be producing the equivalent of one million barrels of oil per day from coal. But coal-to-liquids will remain a niche market for coal, at least for the next decade or longer. Two-thirds of all the coal mined is used for power generation. It is, therefore, this sector which will continue to attract most attention.

The continuing growth of global energy demand raises some important issues: the ability to supply sufficient oil and gas, whether sufficient coal can be transported, and the almost exponential rise in CO_2 emissions from fossil fuel use. From a graph Brian presented it was possible to see that the growth in demand has led to a step change in coal prices. After many years of a general trend downwards, there was a price hike in 2003/04 that shocked most coal buyers. And the reason? Rapid economic growth in China, sucking in commodities and driving up coal prices and the rates for shipping coal.

Hard coal production, that's steam coal used for generating electricity and coking coal for steel making, is currently growing more strongly than at any time since the IEA was created in 1974. In 2005, production grew by a whopping 8%. In total, 5.9 billion tonnes of coal were mined in 2005 (5.0 hard + 0.9 brown), supplying 24% of the world's primary energy.

Oil's share of primary energy is greater at 34.4%, but why does it receive so much more attention from analysts, politicians and the media?

- Oil is a more expensive commodity, much more expensive right now.
- Unlike coal, ownership of oil reserves is concentrated.
- There is no alternative to oil for transport fuels (except coal liquefaction in South Africa and soon in China).
- Supply disruptions are felt quickly by the end consumer – I recall the 3rd conference in this series, at Aston University in 2000, which continued merrily along whilst the rest of the UK ground to a halt because the petrol pumps had run dry after just two days of disruption to supplies.

In contrast to the many headlines about oil, coal quietly underpins 40% of the world's electricity – a share that is likely to be maintained in the future as developing countries, such as China, move to alleviate poverty, especially through electrification. Chinese hard coal production has grown steadily over the last 30 years mainly from underground mines. It overtook US coal production during the 1980s when China became the world's largest producer. With its booming economy, production has risen strongly over the last few years, reaching almost two billion tonnes. Initially, there had been some questions marks over the accuracy of these statistics since some of the year-on-year growth rates looked remarkable. But the trend is now clear and the Chinese government reports that it expects production to continue growing and to reach 2.5 billion tonnes by 2010. China's total demand for energy in 2004 was 1.40938 Btoe. That is 62% of US energy demand, or 13% of total world demand. With such a large population, the per capita consumption of energy remains low by western standards at just 1.09 toe per head, compared with 3.91 toe here in the UK.

A pie chart was presented which showed a breakdown of China's primary energy consumption. Dominated by coal, but includes a substantial and growing demand for oil, mainly used in the transportation sector. Hydro electricity is an important energy source – with the Three Gorges Dam project being a notable example that is already operating, although it will be 2009 before all 26 turbine-generators of this US$25 billion, 18,200 MW project are commissioned. Not all of this energy demand is met from indigenous sources – China imports about half of its oil and, in the future, expects to import more oil and gas. It is already the world's second largest oil consumer after the USA, having surpassed Japan in 2003. As such, China's oil demand is a key factor in today's oil market. Coal demand is met predominantly by local production although China does import some coking coals and even some steam coal for power generation in the south of the country. In contrast to Europe, China is planning a future that is heavily dependent on coal rather than imported oil and gas. This growth is set to continue. New power plant construction in China is at an all time high this year. Between 2000 and 2005, China added an average of 27.5 GW of new coal-fired capacity each year. This year, it is likely to exceed 50 GW [70 GW reported] – that's as much coal-fired generation capacity as in the whole of Germany [54 GW] – all commissioned within the space of 12 months. Such capacity additions are a leading indicator of future coal demand. Plant built today will still be running in thirty years time, and many could still be running in fifty years. On this graph, we see just how ambitious the planned growth targets are for coal-fired generation in China and

India. They are based on high economic growth and, in the case of India, past performance suggests that they are unlikely to be met. In China, past performance suggests that they will be met. I'm not forecasting, merely reporting what is contained in government planning documents or "guidelines" as China now calls its 11th Five Year Plan.

To put Chinese growth into perspective, electricity generation across the OECD countries has been growing at just over 1% per annum. Between 2000 and 2004, OECD countries generated an additional 322 TWh from gas-fired plants, and an additional 136 TWh from coal. Over the same period, electricity output from coal-fired plants in China grew by 13% per year. In India, annual growth from thermal plants was 5%, predominantly coal-fired, but with some from natural gas. The combined growth of fossil-fired generation in all 30 OECD countries is swamped by the output growth in China alone. And the growth in India is not insignificant.

This does not bode well for future CO_2 emissions. These figures from the IEA Reference Scenario for carbon dioxide emissions are stark – emissions grow by over 50% from 24 Gt in 2003, to 37 Gt in 2030. When figures are published later this year for 2004 emissions, they will be above the World Energy Outlook's Reference Scenario. And continued high economic growth in China and India would ensure emissions stay above the Reference Scenario.

It is notable, but inevitable, that emissions from developing countries overtake those from the rich countries, or rather the OECD countries, during the 2020s. The increase in emissions from China alone exceeds the increases from all the OECD countries and Russia combined. And, as a non-Annex I signatory to the UN Kyoto Protocol, China does not have any binding target to reduce its CO_2 emissions. Even with these substantial increases, per capita emission from developing countries will still be four times lower than our own, in the OECD countries. These projections do not reflect the political desire to tackle greenhouse gas emissions and reduce the impact of climate change. There is an urgent need to adopt clean coal technologies in China and elsewhere, including technologies where CO_2 is captured and permanently stored in geological formations to stabilise CO_2 emissions at a much lower level.

Two clear actions are urgently needed : improve energy efficiency and deploy cleaner technologies. Improving the efficiency of electricity generation at coal-fired power plants demands that the best technologies are specified for new plants and improvements made at existing plants. The technologies exist to do this, but they are not necessarily economic, especially where coal is cheaply available (i.e. where there is little need to invest in high-efficiency plant). Ways must be found to encourage the very best technologies to be adopted in the market place. The scope of the IEA's G8 work programme includes inputs from IEA Implementing Agreements and advisory bodies. The IEA GHG R&D Programme in Cheltenham has commissioned an engineering and cost study on "capture ready" plant. The IEA Clean Coal Centre in London is building up its existing database of coal-fired power plants, to bring greater precision to the analysis, and is preparing a series of case studies at recently-constructed plants. The IEA Coal Industry Advisory Board is examining best practices at existing plants. The Secretariat in Paris will bring together this work on efficiency and CO2 capture and storage, including a study of the potential for retrofitting capture technology at existing plants, and report its findings in 2008 when Japan takes the G8 chair.

At the G8 summit at Gleneagles last summer, held under the UK's presidency, Africa and climate change were priorities chosen by Tony Blair. The communiqué issued at the summit by the G8 leaders is a landmark statement. For the first time, there is a consensus that the "*increased need and use of energy from fossil fuels, and other human activities, contributes in large part to increases in greenhouse gases associated with the warming of our Earth's surface*." There is now little argument amongst world leaders that CO_2 emissions are causing environmental harm. A plan of action accompanied the communiqué. It assigned certain tasks to the International Energy Agency and the Word Bank to tackle climate change. The plan is pragmatic in that it recognises that many of the world's major economies are heavily dependent upon coal, and that developing countries, including China and India, will want to further exploit their indigenous coal resources.

Looking firstly at efficiency. In electricity generation, there is a direct relationship between efficiency and CO_2 emissions per unit of electricity generated, as shown here. The very oldest coal-fired plants are inefficient. Just 25%, or even less, of the energy in the coal is converted into electricity. Three quarters of the energy is lost, mainly as waste heat in the cooling water and in the flue gases. The very best, state-of-the-art plants achieve an efficiency of 48% under ideal conditions of low ambient temperature and good quality coal. But these are extremes. The average efficiency of coal-fired power plants across the OECD is 37%, emitting just under one kilogramme of CO_2 per unit of electricity. In China it is 33% and in India, the average is 28%. The higher the steam conditions, the more efficient the plant, but the materials needed to withstand the higher temperatures and pressures make the plants more expensive. In Europe, the latest development work under the AD700 programme aims to achieve an efficiency of 53%. Coal gasification or IGCC can also deliver high efficiencies, although these plants are more complex. The choice of technology is driven by economics and, for most countries, supercritical is now the standard choice. Whilst ultra-supercritical and IGCC can reduce fuel consumption and emissions still further, few examples exist.

A plot of gCO2/kWh versus LHV (net) showed that the biggest gains come from replacement of old, inefficient plant. Indeed, replacing older, subcritical plants with new supercritical ones can typically reduce emissions by 20-25%, or by 45% in the case of the oldest plants. But this is rarely an option: with growing electricity demand, the old plants stay open, and we even see examples of closed plants being re-commissioned, for example in South Africa [Camden, Grootvlei, Komati] and the UK [Uskmouth in South Wales]. In China, the efficiency of new plants often matches that of recently-built plants elsewhere. In India, the performance of new plants could be better. The emission reduction gains of adopting state-of-the-art technologies for new power plant projects would amount to roughly 10%. Aside from the fact that this would not be economic, neither does it achieve enough. Greater gains can be achieved by replacing the thousands of small, old and inefficient plants that can be found in all countries. In China alone, there are over 8,000 units with a capacity below 200 MW, many below 20 MW. In the USA, the average coal-fired plant is over 30 years old. In developing countries, the Kyoto Protocol's Clean Development Mechanism should have encouraged this, but no coal-fired projects have been approved because of the difficulty of agreeing additionality and baselines. New policies and financing schemes are needed to secure the widespread replacement of old plant.

Improving efficiency and replacement of old plant do not, alone, reverse rising emissions. Only CO_2 capture and storage can do this, removing 90% or more of the CO_2 emitted from a coal-fired power plant. In one scenario from the IEA's

Energy Technology Perspectives book, published in June, 4 $GtCO_2$/yr could be captured from coal-fired plant by 2050 – that is the equivalent of 20% of the total CO_2 emissions [from fossil fuel use] in 1990. This is a technology with significant potential, a technology that can be demonstrated now, and a technology that must be adopted as one mitigation measure if CO_2 emissions are to be reduced. There are a growing number of demonstration projects appearing, Vattenfall, RWE, FutureGen, GreenGen... These are tentative steps, not all are fully funded, not all will go ahead, but with greater co-operation and collaboration, between governments and industry, and between nations, demonstrations of the key technology options could proceed. In fact, if there was more clarity about the future price that governments will impose on emitters of CO_2, these demonstrations would undoubtedly proceed. The G8 communiqué is clear – progress must be accelerated to allow the deployment of these technologies. So, the IEA will work with other international bodies, such as the Carbon Sequestration Leadership Forum and propose what policy measures are needed to achieve progress. The IEA believes that progress demands that 10 major power plants should be fitted with capture technology by 2015 to prove a variety of technologies with coal and gas. At the same time, the concept of a "capture ready" plant must be demonstrated because, until it is, every new coal-fired power plant built is locking-in CO_2 emissions for decades to come. New plants should be built with at least the option to capture CO_2 in the future.

Turning briefly to CO_2 storage. There are three large storage projects in the world. Sleipner in the North Sea where Statoil strips CO_2 from natural gas before re-injecting it into a deep saline aquifer, thus avoiding Norway's carbon tax; Weyburn in North America where CO_2 is sold from a coal gasification plant to enable enhanced oil recovery to take place from a Canadian oil field and at In Salah in Algeria, where BP re-injects CO_2 from natural gas production to avoid some very large emissions, a decision driven by the company's own corporate responsibility. Together, these projects store roughly the same CO_2 as that emitted from a single 500 MW, coal-fired unit at a power station. The challenge then, is to replicate such storage projects and capture a large part of the emissions from coal use. No small challenge.

The CO_2 challenge for coal 9,593 million tonnes of CO_2 released from coal use in 2003 c.3 million tonnes of CO_2 stored underground each year today.

We project energy demand will rise by one half over the next 25 years, mostly met by fossil fuels. However, with the rising CO_2 emissions from fossil fuel use, it is clear that "business-as-usual" is not a sustainable way forward. We should look to more radical policy actions and technology break-throughs to reverse the trend in CO2 emissions. This has to include more efficient, coal-fired plant, and CO_2 capture and storage; coupled with policies that recognise the global nature of the challenge and that are built on an international consensus.

If we are to avoid future conflict over supplies of primary energy and take some bold steps to protect the environment, then we must do so in co-operation with China. The G8 Action Plan on Climate Change is a step in that direction and the IEA will be working more closely with China and other developing countries including India. And what is expected of coal researchers, those presenting here over the next three days? You need to move ahead, taking some leaps and bounds to improve the clean coal technologies already available and to bring new technologies into the market place: improved efficiency, better pollution control, and viable CO_2 capture processes. But researchers also have a role in strengthening international relationships. The language of science is universal; it

is often much easier for scientists to meet and exchange their ideas and thoughts – as at this conference. Then, in a few years, the same people might be found at policy negotiations and the world is a better and safer place because of a common understanding. The challenge for coal is clear. So, press on with your endeavours and, together, we can make a difference. Thank you".

The parallel sessions then began and covered over the three days topics such as Monitoring, control and modelling, combustion, co-firing, image processing, trace elements, coal characterisation, gasification, fouling, slagging and ash, emissions – organics and NOx, carbon capture and storage, coking and blast furnaces and preparation and blending.

A poster session was held in the evening of 5th September followed by a buffet dinner. The conference dinner was held on the evening of Wednesday 6th September and was much enjoyed by all.

The closing address was given by Professor Jim Harrison on Thursday 7th September and the general consensus seemed to be that it had been a success and enjoyed by many.

There was a strong desire on the part of many delegates for the slide presentations to be circulated to attendees. This has not been the practice in the past but a view was reached that subject to the approval of the presenter the slides would be made available accessible to view at the Coal Research Forum's website. Work is in progress to determine which of the presentations may be included on the CRF web site. This will hopefully take place in the near future when the updating of the CRF website currently in progress is complete.

Joint Environmental Division and RSC Energy Sector Meeting

"Recent developments in CO_2 capture research for the UK power market" 15th November 2006

Such was the interest and timeliness of the subject matter given interest in climate change and the recent publication of the Stern report that the meeting, RWEnpower Didcot 'A' Power Station, was oversubscribed. This must be a record for a CRF meeting!

The meeting was opened by John Rainford, the Didcot station manager, who welcomed the attendees and explained some of the history behind Didcot's coal-fired power plant. Didcot 'A' is one of about a dozen 2,000MW coal-fired stations built in the 1960's to 1970's. Consuming around 800 tonnes of coal per hour it has been calculated that Didcot has consumed of the order of 92 million tonnes of coal during its lifetime. As an LCPD opt-out station Didcot is expected to have to close by 2015. However, since it was built a number of significant improvements to its performance have been introduced. For example, it now emits 80% less sulphur dioxide, 40% less NOx and 60% less particulate matter than when built. Like most UK coal-fired power station, Didcot has test fired a number of biomass-based fuels, originally in its small test facility, known as Baby Bio. A new £3.5M biomass plant has recently been completed which will allow Didcot 'A' to replace

10% of the coal it burns with carbon-neutral fuels such as biomass. John also reminded the audience of the recognised need for new generation capacity in the UK. Between 25GW and 35GW will be needed during the next 25 years. To put this into perspective John said this was equivalent to building a new gas-fired boiler plant like Didcot 'B' every 11 months, a new Sizewell 'B' nuclear station every 8 months or a new wind turbine every 11 hours! And on that sobering thought John handed over to the chairman for the first session Phil Evans, also of RWEnpower.

Phil made a brief mention of the planned developments that RWE were expecting to implement over the next few years. A coal-based IGCC plant scheduled for operation in Germany in 2014 and R&D in the UK will continue on climate protection focusing on oxyfuel firing and amine scrubbing at Tilbury.

The morning session involved presentations from industrial organisations. The first presentation was given by Scott Hume of Mitsui Babcock Energy Ltd, to be known as Doosan Babcock in January 2007 but still answering to the former name at this time! His talk was entitled 'Clean Coal Technologies for the UK'. Scott began by explaining that MBEL believed that to meet the requirements of the Energy White Paper a diverse portfolio was necessary together with a drop in energy demand by efficiency improvement. The UK energy gap by 2016 was said to be ~20GW and comprised 8GW closed coal stations, 3GW closed oil stations, 2.3GW closed Magnox stations and 7GW new plant requirements. It was felt to be too late for nuclear to fill the gap, and that the gap was too large for renewables. Gas could fill the gap but security of supply issues remain a serious risk. This situation requires new build plant and retrofitting of existing plant to meet the energy shortfall in an environmentally acceptable manner. The answer, MBEL believe, is to use CO_2 capture on new and retrofitted supercritical boiler plant.

Continuous improvement to plant efficiency was demonstrated by the progression from natural circulation, via once-through and supercritical technologies to the use of MBEL's ASC Posiflow vertical boiler tubing. MBEL have supplied nine different countries with SC plant including 24GW to China since 2001. By comparison with the UK, China is building 30GW to 40GW of new, coal-fired capacity <u>each year!!</u>

Carbon capture and storage will be necessary if coal is to continue to be used in the future and MBEL are leading a DTI project (407) which aims to demonstrate how to make ASC retrofits 'capture-ready'. Other project partners include Alstom, E.ON, Air Products, IC London and the sponsors are E.ON, DraxPower, EDF, SSE and RWE. CCS scenarios compared were ASC + amine capture and ASC + oxyfuel firing. The net efficiency for both systems was similar at about 35.5%. Indicative costs showed that SC capture-ready, new build investment costs were £850 to £950/kWe rising to £1,075/kWe with capture in place. Costs of electricity ranged from 2.8 to 3.3p/kWh capture-ready to 3.4 to 3.8p/kWh with capture in place. Retrofit SC capture-ready was £355 to £544/kWe rising by an additional £240/kWe with capture in place. Costs of electricity ranged from 1.6 to 2.5p/kWh capture-ready to 3.8 to 4.2p/kWh with capture in place.

Available data indicates that electricity generated from clean coal is less expensive than that from gas or wind and has the lowest cost of carbon abatement of available generation options.

Plans for ASC plant in the UK include one or two 500MWe capture-ready retrofits for Ferrybridge (SSE); 1,000MWe replant SC coal station at Tilbury (RWE) and 2 x

800MWe SC capture-ready new build (E.ON).

To summarise, coal will need to be used for power generation well into this century and the technology already exists for retrofit and new build application with CO_2 capture.

The second paper was given by Simon Maycock of Alstom and was entitled 'Alstom Clean Power Combustion'. He began by citing the market drivers which have resulted in the need for clean power combustion. These were the growth in GDP, the ageing fleet of current electricity generation plant, environmental pressures and deregulation. The present state of affairs is very challenging in that it requires limiting plant emissions while maintaining power plant economics. More specifically there is a need for near-zero emissions, the utilisation of all low cost domestic coal resources with the most competitive conversion costs. This must be done with the highest level of reliability with operating parameters appropriate for grid-based generation.

Alstom's view is that high efficiency PF firing offers the lowest cost of power and is available now. The best options for CO_2 capture from coal are advanced post combustion capture using chilled ammonia or newly developed amines and oxyfuel firing. Efficiency increases moving from subcritical to ultrasupercritical can yield up to 25% CO_2 reduction.

Improvements in power output, net efficiency and steam parameter with time were shown for Alstom's lignite fired steam generators. A similar time line showed decreases in NOx and sorbent use in the development of their CFB technology.

Alstom also suggested that oxyfuel firing was a realistic near-term solution to CO_2 capture as it would use existing air-fired PF combustion technology. Commercially available air separation units would provide the oxygen and the collection clean up and compression of the CO_2 produced is also readily available. A 30MWth pilot plant at Schwartze Pumpe is been developed by Vattenfall with start-up expected in 2008. Commercialisation is expected in 2016 to 2020 following larger scale trials in the intervening years.

Chemical looping combustion and chemical looping gasification were also presented as being topics for longer term development which would involve carbon capture, the hydrogen economy and power generation.

Alstom expect the emission of pollutants such as SOx, NOx, particulates and mercury to continue to be driven downwards by improving existing technologies and introducing multi-pollutant control which will also show a cost benefit.

An illustration of Alstom's Flowpac FGD system was provided which has been installed at one of the units at Karlshamn power plant. It was claimed that the system offered many benefits such as SO_2 emissions approaching zero with the use of adipic acid; high collection efficiency of SO_3 and particulate matter; low construction and maintenance costs and high availability. Data was provided which showed a greater than 99% SO_2 removal, ~70% removal of $S0_3$ and ~60% particulates from a 2.5% sulphur HFO.

Alstom are developing an ammonia-based system for CO_2 capture. A comparison was presented between the expected costs of removing similar amounts of CO_2 using the chilled ammonia system and Fluor Daniel's MEA extraction system. The chilled ammonia process showed a similar total power plant cost but lower

levelised cost of power (c/kWh), lower avoided cost ($/ton CO_2), lower CO_2 emission (lb/kWh) and lower parasitic costs (-41MW compared to -133MW). Commercialisation is expected in 2011 with phased development to take between then and now.

Simon closed his presentation by identifying Alstom's development priorities. These were he said; ultra super critical steam plant based on hard coal and lignite; multi pollution control for very low emissions of conventional pollutants; post-combustion CO_2 removal from both coal and gas plant; oxy-fuel combustion of solid fuel; fuel flexibility and H_2 for gas turbine; retrofit and new equipment solutions and continued research and development.

John Griffiths of Jacobs gave his talk entitled 'New coal plant for CCS'. Like some before him John opened with the drivers for UK power generation which were, in his opinion, energy resources, carbon emission abatement and generation capacity. He also highlighted the capacity gap which would result, if predictions were correct, in 'lights-out' in 2015.

In terms of the choice of plant John felt that renewables are unpredictable and insufficient, that base-load nuclear is not flexible in response and from this he concluded that there is an evident need for fossil fuels, including coal. Fossil fuels can only be accepted with CO_2 control and therefore Carbon Capture & Storage (CCS) is essential.

John pointed out that although projected supplies of gas look adequate and a number of new pipelines are now, or soon will be, linked to the UK this does not necessarily mean that the gas will be available to the UK. Other purchasers may be willing to pay more for the gas which would put it out of the reach of the UK.

In terms of options for coal-fired plant with CO_2 capture retrofitting conventional PF plant would require flue gas scrubbing and conversion to oxyfuel firing. For GT retrofits, the provision of a gasification module such as Jacobs GEM™ (gas enabling module) was suggested.

John also introduced a concept known as IGSC, (Integrated gasification single cycle). This process is based on a new burner developed in California by Clean Energy Systems Inc. (CES). It is derived from a rocket motor design and burns oxygen and syngas with water. The combustion products, (80% steam/20% CO_2) are fed into a steam turbine. The CO_2, which is the only gaseous emission from the plant, is removed from the condensate and the water recycled to the burner. Designs to incorporate this concept into full-sized power plant are being developed. These developments which are realistic and in various stages of maturity could also be applied to new-build power plant.

John then quoted the findings from a joint study by Jacobs E.ON UK and others in which the expectation of a continuing rise in the price of natural gas would make the use of syngas technically and economically feasible for gas turbine power generation.

A description of the three proposed IGCC plant for the UK was presented and suggestions were made for qualification of CO_2 capture-ready plant under section 36. In the view of Jacobs these should include adequate land space, the anticipated new output and efficiency of the plant, the commercially available technologies that are to be used, the completion of an EIA for the capture mode of operation and the predicted down-time to install capture facilities should be

indicated. And at that point John ended his interesting and thought-provoking presentation.

Robin Irons from E.ON UK followed up with his presentation entitled 'Evaluation of clean coal technologies in UK power plant'. Like earlier speakers Robin also identified the key drivers and scale and likelihood of the creation of an 'energy gap'. In terms of generation options considerations should include: Government Policy (including post-Kyoto position, Security of Supply) – the Energy Review; Environmental Performance; Commercial Viability (including cost of fuel and carbon); Public Acceptability (a factor for new nuclear?); Technology maturity (clean coal technologies, marine?); Reliability (e.g. the intermittency of wind, availability of IGCC); Extent of Deployment (can enough be built in time; e.g. small scale CHP, nuclear). Robin also indicated that replacement with gas-fired CCGTs will <u>not</u> reduce overall CO_2 emissions – and lead to ~70% gas dependency.

The twin track approach to meet CO_2 abatement targets using track 1 (efficiency improvements and the use of biomass) and track 2 (CCS) was also described. An interesting overhead was presented in which the relative price of gas and coal (x axis) and that of carbon dioxide (y axis) was depicted. The plot was split into four segments indicating the preferred choice of plant and was based on the combined effect of the two prices. High cost of carbon suggested CCGT firing with CCS; high price of gas suggested the use of coal without abatement of CO_2. At low carbon and low gas prices, unabated CCGT is the preferred option (where the UK market is positioned at present); whilst at high price of both, clean coal technology with CCS would be the preferred option.

The world price for nickel has been rising sharply and it was revealed that one large supercritical boiler may use 2% of world's annual production.

Concerns over oxyfuel combustion were raised such as: How high can the percentage O_2 be pushed? What is the optimum burner configuration? How will materials behave in high heat flux, high CO_2 atmospheres? Can systems be optimised for air/and O_2 comburents? How small can the boiler be made? What is the mineralogy of deposits in a CO_2 atmosphere?

Concerns over IGCC which still have to be addressed include: the operation of H_2 combustion whilst maintaining low NOx levels; the development of systems capable of dual-fuel operation (syngas/methane or methane/H_2); the demonstration of flexible operation and the delivery of acceptable reliability.

Robin briefly mentioned CO_2 storage and indicated that some recent progress had been made on the London Convention over the legal acceptability of seabed storage of CO_2.

Robin then moved on to describe the first proposed E.ON UK IGCC plant. The plant will nominally be a 450MW IGCC with CCS fuelled on coal which will either be built on or close to the existing Killingholme site. Multiple CO_2 storage options have been identified in the Southern North Sea (SNS). Killingholme is well positioned for CO_2 evacuation from Easington and Theddlethorpe. The vast majority of gas fields in the SNS are capable of storing CO_2 with a capacity of 2.8BT. The proposed plant will produce 3MT of CO_2 per annum. The feasibility study is now complete and front end engineering design should be complete by the middle of 2008. If a positive investment decision is taken the plant could be

commissioning by the end of 2011. Whilst recognising that this timetable is ambitions it is designed to ensure that E.ON remains a front-running utility on coal-based carbon capture. Clearly, however, there are factors that could cause delay.

Robin concluded his presentation by stating that the E.ON view is that coal will play a major part in the next portfolio of plants to be built world-wide. The technologies exist to make coal, potentially, a near-zero CO_2 emitter. There is no clear winner among the technical options for CO_2 capture. All the technologies under consideration offer major technical challenges. E.ON is developing a range of projects using different technologies to maintain continuity of supply and diversification of fuel.

A short video was presented which showed the changes proposed for Kingsnorth where the existing plant may be replaced by 2 x 800 MWe SC coal-fired boilers. The video indicated tower boilers but it was understood that no decision had yet been made on this matter.

After a break for a really excellent lunch the meeting reconvened with Michael Whitehouse chairing the afternoon session.

This began with the last presentation of an industry perspective as Richard Hotchkiss of RWE gave his talk which was entitled 'Major risk and uncertainties in applying carbon dioxide capture at Tilbury'. Mindful of our post luncheon languor, Richard began by taking us gently thorough some basic chemistry and engineering before getting into the more technical aspects of his work. Richard reviewed the carbon capture options and the risks and outlined R&D work planned for RWE's 0.5MWth combustion test facility. This work is to include oxyfuel and amine technology.

Although the use of gasification and the water shift reaction is the lead short-term large-scale CCS technology for RWE in Germany, (full flow capture from the start), there are other more attractive options for Tilbury. An overview of Tilbury showed that the site has 3 x 350 MWe units operating. It has opted out of LCPD so will have 20,000 hours of operation from 2008. One unit, Unit 7 is mothballed. It is a good site from the point of view of power demand and coal jetty and its current efficiency around 35%.

The clean coal strategy for Tilbury is a supercritical coal replant option for 3 or 4 units which will have a substantially lower capex than a green field coal station. As a minimum, the replanted units would have FGD, SCR and would be designed to be CO_2-capture ready. Part of the strategy is to assess the option of carrying out the replant with CO_2 capture equipment fitted on all units constructed or on all or part of a single unit at an early date. Questions that need to be asked are How many units, what size and when? What steam conditions? Risk v efficiency?

Generic risks for Tilbury are; planning permissions, especially for additional equipment; how can RWE optimise between minimum changes (lower planning risk) and best power plant. Should the process plant be inside a building or outside? Cooling water – currently direct cooled; EA and HSE constraints; stored/liquefied CO_2 issues; CO_2 transport and oxygen store for oxyfuel.

Richard then discussed the issue of where then CO_2 would go and there are sites in the North Sea. In respect of the laws regarding CO_2 storage there are many issues to be considered: Ospar and London convention against dumping at sea,

including under sea; London change agreed; does this cover CO_2 in oil wells? Is CO_2 for enhanced oil recovery different to storage? Is storage the same as dumping? Stored CO_2 a resource to be used to increase greenhouse effect during the next ice age? Do the conventions cover stores under the sea where the only access (pipe) is from land?

Efficiency and cost implications options for 'capture' compared to 'capture- ready' showed an increase in fuel required per kWhr of between 25 and 50% compared to non-CCS. This will increase the cost of generating electricity by 30 to 100%. What happens to the CO_2 once separated? Most of the CO_2 separated from natural gas at wellheads or landing sites is vented to atmosphere. The same appears to be true for food, drink and petrochemical industry. Richard completed his presentation with artist's impressions of the converted Tilbury site both in the summer and in winter when global warming has clearly been reversed!!!

This was followed by two offerings from the UK's academic community. The first was a summary of 'Recent university research on carbon capture' by Jon Gibbins of IC London. John began by describing his involvement with the UK Carbon Capture and Storage Consortium, which is part of the Councils TSEC Programme. John outlined the scope, structure and coordinators of the programme.

He then listed some of the project activities currently in progress. These were "Geochemical reaction rates during pore water acidification" from the School of Earth and Environment at The University of Leeds; "Relative permeability of mudstones" by the University of Newcastle upon Tyne; "Artificial soil gassing and response detection" by the University of Nottingham; "Ocean acidification: update on recent research developments" by the Plymouth Marine Laboratory; "CO_2 storage capacity of Esmond Field" by the Heriot Watt Institute of Petroleum Engineering, "Window of opportunity for CO_2 EOR" by the University of Aberdeen; "Adsorption for CO_2 capture" by the University of Nottingham and "Effect of coal type and oxyfuel combustion parameters on pulverised coal ignition" by Imperial College.

John then very briefly mentioned a number of areas of interest including the UKCCS consortium survey, capture-ready steam turbine options, and steam cycle efficiencies for capture-ready turbine options. John summarised his talk by saying that it had been a busy year! Carbon dioxide capture and storage is a big field and needs breaking down into subject areas. But there are big benefits from an integrated academic group. Industry links will be formalised early in 2007. There is a need to get ready for infrastructure developments and everyone is waiting for demo project progress!

The second academic presentation was from the University of Reading, given by Naser Odeh and entitled 'Life cycle analysis of coal-based power generation in the United Kingdom'. Naser explained that the objectives of his work were to examine the techno-economics of CCS, via an investigation into the extra cost of electricity and involving economic modelling and scenario analysis. In addition Life Cycle Analysis (LCA) of non-CCS and CCS technologies would be used to create a simple UK database. The work would then apply LCA methodology to modelling and scenario analysis.

As background for non-experts, Naser defined LCA as a systematic analytical method used to quantify the environmental benefits and drawbacks of a process. It can be performed on all processes of a system, cradle-to-grave, and resource extraction to final disposal. It helps to pinpoint areas that deserve special

attention and reveals unexpected environmental impacts so that research can be focused on mitigating them in order to avoid show-stopping surprises.

Data needed for LCA includes: location of power plant relative to mine, landfill and limestone quarry; train and truck capacities and fuel combustion rate (l/km); mining equipment requirements (in terms of tonnes of steel); energy (fuel & electricity) and material requirements for coal extraction and cleaning; limestone and ammonia requirements and amount of waste generated as a function of rated power (MW) or coal requirements; emissions factors for steel, concrete, aluminium (all in kg CO_2/kg of material produced); emissions factors for diesel and light fuel (in kg CO_2/ litre consumed); electricity emissions factor calculated from the fuel mix and typical emissions factors for coal/gas/oil/nuclear and renewables.

Upon completing the LCA analysis Naser found that indirect emissions from a typical UK coal-fired power plant are around 120 g/kWh (10 % of all LCEs). In the presence of CCS, emissions during generation decrease to a level where emissions from upstream and downstream processes (i.e. coal production and transport, waste disposal, etc.) become dominant and so the life cycle efficiency of the CCS system can be significantly reduced. Emissions from the construction of a power plant with CCS are expected to be negligible. However, emissions from pipeline and injection platform construction need to be considered. In power plants with CCS, operational emissions need to be traced back to emissions from the production of chemicals such as MEA or Selexol.

Naser concluded his presentation by identifying future planned work which comprises updating the database; applying LCA methodology to various fuel cycles with different technologies and modelling the performance and economics of power generation technologies with and without CCS.

The final presentation of the day was from Stanley Santos of the IEA Greenhouse Gas Project and was entitled 'Developments in CCS technology for power generation: An update to various international activities'. Stanley began by outlining the IEA GHG programme and its composition. He said that its main role is to evaluate without any bias technologies that could provide significant reduction to greenhouse gas emissions. Its main aim is to provide its members with up-to-date information on the role that technology can play in reducing greenhouse gas emissions. IEAGHG has completed more than one hundred member studies in the past 15 years. It also manages six research networks on CO_2 capture, oxy-combustion, biofixation, monitoring, risk assessment and well bore integrity. It also organises network workshop meetings.

Stanley then went onto provide an up-date view of post combustion capture. He described the CASTOR project which is at Esbjerg in Denmark and involves a pilot plant which captures ~1,000kg CO_2 per hour. It is coal fired, produces ~5,000Nm3/h of flue gas and started operation in March 2006. In Japan, Mitsubishi have many years experience in CO_2 capture and have designed large commercial scale plants for this purpose.

Mitsubishi have also constructed a pilot plant for CO_2 recovery from coal fired boiler flue gas in Nagasaki, Japan using KS-1 solvent with a capacity of 10 tonnes per day. This demonstration plant aimed at long-term operation was constructed with support from the Japanese Government (50%).

Stanley highlighted Alstom's USA activities using the chilled ammonia process which was described earlier by Simon Maycock.

In Australia the $500 million Low Emissions Technology Demonstration Fund is a flagship initiative of the Australian Government's Energy White Paper*:* Securing Australia's Energy Future. The Fund will support the commercial demonstration of technologies that have the potential to deliver large-scale greenhouse gas emission reductions in the energy sector; it is designed to leverage $1 billion in additional private sector investment. One of the first awards was $50 million towards a $360 million pilot for a brown coal drying and a post-combustion carbon dioxide capture and storage project at the International Powers' Hazelwood facility in Gippsland. Construction is to begin early next year with the project to be completed by the end of 2009. This project has also attracted Victorian state government funding. This was said to be the world's largest amine pilot plant for coal but the majority of the funds are to be spent on the drying side not on CO_2 capture.

Moving on to oxyfuel firing Stanley described the R&D in progress in Europe including Vattenfall's project at Schwarze Pumpe. A number of operators are planning tests, i.e. E.ON's 1MW and RWE's 0.5MW combustion test facilities and MBEL are planning a 60MW burner test in 2007-2008.

The Australian Government recently, (October 2006), announced a $50 million grant from LETDF to support the Callide-A Oxy-Combustion Retrofit Project which is a collaboration between IHI (Japan) and CS Energy (Australia). The project is also supported by the Australia Coal Association, JCoal and JPower (EPDC).

In October 2006 SaskPower (Canadian) announced the choice of oxy-combustion for its 300MWe Clean Coal Project (in co-operation with Babcock and Wilcox and Air Liquide). It was said that SaskPower is moving to a 400MWe oxyfuel plant by 2010. In addition, Jupiter Oxygen (USA) intended to develop a 26MWe Retrofit Project in co-operation with NETL, Ohio Air Quality Development Authority and Orville Utilities.

Stanley identified the four key outstanding issues for oxyfuel firing. One of these was air ingress. It is estimated that every 1% of air ingress is equivalent to about a 4% reduction of the CO_2 concentration in the flue gas. Several failures have been noted from previous test where the desired concentration of CO_2 was not achieved due to air ingress. It was felt that this is a big challenge especially when retrofitting a power plant.

The second issue is boiler and burner development. He feels we need to build our confidence in running an oxy-fired burner/boiler especially at the same scale of our current PC boiler. Various technical issues have been clarified including heat transfer aspect, ash and slagging, equipment scale-up, but more work remains to be done. For example, the largest oxyfuel fired burner test (to this day) was done by International Combustion Ltd in the UK during the 1990's but we still have much to learn.

The third issue is the cost of producing oxygen and the fourth involves SO_3. In the opinion of Stanley the SO_3 issue is the big missing link! A study by ANL study (1985) indicated that SO_3 formation is 3 to 4 times greater than that from conventional firing. We need to know more about this potential serious operational issue.

Moving on to pre-combustion capture Stanley described IGCC plant without

capture systems. Coal-based IGCC demonstration plant operates in the USA, (Tampa-250MWe, Texaco since 1996 and Wabash River-262MWe, Dow since 1995), Netherlands (Buggenum-250MWe, Nuon) and Spain, (Puertollano-300MWe). Despite large scale experience with this type of plant IGCC is not at present the preferred technology for new coal-fired power plants. The main commercial interest in IGCC is for use of petroleum residues and several plants have been built and are planned at refineries. IGCC has a small advantage over PC plant when CCS is added.

In conclusion, Stanley summarised his talk by saying that several activities have been initiated worldwide in the development of Carbon Capture for Power Generation industry. All options for new-build and retrofit plant are still in contention at the moment! We need large scale demonstration of carbon capture technology to build the confidence necessary for a rapid deployment. We must accelerate the take up of clean fossil – this will require worldwide efforts.

The event was wound up at about 4pm by Michael Whitehouse who thanked the speakers for their efforts. He, in return, was thanked for organising the meeting, and this was echoed by the audience who, I'm sure would have all agreed that it had been an interesting and worthwhile day.

FP7 TAKES OFF

2 January 2007

The EU's largest ever funding programme for research and technological development, the Seventh Framework Programme (FP7), was launched on 1 January. The programme cleared its final hurdle when it was adopted by the Council on 18 December 2006. The decision was widely expected following an agreement on a common position between the Parliament and Council in November. The common position meant that the decision could be adopted by the Environment Council without discussion. With a total budget of €50.521 billion, FP7 will run for of seven years. An additional €2.7 billion has been earmarked for the Euratom programme on nuclear research, which will run for five years. EU Science and Research Commissioner Janez Potocnik hailed the FP7's approval as 'great day' for European Science. 'In financial terms, this is a major improvement over the last framework programme. In real terms, there are 40 per cent more funds on average per year,' he said.

FP7 will aim to build on the accomplishments of the previous research framework programme, and will be implemented through four specific programmes. The 'Cooperation' programme will support research cooperation in a number of key thematic areas. 'Ideas' will fund investigator-driven research through a newly created European Research Council (ERC). The 'People' programme will support training and researchers' career development, while 'Capacities' will fund the coordination and development of research infrastructure, regional research clusters, international cooperation and closer ties between science and society. Featuring simpler instruments and streamlined procedures for funding and participation, FP7 should facilitate the greater participation by and cooperation between universities, research centres, small and medium sized enterprises (SMEs) and companies on a broad range of research areas. In doing so, the new programme should make headway on the goal of creating a European Research Area (ERA) - the equivalent of a 'common market' for research - to become the world's leading research area. Under FP7, the highest portion of the budget will go to information and communication technologies (€9.11 billion), followed by health (€6.05 billion), transport (€4.18 billion) and nanotechnology (€3.5 billion), energy (€2.3 billion), and food, agriculture and biotechnology (€1.935 billion).

Other budget lines include environmental research (€1.8 billion), space (€1.43 billion), security (€1.35 billion), and social-economic sciences and humanities (€610 million). Political discussions on FP7 were first held back by the lack of agreement on the EU's financial perspectives for 2007 to 2013. Consensus among the EU's Heads of State and Government on the overall budget was needed before the FP7 budget could be set. Subsequent negotiations addressed ethical questions related to EU funding for human embryonic stem cell research, the structure of the ERC and the risk-sharing finance facility.
For further information, please visit: http://cordis.europa.eu/fp7

Coal waste could heat homes

January 12, 2007- C.M. Mortimer - TRIBUNE-REVIEW

Two clean-power generation technologies being developed by Consol Energy Inc. could someday heat the homes of Pennsylvanians and help generate power to meet anticipated demand, experts said Thursday. One of the projects is a first-of-a-kind, micro-turbine generator built to use unprocessed coal mine methane gas directly from an underground mine to generate electricity. The other project is a test facility that generates power from waste coal and other fuels. It uses a pressurized boiler that reduces sulfur dioxide emissions by 95 percent. Both projects were dedicated yesterday at Consol's Research and Development facility in South Park. Consol is the only coal company in the U.S. with its own research and development department.

"Impressive and economically exciting. This is real bread and butter for our economy," Kathleen McGinty, secretary of the state Department of Environmental Protection, said at yesterday's dedication. The U.S. Department of Energy in November awarded $1 billion in tax credits to promote clean-coal power generation. The Energy Policy Act of 2005 authorized the Department of the Treasury to provide tax credits as incentives to move advanced technologies to the market.

The federal energy department's Office of Fossil Energy typically manages more than 500 active research and development projects, spanning a wide range of coal, pretroleum and natural gas projects. Coal burned at power plants produces 52 percent of the nation's electricity. "There's no one silver bullet to get control of the future energy situation, but it's possible to capture carbon dioxide and technology needs to move in that direction. Advanced clean-coal technology does pretty good, but we're hoping for no emissions at some point," said Thomas Tuffey, director of Citizens for Pennsylvania's Future's Center for Energy, Enterprise and the Environment.

Consol worked with Pressurized Fluidized Bed Combustion-Environmental Energy Technology, Inc., based in Monessen, to help with the design and construction of a process test facility, the first phase of the project. In April 2005, the project received a $1.64 million grant from the state.

The test facility is capable of burning a wide variety of Pennsylvania waste coals with the objective of providing combustion and emissions data needed to design and build commercial-scale, pressurized fluidized-bed, electricity-generating units. "This is a trend that has been going on since people began burning coal, and there are a number of clean-coal projects out there," said Steven E. Winberg, general manager of Consol's research and development. He estimates there are

roughly four to five billion tons of waste coal in Pennsylvania. Winberg said clean coal technology essentially is divided between technologies that burn coal waste and retrofit technologies for reducing emissions. He said the 1990s focused on the acid rain issue, and today many projects involve deep reductions of sulfur dioxide, nitrogen oxides and mercury emissions.

U.S., Japan To Increase Energy Research Cooperation

By Kathryn McConnell -USINFO Staff Writer.
The two countries, both major energy consumers -- "recognize that improving energy efficiency and diversifying their energy mix ? are essential for ensuring the mutual energy security", according to an Energy Department statement. One key effort will be collaboration on research and development to support the construction of new nuclear power plants and more cooperative research in civilian nuclear energy technologies, Bodman said at a January 9 press briefing in Washington.

Bodman was joined at the briefing by Japan's minister of economy, trade and industry, Akira Amari, following a meeting between the two earlier that day. The United States and Japan are developing a joint nuclear energy action plan expected to be completed by April, Bodman said. Japanese engineers have "enormous technical skills" to bring to the collaborative efforts, Bodman said. The announcement of more cooperation is a "turning point in energy policy," Amari said. Japan also agreed actively to participate in the FutureGen Project, a U.S.-sponsored initiative to build the world's first emission-free coal-fired electricity generation plant. FutureGen is a $1 billion, 10-year public-private partnership begun in 2003.

The United States and Japan will accelerate research and information exchanges between the public and private sectors in clean coal technologies such as the integrated gasification combined cycle (IGCC) and carbon capture and storage (CCS). IGCC is a clean coal technology that turns coal into a gas, and then removes impurities from the coal gas before it is combusted. Carbon capture and storage (CCS) captures carbon dioxide emissions from major sources, such as power plants, and stores it away safely instead of releasing it into the atmosphere possibly affecting climate change.

The countries also will continue to exchange research information on methane hydrates, specifically in production testing and detection, to accelerate the feasibility of commercial methane production, Bodman said. Methane hydrates are energy-rich compounds of methane trapped in sediments underneath oceans and polar permafrost. (USINFO is produced by the Bureau of International Information Programs, U.S. Department of State. Web site: http://usinfo.state.gov)

Coal gasification technology for China

18th January 2007
Siemens Power Generation (PG) has been awarded a contract by Shenhua Ningxia Coal Industry Group Co Ltd (SNCG) in China to supply two entrained-flow gasifiers with a thermal capacity of 500 MW each and further key equipment for a

coal gasification plant. The coal gasification plant is to be used for the Shenhua Ningmei DME project in Ningxia Province in northwestern China.

When the plant is ready to operate in early 2009, Shenhua Ningmei DME will produce 830,000 tons per year of the clean, environmentally-friendly synthetic fuel dimethyl ether (DME). The contract is worth about EUR30 million for Siemens. As a low-cost, widely available fuel, coal is destined to play an important role in meeting the world's future energy needs. From the standpoint of environmental and climate protection considerations, techniques like coal gasification and liquefaction are gaining preference.

In addition to being the world's second-biggest energy consumer, China also happens to have some of the world's largest reserves of coal, along with the United States and Russia. Coal is used to satisfy 76 per cent of China's primary energy consumption and 70 per cent of its electricity generation. In view of the country's fast-rising energy consumption and the fact that it does not have ample reserves of crude oil and natural gas, China is investing heavily in the production and processing of coal. Besides being used for power generation, coal is also increasingly being used to produce synthetic gases and as a source of carbon for the chemicals industry.

Siemens Power Generation

http://www.engineerlive.com/news/17072/coal-gasification-technology-for-china.thtml

Global Potential of Coal Bed Methane
New Report Examines Market Potential

Phoenix, AZ – January 17, 2007 –
Coalmine methane (CMM), for centuries the bane of canaries and miners, now offers potential as an alternative fuel source. A new report from Energy Business Reports examines the market potential for this energy source (www.Energybusinessreports.com).

Coal bed methane (CBM) refers to methane deposits in the pores of coal seams. The methane is in a near-liquid state, contained in tiny pockets within the coal. Coalmine methane (CMM) is released when coal is fractured during mining operations.

Seen in the past mainly as a safety hazard for coal miners and a costly nuisance for mine operators, CMM is now being widely studied and exploited. A number of countries are currently exploiting CMM, including Australia, the Czech Republic, France, Germany, Japan, Poland, the UK, and the U.S. Globally, recovery projects utilize three distinct types of coal bed methane to varying extents: Drained coal mine methane gas from active mines (or drained gas); collected methane from abandoned mines (AMM); and captured ventilation air methane (VAM). Three commercially available technologies can be used to generate power from drained CMM – internal combustion engines, gas turbines, and microturbines.

There are a variety of profitable uses for CMM, including natural gas pipeline injection for resale, fuel for on-site or off-site electricity production, fuel for co-firing boilers, fuel for on-site or off-site heat, and use as an industrial feedstock. Capture and use of CMM has benefits for the local and also the greater global

environment, including the mitigation of greenhouse gas emissions and the utilization of an otherwise wasted clean energy resource. In addition, other ancillary benefits can include improved mine safety and mine productivity as well as energy and economic independence.

There are a number of negative environmental impacts associated with capture and use of CBM/CMM including climate change, effects on drinking water, air quality, and surface disturbances. Nevertheless, the sharp rise in energy prices has renewed focus on coal bed methane and coalmine methane projects in coal-producing countries around the world. Additionally, several other factors have prompted a resurgent interest in CMM projects. First, the steep growth in global energy demand has catalyzed the search for new, unconventional sources of natural gas and power. Second, programs, such as the Kyoto Protocol's Clean Development Mechanism (CDM) and Joint Implementation (JI), have created financial incentives to develop projects that reduce greenhouse gas (GHG) emissions. Third, multi-national collaborative initiatives such as the Methane to Markets Partnership have focused on overcoming the policy, regulatory, legal, and technical barriers that inhibit project development.

CBM/CMM utilization projects are in the operational, development, or planning stages in at least 13 countries. The total methane emission reductions that could be achieved by these projects are approximately 135 billion cubic feet (Bcf) per year (equal to 14.8 million tons of carbon equivalent per year). This global activity level reflects a growing awareness of the technological practicality and the economic attractiveness of coalmine methane recovery and use.

The U.S. EPA's Coalbed Methane Outreach Program (CMOP) estimates that there are over 200 CMM projects in operation around the world. Many more project opportunities exist, especially in developing countries and countries in transition. These opportunities are being eagerly pursued and encouraged by project developers, technology vendors, coalmine companies, and government officials.

About the Publisher: "The Global Potential of Coal Bed Methane" is published by Energy Business Reports (www.EnergyBusinessReports.com), an energy industry think tank and leading source for energy industry information and research products. Other reports available from EBR include: Business Process Outsourcing for Utilities, Bitumen Recovery and Technology, The Market for Cellulose Ethanol, The Potential of Oil Sands as an Energy Source, Weather Risk Management, Natural Gas Storage Effects on Energy Trading, Fuel Cell Technology, The Outlook for Unconventional Gas, Securing Energy Assets and Infrastructure, The Market for Solar Photovoltaics, and Understanding the China Energy Market. This report can be ordered at www.CBMPotential.com

Update on current EPSRC Energy Projects

(as of January 2007)

AURA-NMS: Autonomous Regional Active Network Management System	Professor T Green	2,512,336
Chair in Power System Engineering	Professor D Kirschen	818,336
Delivering sustainable water systems by optimising existing infrastructure via improved knowledge, understanding and technology - project NEPTUNE	Professor NJD Graham	2,326,981
Energy project officer	Professor G Tomlinson	80,191
Energy research development manager at Imperial College London (Linked to EP/E011705)	Professor NP Brandon	193,377
EPSRC - Energy Research Senior Fellow	Professor NP Brandon	1,029,817
EPSRC Star Academic Proposal	Professor J McDonald	709,745
High Throughput Synthesis and Screening of Novel Hydrogen Storage Materials	Professor WIF David	243,193
High Throughput Synthesis and Screening of Novel Hydrogen Storage Materials	Professor P Edwards	485,413
International Networking for Young Scientists Working on Renewable Energy - China:UK Partnership - Revision 3	Dr R Wallace	10,714
Keeping the Nuclear Option Open	Professor RW Grimes	6,114,715
Seminar for the Next Generation of Researchers in Power Systems	Professor D Kirschen	18,086
Small Scale Biomass-Fired CHP System	Dr H LIU	134,976
SUPERGEN - The Energy Storage Consortium	Professor MS Islam	2,156,535
SUPERGEN 1 Renewal Core - FlexNet: Renewal of the Supergen consortium on Future Network Technologies	Professor J McDonald	6,974,971
Supergen Marine - Core	Dr R Wallace	5,539,980
The Supergen5 Biological Fuel Cells Consortium	Professor FA Armstrong	2,022,490
UK-Japan Hydrogen Storage Research Network	Dr D Book	143,919

Wind Energy Technologies	Professor P J Tavner	2,552,788

Total number of projects: **19**

Total value of support **£34,068,550**

Please 'click' on the Project Titles for more details

CALENDAR OF COAL RESEARCH MEETINGS AND EVENTS

Date	Title	Location	Contact
7 Feb 2007	2nd international conference on underground coal gasification	London	Rohan Courtney, UCG Partnership Limited, Coronation House, Guildford Road, Woking GU22 7QD, UK Tel: +44 1483 832 227 Email: rohan.courtney@ucgp.com
21-22 Feb 2007	EuroCoal 2007 conference	Berlin, Germany	Julia Meurer, Euroforum Deutschland GmbH, PO Box 111234, D-40512 Duesseldorf, Germany Tel: + 49 211 9686 3433 Email: anmeldung@eurofurm.com
Monday 16th April 2007	**Coal Research Forum Annual Meeting, Coal Utilisation Subject Group Annual Meeting and Combustion Divisional Meeting, title to be announced**	**Department of Mechanical Engineering, Imperial College London**	**Dr David J A McCaffrey The Coal Research Forum P.O. Box 154 Cheltenham GL52 5YL Tel: 01242 236973 Fax: 01242 516672 E-mail: mail@coalresearchforum.org**
25-26 April 2007	**"Low Carbon Economy" organised by the Enivronmental Protection Subject Group of the IChemE and supported by the Coal Research Forum.**	**Dunchurch Park Hotel, Dunchurch, Near Rugby, Warwickshire**	**Mr C Hadfield Tel: 01455 552999 Email: chadfield@tiscali.co.uk**
7-11 May 2007	World Of Coal Ash 2007 Conference	Cincinnati, OH, USA	Michael MacDonald, American Coal Ash Association, 15200 East Girard Avenue, Suite 3050, Aurora, CO 80014, USA Tel: +1 720 870 7897 Fax: +1 720 870 7889 Email: wocainfo@acaa-usa.org Internet: www.worldofcoalash.org

15-17 May 2007	3rd International Conference On Clean Coal Technologies For Our Future	Cagliari, Sardinia, Italy, Consulcongress Srl, Via San Benedetto, 88-09129 Cagliari, Italy	Tel: +39 070 499242 Fax: +39 070 485402 Email: info@cct2007.it Internet: www.cct2007.it
Provisionally Wednesday 20th June 2007	**Advanced Power Generation Divisional Meeting - Title to be announced**	**Rugeley Power Station, International Power plc.**	**Mr P W Sage** **Tel: 0870-190-6243** **E-mail:** **peter.sage@aeat.co.uk**
28th - 31st August 2007	The International Conference on Coal Science and Technology, (ICCS&T), 2007	The East Midlands Conference Centre, The University of Nottingham, Nottingham	Dr A J Wickham Conference Management P.O. Box 50 Builth Wells Powys LD2 3XA E-mail: confer@globalnet.co.uk or info@2007iccst.org
November 2007, (Date To Be Announced)	**Coal Preparation Divisional Meeting Joint with the Minerals Engineering Society Southern Group**	**The University of Nottingham, Nottingham**	**Mr Andrew Howells** **E-mail:** **hon.sec.mes@lineone.net**
3rd - 5th September 2008	**7th European Conference on Coal Research and its Applications**	**University of Cardiff**	**Dr A W Thompson** **Tel: 0115-936-2351** **or 01332 514768**