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NEWSLETTER

of the Coal Research Forum

Editor Alan Thompson wishes all our readers belatedly!

EDITOR'S MUSINGS:

It is my genuine hope that all of you have enjoyed a pleasant and enjoyable break over the Christmas period, I know I have, even though it seems an awfully long time ago!! At least this year our festive turkey did not go cold as the horrific images from the Asian tsunami were broadcast on television. Although the events in south East Asia were probably unrelated to climate change the record numbers of tropical storms and hurricanes which hit the US last year show just what Nature is capable of. We already have a good idea of what might happen if we fail to control greenhouse gas emissions so I ask the question "Will the actions of mankind ever be able to bring about a positive change in the weather?" Even with the fanciful notion of a concerted effort by all nations I personally very much doubt it. It is not that I don't think we should try to limit the man-made emissions of greenhouse gases, I think we should. And improving process efficiency obviously makes a lot of sense. I just fear it is beyond us and I think we should try harder to learn how to adapt to living with these effects – just in case Mother Nature refuses to be controlled!

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"Clean Coal – A Contradiction in Terms or a Real Sustainable Power Generation Option"

by Dr Allan R. Jones, E.ON UK plc
53rd BCURA Robens Coal Science Lecture:

Monday 10th October 2005

Unfortunately, your editor was unable to attend in person, although the consensus view after speaking with those who did hear the talk was that it was well worth the cost of the ticket (only kidding Allan!). I and I'm sure many others were very pleased to find that Allan's slide presentation is to be found on the BCURA website under:
http://www.bcura.org/csl05.pdf

The presentation summarises all of the important issues of coal combustion; from its composition and image problem, through the development of coal-fired power generation from early days up to the present, how clean-up of the various pollutants was tackled to today where energy supply and climate changes are now much to the fore. Allan's conclusions are that coal has successfully cleaned up its act over the years and that technologies exist (despite what George W. might think! Ed.) for near-to-zero emissions from power generation plant. The necessary stimulation in investment in generation will follow from clear Government direction regarding the future energy mix and the right market conditions, specifically stability. Clean coal technology can provide a hedge against gas price movement, the intermittency of renewables and the public uncertainty over nuclear generation. Furthermore, the developed world must be able and willing to help the developing world to be able to reduce its considerable impact on global warming.

I suggest that this set of slides would be a very useful introduction to anyone new to the trials and tribulations of coal-powered generation whether in industry or academe.

"The Future for Coal in Power Generation with Carbon Abatement"

a one day seminar held at 1, Portland Place, London
courtesy of the Institution for Chemical Engineering,

30th November 2005.

This seminar was arranged by the Energy Conversion Technology Subject Group with help from the Coal Utilisation Subject Group in association with the Coal Research Forum. The intention was to provide speakers from Government, industry, the EU and academe who would present the latest thinking on technology options, environmental issues and economic appraisal.

The Chairman, Professor Jim Harrison, welcomed the delegates and introduced the first speaker, Peter Sage of Future Energy Solutions. Peter spoke on the UK CAT Strategy and provided an update on the FENCO

Initiative. Peter spoke at some length to describe the background to the UK CAT strategy document which was issued in June 2005. He described the scope of the strategy and how there are three approaches that have been identified, namely CO_2 capture and storage, (90% reduction in CO_2 emission), improvements in efficiency (15% to 20%) and co-firing (5% to 10%). Peter also highlighted the currently open call for proposals from the DTI Technology Programme detailing deadlines, scope of proposals and the amount of funding available.

Peter concluded his talk by saying that the CAT strategy is looking long term (10 year programme) and includes support for demonstration for the first time, which is something to build on. It aims to strike the right balance between technical and non-technical areas for action. The programme will be industry–led and its success will depend on industry coming forward with innovative projects. CAT's involve big investment and the programme emphasises international collaboration – the DTI is a partner within the FENCO-ERA CA initiative.

This was followed by a talk entitled "Coal-based technology R, D&D needs within Europe" by Andy Minchener, of Andalin Consultants. The work described was carried out as part of the EC's POWERCLEAN Thematic Network Programme. He explained that there are three Thematic Networks which link fossil fuel power plant technologies. These are CAME GT, involving gas turbine power plants, CO_2NET involving CO_2 capture and storage and POWERCLEAN associated with coal and other solid fuel power plants. The EU's rationale for action is the need for security of supply on a competitive basis, in which fossil fuels will play a major role. In addition, there is a need to meet stricter environmental limits, where deep cuts in CO_2 emissions are needed for Kyoto and beyond and a need to ensure that the EU is a world leader in low emissions power plants, so that market opportunities are created. A further incentive for this work was that a shortfall in power capacity, comprising new and replacement units, of around 550GW is predicted by 2030.

Andy summarised previous programmes (FP5 and FP6) and described expectations for the new Framework 7 (FP7) programme. FP5 had provided 16 million euros from a total budget of 31.8 million euros over a five year period. Activities included gas turbines, CCS and advanced coal-fired plant together with the establishment of the three Thematic Networks mentioned previously. FP6 involved CCS associated with clean fossil fuel use and had a total budget of 130 millions euros of which the EU provided 70 million euros, also over a five year time period. During the 1st call projects such as CO_2SINK, CASTOR, ENCAP, CO_2GEONET and an IGCC project were funded. The second call resulted in the acceptance of CACHET, CO_2REMOVE, CLC GAS and DYNAMIS projects whilst the 3rd call is for the instrument known as Complementary Actions.

The next programme, FP7, is of seven years duration with funding levels which are not yet finalised. It is possible that the Energy theme may be allocated ~3,000 million euros. Within this is included the development of zero emissions power plants for the transition towards sustainability which will operate via an instrument known as a Technology Platform (TP). The

two R, D & D themes are clean coal technology and CCS. The TP will involve a stakeholder initiative to define a common vision and a strategic research agenda. It will be industrially focussed and was launched in Brussels in December 1st 2005. The TP will comprise an advisory panel of 25 persons and specialist working groups. Their role will be to define R, D & D strategy and plans and to advance the European Research Area (ERA) vision of a critical mass of RTD. It will also attempt to increase public awareness and acceptance.

The Joint Thematic activities were used to provide a template for the TP strategy and plan. They were intended to provide a document which would focus attention on the key fossil fuel related R, D & D needs, to support the Commission in formulating the scope and priorities for FP7 and to provide information to political and strategic decision makers outside the Commission.

Andy went on to describe the strategic considerations that were felt essential to meet the objective of a sustainable energy future. Development and demonstration were essential and all measures will be required. There would be no single 'winning' technology and a broad portfolio approach will be necessary. A two trajectory approach was also described with higher CO_2 reductions over time being achieved with the 'zero emissions trajectory' and a lower plot identified as the 'increased efficiency trajectory'. Key issues within these aspirational targets are the value of CO_2 and the need for the most efficient plant for zero emission technology. It is recognised that opportunities may arise for technologies which will allow an upward change of trajectory. So-called 'Lighthouse' projects are envisaged which will arise from R&D which has validated the technology and will accommodate the non-technical issues such as CO_2 protocol, legal, health, safety and perception. They will be developed and implemented over the next 25 years with an increase in complexity which is in tune with market developments.

He next summarised the EU Carbon Management R, D & D Programme for Fossil Fuel-based Power Generation, saying that emphasis would be on coal, with the co-utilisation of biomass and wastes. It will be targeted towards achieving significant process efficiency improvements and will involve effective and integrated CCS. The development and integration of key enabling technologies such as turbo-machinery was essential as is the production of hydrogen. The latter is seen as a step towards a more diverse transport fuel system and sustainable power production. In respect of a timescale for technology development and deployment, CCT's need to be competitive in the near to medium term (~10-15 years) for improved environmental performance and better economics. Near zero emissions technology deployment is regarded as medium to long term (>15 to 20 years). Underpinning all of these advanced technologies is turbo-machinery development, i.e. near to long term requirement.

Andy spent some time describing the priority coal-based needs of a number of topic areas. In the case of combustion, it was felt that the implementation of an ultra-supercritical PF combustion demonstration power plant was essential. It should build on the approach established by

EU industry within the AD700 project. In addition, a state-of-the-art CFBC utility scale unit was necessary, using advanced supercritical steam conditions and incorporating a coal biomass co-firing capability. CCS studies should continue, as appropriate, to optimise and integrate the CO_2 capture systems that are necessary to attain near zero emissions.

Priorities for near zero emissions schemes are the need to develop less energy intensive CO_2 removal methods compared to chemical scrubbing using amines, to determine if oxyfuel combustion can be attractive economically as well as technically and to develop lower cost, more efficient oxygen plant, (also useful for IGCC). There is also a need to integrate the combustion and CO_2 capture processes in order to minimise efficiency losses and potential plant flexibility/availability problems.

Priority needs for gasification are the establishment of an integrated R&D programme for multi-function IGCC development which is appropriate to hydrogen and power production. It will include component development, improved design for higher efficiency and greater operational reliability, the optimised integration of CO_2 capture and the provision of a hydrogen-burning gas turbine capability. The multifunctionality of the selected approach must be determined and demonstrated.

Enabling technology priorities include higher performance steam turbines for USC plant and improved gas turbines with better part load behaviour. Cycle studies and techno-economic analyses will be needed to help improve lifetime and component designs. Other issues are the impact of CO_2-free flue gas, corrosion / materials matters and the need for flexibility in adding or operating CO_2 capture equipment.

Andy concluded his talk by explaining the role of the Commission in these activities. The short term aim of a demonstration of advanced cost effective, efficient and environmentally sound technologies is essentially one for industry. However, support from the EU is needed through policy development, influencing public opinion, together with an element of financial input. The medium to long term aim is for the development and validation of innovative concepts prior to demonstration and this is essentially a research task, in co-operation with industry as the final end user. The role of the EU in this case is essentially to finance the R&D tasks.

The next presentation was by Jon Gibbins of Imperial College London and was on "Getting Ready for Carbon Capture and Storage". Jon developed a scenario based on three interlinked statements, viz. CCS vs. Carbon Price, Demand for Big CO_2 Emission Reductions and Agreement on Global Action. The scenario was demonstrated by plotting Cost of CCS, the price of carbon and the number of plants with CCS against time. With the passage of time the cost of CCS fell and the price of carbon and the number of plants with CCS rose. This was defined by Jon as the "Getting ready" phase. Further down the time line the cost of CCS fell more but the number of plants with CCS rose sharply and an intersection was noted. This Jon defined as the 'Mitigation Tipping Point' and beyond this time

point we are into the CCS phase. Interestingly there was no scale on the time line!!!

A multi-track approach to getting ready for CCS was favoured by Jon that involves making sure that new fossil fuel plants of all types are built so that within the limits of the best current understanding, they can have capture ready retrofitted in the future with the minimum additional and performance penalty. It should also be aimed at improving the technologies that will be needed to convert these 'capture-ready' plants (and other existing plants) to capture CO_2 and feeding experience from this back into capture ready plant design. The approach should make sure that any additional technologies that may not be so competitive until CO_2 capture becomes the norm are also developed for rapid deployment later. Finally, proven and socially acceptable CO_2 storage options should be developed.

The general, fundamental principles for making plant capture ready are firstly, that there should be sufficient space on the site and in critical access locations to add CO_2 capture plant and necessary interconnections. A design study should be undertaken for adding CO_2 capture to assess technical feasibility and cost-effectiveness. Optional pre-investments should be considered as it can prove to be financially advantageous to do so, although the uncertainty factor must also be acknowledged. A credible disposal for the CO_2 from the site must also be identified.

Capture ready plant will almost inevitably involve uncertainty and getting to this position with plant is, in effect, risk management. It must not be just capture ready; it must be backed up by technology development and storage at policy level and plant level. It is also a good thing if capture ready is almost 'business-as–usual'. Money is needed for CCS demonstrations and for further necessary academic research.

Jon then spoke briefly about the UK Carbon Capture & Storage (UKCCS) Consortium. It is part of the Research Councils TSEC Programme and the talk was subtitled "Getting Ready for Carbon Capture and Storage in the UK". The Consortium's mission statement will be "to promote an understanding of how options for decoupling fossil fuel use from carbon emissions through the use of carbon capture and storage could be used to assist the UK in achieving an energy system which is environmentally sustainable, socially acceptable and meets energy needs securely and affordably".

Jon provided a status report on the UKCCS. The formal start is June 2006 and it is a three year project but is front loaded. Two project planning meetings have been arranged and international links are being developed. Research staff are being recruited and the projects are starting. Stakeholder advisory panels are being set up in early 2006 and evidence will be presented to parliamentary committees. A paper is being prepared for the Exeter Climate Change Conference.

The next presentation was given by Chris McGlen, a market analyst with UK Coal, and was entitled "Coal Producer's Perspective for Clean Coal Technology". Chris began by giving a review of the current position of coal usage for power generation in the UK. Coal use for electricity was around 50Mt in 2004, which was up by 23% from 1999. Around one third of UK electricity is generated from coal. Unfortunately, however, the UK no longer supplies all of this coal and in 2005 imported coal amounted to 40Mt compared with 20Mt from within the UK. Chris argued that coal brings benefit to the UK energy markets by providing diversity and flexibility, a competitive price and security of supply. Coal-fired plant will be needed to cover risks from the future expended gas fired portfolio coupled with the higher gas prices. It will also be required to ensure power supplies are maintained if renewables supply remains intermittent and if the older Magnox plants are actually closed. Chris believes that the future for coal-fired generation looks good with a strong demand for coal, high and rising natural gas prices, high load factors for 'opted-in' plant and newly committed FGD plant. Long term policy on coal utilisation in the UK seems promising as the Government appears to have recognised important key issues. These are that renewables and energy efficiency alone will not achieve the 'deep cuts' that are recognised as being necessary; that gas has security of supply and price ramifications and should only be regarded as medium term solution; that to be credible 'Global Leadership' on climate change must include a vision for coal; and finally that clean coal with carbon capture and storage must form part of the solution.

Chris then posed the question 'Will large scale investment in clean coal be forthcoming in the UK?' Although the outward signs look encouraging, including the fact that UK power producers are supportive of clean coal investment, the answer was in his opinion 'No – not without the introduction of a market mechanism'. Precedents already exist for nuclear and renewables generation so why not clean coal? It was felt that additional help was needed for a number of reasons, for example, regulatory and investment risks; the large timescale of payback (15+ years?) the uncertainties over the LCPD and emissions trading in Phase II (2008-2011) and post Kyoto and lost earning during unit outages. Furthermore, these uncertainties will cause the generators to defer investment decisions as late as possible which then means that gas becomes the fuel of choice by default due to its lower capital costs and shorter build time.

The cost of carbon allowances will be vital to ongoing UK investment. Generators are very short of Phase I allowances and it is known that the shortfall in the coal sector is around 23 $MtCO_2$ with a current market value of ~£350M. It is the cost of carbon allowances which will determine generation priorities and who knows what the long term price of these will be.

Chris believes that coal requires additional assistance since any CCS mechanism without it will result in investment in gas because of its lower carbon content, higher efficiency and lower CCS capital plant cost. Possible mechanisms are a reduction in the upfront capital cost of building

new clean coal power stations or retrofitting existing plant or the provision of greater certainty on future revenue streams from clean coal plant.

Chris described a list of existing and potential instruments. Existing instruments include enhanced capital allowances for low carbon technologies, R&D tax credits, The Carbon Trust, CCL relief (coal mine methane) and capital grants for demonstration technologies. Potential instruments included capital grants for investment, enhanced capital allowances on all technologies, Nil CCL rating from clean coal technologies, a Clean Coal Obligation, enhanced oil recovery tax credits or a contract for carbon credits by the state. The latter would provide a guarantee price of carbon reduction or contract for differences over CO_2 allowance price. Carbon storage must also qualify for the EU's ETS. Chris described, as an example of what is possible, a German model which had been used to encourage investment in clean coal.

Chris felt it was possible to divide the mechanisms he had mentioned between those that were easy to achieve but had little effect and those in which the reverse was the case. Easy to achieve mechanisms were felt to be CCL relief, R&D grants and enhanced capital allowances. More difficult mechanisms were capital grants, contract for the purchase of carbon, enhanced oil recovery and a Clean Coal Obligation.

Chris concluded his presentation with the view that the market is unlikely to invest in large scale carbon abatement technologies because of uncertainty, potential loss of revenue and a lack of a clear energy policy. Without investment, coal stations will close due to LCPD requirements regarding SOx and NOx. The uncertainty will drive investors to delay investment decisions which will result in gas being the only option. A suitable mechanism is required to aid investment.

The meeting then adjourned for refreshments.

After a notably good lunch the delegates reassembled with their usual post-eating tardiness to hear "Enabling the commercialisation of CO_2 capture and storage" by Harry Audus of IEA's Greenhouse Gas Project. He began his presentation by describing the magnitude of the task. CO_2 emissions were expected to rise in all of the key sectors but that from power generation showed the highest rise. A further indication of why this was happening was the revelation that currently about 40 power stations per year are built of which some 30 are coal-fired and 20 of them are in China. Each tonne of coal produces about 2.9 tonnes of CO_2 and from the global shipment of coal of around 3,600 million tonnes per year this equates to ~11 gigatonnes of CO_2 per year. As the Sleipner storage project is storing ~1 million tonnes of CO_2 per year there is a need for 11,000 similar sites!!

Harry then described the current status of the three main CO2 capture options, namely post-combustion, pre-combustion and oxyfuel firing. Post-combustion has been in use for some time but has not been demonstrated on a flue gas or at full size. Bench scale tests, (using a simulated flue gas), and pilot scale, (on real flue gas as a slip stream)

have been demonstrated. These include EU CASTOR project (~23tpd), MHI Nagasaki (~10tpd) and ITC Boundary Dam (~4tpd). There is an urgent need for a post-combustion capture demonstration which will show that a high percentage of the CO_2 produced can be reliably captured without serious impact on power station reliability and operability. As the knowledge base increases attempts must be made to lower costs and other requirements must be addressed such as integrated operation, satisfactory solvent life and performance and the environmentally acceptable treatment of solvent emissions and solvent-degradation products.

Pre-combustion capture involves, as a first stage, the use of IGCC. So far this has been well-demonstrated at large scale but the CO_2 capture phase has not, as yet, been attempted. Projects are in existence to demonstrate this and include FutureGen (IGCC, USA), HypoGen (IGCC, EC), DF1 (Partial oxidation, BP-Miller, Peterhead) and Stanwell, Australia (IGCC). These are operations at commercial scale of around 1 million tonnes of CO_2 capture per year.

Harry moved on to describe two storage options, ocean and geological. In the case of ocean storage some countries may have to consider it if other geological options are not available. Concerns exist regarding ocean storage in terms of its effect on marine ecosystems and the legality of it under existing international treaties. Not surprisingly, resistance from environmental pressure groups is also being shown.

It seems that the current legal situation on off-shore CO_2 storage is unclear although there is a greater awareness of ocean acidification. Conventions were not drafted with CO_2 in mind and OSPAR and London conventions may prevent 'dumping' of CO_2 at sea and under the sea bed. However, CO_2 injection as part of EOR operations is acceptable. Some clarification may be in the offing as it was reported at the London Convention in October 2005 that 'There now exists a willingness to consider amending the Convention Instruments to permit CO_2 storage in the sub-sea bed'.

Geological storage options comprise unmineable coal seams, depleted oil and gas fields and deep saline aquifers. Storage capacity varies and it was shown that unmineable coal seams with a capacity of ~30Gt CO_2 would only be able to store less than 2 years of CO_2 production at the estimated formation rate for 2030. Depleted oil and gas fields with a capacity of ~930Gt of CO_2 could store 50 years CO_2 production and the deep saline aquifers at 400 to 1,000 Gt of CO_2 could store 20 to 530 years CO_2 production. The storage costs were estimated at up to $20 per tonne of CO_2.

Harry went on to examine key issues of which cost was clearly one. The overall cost of CCS was stated to be around $40 to $60 per tonne of CO_2, of which capture accounted for $30 to $40, transmission $5 to $10 and storage $5 to $10. It was hoped that a similar scenario would evolve with solvent-based CO_2 capture as with FGD. The latter was very expensive when initially developed but major cost reductions have been realised in

recent years. One major capture issue is the urgent need for demonstration plants to give credibility and reduce cost. Concerns are urgent because of the current planned coal-fired power station build and the long lead time (5 years) to initiating the building of a demonstration plant. The IEA GHG proposed post-combustion demonstration is regarded as a major 'missing link'. Costs for these demonstration projects are high with FutureGen being quoted as costing $800M, so international co-operation is essential. To put this figure into context, however, $800M is about 0.5% of the cost of all the coal shipped globally in 2003.

Storage key issues involve the provision of safe and secure long-term storage, the use of depleted oil and gas fields, the creation of a 'storage industry', availability and capacity of stores and legal and regulatory issues.

For safe and secure long-term storage public perception is paramount and potential hazards must be minimised and effectively dealt with. It is accepted that some CO_2 emissions will occur given the quantities to be handled and a large number of installations will be necessary. Equally, as storage will be for hundreds of years, carbon accounting issues will inevitably have to rely on projections made by modelling. Consequently, the reliable immobilisation of CO_2 is highly desirable.

A number of CO_2 storage issues relate to depleted oil and gas fields. One question was why there is only a limited take-up of CO_2 storage for EOR. It may be that there is conflict between storage in 'depleted' oil fields and the need to improve the recovery of oil from its original location. Another issue was the potential for leakage from the large number of old wells in some sites and also whether it would be better to store natural gas or CO_2 in such locations.

A necessary CO_2 storage industry does not exist and its creation poses a number of issues. Firstly, who would commercialise the stores and how much would they be worth? There is also the need to reconcile storage of CO_2 for probably hundreds of years with the transient nature of corporate entities. Would large stores be able to serve multiple sources, and finally, how could a competitive market be introduced?

In terms of availability it needs to be recognised that some countries may not have any suitable storage sites. Capacity is another issue where problems exist in that it is proving very difficult to quantify the capacity of any store, especially in the case of aquifers.

A summary of the legal status shows that acceptance of CCS under international law is progressing and that it could be endorsed under the Kyoto Protocol and for the Clean Development Mechanism. It is believed that by 2006 sub-sea bed CCS could be fully accepted by Maritime Treaties. The development of national standards is underway and the adaptation of existing standards, as in the Netherlands, USA and Canada seems to be a favoured route.

Harry's final message was that on capture, demonstrations and cost reduction were needed and for storage, a credible long-term storage industry must be established.

An entertaining if somewhat alarming presentation on "Enabling the commercialization of CO_2 capture and storage - Beyond Battersea & Buggenum" was given by John Griffiths of Jacobs Engineering Ltd. He began by listing the needs of the utility industry which were; instantaneous reliability, the ability to meet demand, a reasonable cost and long term reliability and security of supply. Gas production from the UK continental shelf was then shown and compared with demand which demonstrated a shortfall as of now, increasing to a significant amount by 2012. To address this shortfall a number of new gas import projects are planned. The biggest of these is the Langeled pipeline from Norway which is scheduled to start supply in Q3 of 2007. Other LNG terminal upgrades are planned for Grain and Milford Haven some of which will not be completed until 2009/2010. The overall supply capability of the new import projects is ~60 to 100 billion cubic metres (bcm) per year but the current UK demand is already >100 bcm per year. Piped gas will be coming from Russia, which was shown to have easily the highest proven developed reserves of oil and gas in the world, but don't forget - it's an awfully long way from Russia to the UK market place!

All of this confirms the view of many that coal must have a role in the future and clean coal schemes include conventional combustion with flue gas scrubbing of CO_2, IGCC with pre-combustion capture of CO_2, oxyfuel firing or natural gas combined cycle plant with a gasification module. However, John indicated that new capacity was probably too risky for the power industry given their preference for turnkey bidding, the need to use essentially unproven schemes and doubts over the future of emissions trading schemes. Moreover, high capital costs associated with building CO_2 capture plant and a lack of fabrication and labour resources would cause further concern for investors.

A useful 'halfway house' would be to build new plant using proven technology but with provision made for the fitting of CO_2 capture plant at a later date, the so-called capture–ready option. The attractions of taking this approach are that the efficiency and output of the new plant would be known in advance, as would be the time to install the capture facilities when ready. Adequate space for the capture plant must be allocated and it would be possible to complete an environmental impact assessment for the capture mode of operation before it is fitted. John then briefly described the Jacobs gasification module known as the GEM^{TM}. This device can produce clean fuel gas, CO_2 and sulphur.

John concluded his talk by reiterating that it was probably too much to ask that turnkey clean coal plant be built but that 'capture ready' would be a good intermediate step. However, a clear definition of 'capture ready' is necessary and certified CO_2 storage sites are essential. Finally John urged that the BP Peterhead project should be supported.

Douglas Spalding then described efforts made by Mitsui Babcock towards achieving Zero Emissions Coal Fired Plant. Important facts to note were the changes in fuel mix for electricity generation. In 1980 71% of electricity was generated by coal firing but by 2003 this had fallen to 36%. Gas-fired generation had risen from 1% to 39% and oil-fired generation had fallen from 13% to 1% in the same time period with, perhaps surprisingly, nuclear having risen from 12% to 22%. The total generation had also risen from 265TWh in 1980 to 379Twh in 2003. Gas-fired generation was expected to rise to 70% of the total by 2020.

Of the 18 existing UK coal-fired stations the split was roughly 50/50 on whether to opt-in or opt-out of the Large Combustion Plant Directive (LCPD), with a slight preference for opting-in. In terms of the UK's CO_2 future the existing coal plant infrastructure is valuable for a number of factors such as fuel supply, wires, skills and resources, plant acceptance and the scope for application of clean coal technology. Security of electricity supply is known to be potentially at risk from gas shortages, closure of coal plant as a result of LCPD, planned nuclear shutdowns and insufficient renewables generation.

The EU Emissions Trading Scheme target is 12.5% CO_2 reduction, on 1980 levels, by 2012 but there is pressure for further reductions from the Energy White Paper and the Renewables Directive. Based on the 2005-2007 UK National Allocation Plan (NAP) coal plants must reduce their CO_2 emission by 40MTe now. If the opted-out coal plant were to close this would result in a 60MTe CO_2 reduction. How would this affect security of electricity supply? It was said that if the coal plant were to operate up to its limit i.e. its cap, then the gas plant load factors would rise by almost 30% - with concerns for gas availability and cost.

At this point Douglas introduced the Mitsui Green Coal Technology Concept which it was claimed would address the previous concerns. This concept combines the following CO_2 reduction technologies; advanced supercritical (ASC) plant, enhanced biomass firing and feed water heating upgrade. In the case of advance supercritical technology, the application of a Posiflow boiler design as either a new unit or as a retrofit will produce improvements in efficiency. Biomass co-firing either by co-milling or using dedicated burners or injectors is also of benefit. CO_2 reductions of up to 20% can be achieved using biomass-fired feed water heaters or by partial gas re-powering with a GT feed water heater.

Douglas then gave some budget costs. A 600MWe supercritical retrofit would cost £116M with an overall programme of 36 months; 12 months for site retrofit activities. An equivalent new build cost (supercritical only) was quoted at £375M with an overall programme of 40 months. There then followed a description of how CO_2 capture and storage featured in their Green Coal Technology portfolio. It was claimed that the cost of CO_2 abated was lower using ASC (17% reduction £12/t CO_2) or ASC+CO_2 capture (90% reduction £20/t CO_2) when compared with wind turbines (£40/t CO_2 on-shore, £62/t CO_2 off-shore).

In conclusion it was felt that market conditions demand a continued role for coal in a balanced portfolio and that coal plant and new technology are essential to a secure UK CO_2 future. ASC technology is the first step to ensuring security of supply in the future and Mitsui Babcock's Green Coal Technology can deliver major benefits. These include emissions which are competitive to gas plant; the achievement of more than twice the CO_2 reduction per £ in comparison with wind power; enhancement of merit order and load factors; the provision of a sustainable trading advantage and the utilisation of 'grandfathered' rights and the minimisation of burner for zero missions technology.

Formerly employed by Air Products, now a consultant, Rodney Allam gave his presentation entitled "Options for CO_2 capture from coal-fired power generation: the choice between IGCC and pulverised coal-fired systems". He began by explaining that there are very few coal gasification systems worldwide and those in existence mostly produce hydrogen for chemical synthesis with few producing electric power. The route to clean, high efficiency electric power with CO_2 capture and hydrogen production from coal lies with advanced IGCC systems.

Rodney then described the results of a study on a PF-fired ultra supercritical plant with amine scrubbing system and showed the effects of fitting capture plant on process parameters. Of particular interest were net efficiency, down from 44% to 34.8%; net output, down from 758MW to 666MW; CO_2 emitted down from 738 t/h to 143 t/h; cost of plant up from 950M US$ to 1,172M US$ and cost of electricity, up from 4.7 cents US/kWh to 6.6 cents US/kWh. Details of a coal-fired oxyfuel unit were presented and gave some interesting comparative data. In this case, net efficiency fell from 44.2% to 35.4%, CO_2 emitted down from 489 t/h to 45 t/h and cost of electricity up from 4.9 cents US/KwH to 7.3 cents US/KwH.

Syngas production was then reviewed with a comparison made of the Texaco and Shell entrained flow systems and their products. The Texaco system operates at a higher pressure (60 bar) than the Shell (33 bar) and has a higher residual water content. The Shell gasifier also produces a lower H_2/CO ratio.

Four options were then described for CO_2 separation. These were amine scrubbing with a non-selective solvent such as MEA; use of a physical solvent such as Selexol; pressure swing absorption to separate by-product hydrogen at up to 90% recovery and high temperature CO_2 adsorption combined with shift reactions. The latter process, known as the 'Sorption Enhanced Water Gas Shift Process' involves a water gas shift catalyst and a high temperature CO_2 adsorbent. In the process the CO is converted into CO_2 which is then removed from the hot syngas at $400^{O}C$ to $500^{O}C$. Multiple beds of catalyst and sorbent are used and regenerated when saturated.

Issues relating to amine scrubbing were mentioned. The view that this is an easy option for CO_2 removal is not necessarily correct. Corrosion has been an issue and proprietary amines have had to be developed to combat this effect. $S0_2$ and NOx must be kept low in the flue gas to limit

the formation of amine salts. So far no demonstration plant on a reasonable scale has operated to treat coal-fired power station flue gas. New amines are needed with lower heat regeneration characteristics, better kinetics and resistance to degradation and improved corrosivity.

In the case of oxyfuel firing there now exist large, single-train oxygen plant (3,500 to 6,000 t/day) but so far no large scale demonstration of this technology on a coal-fired power boiler has been made. There is considerable industry experience with small-scale oxyfuel burners and it is believed that scale-up to burners larger than 10MW would present no problems. Trace elements may cause problems and sulphur, nitrogen and mercury need to be removed from gas streams. The burning of high sulphur coals may present increased corrosion risk as the flue gases are recycled and the concentration of SOx will become high. A consideration of the suitability of existing boiler materials will need to be made.

Coal-based IGCC systems have a proven track record of success using a choice of gasifiers and a variety of coals at a large scale with single-train throughputs; for example the GE (Texaco) slurry-feed water quench system; the Shell/Uhde/Conoco-Phillips dry feed system and the Lurgi fixed bed slagging gasifier system. The maximum capacity of gasifiers is much lower than coal-fired boilers. This technology can produce by-product hydrogen or H_2/CO for other applications such as chemicals, vehicle fuel and distributed power systems and might be considered a realistic alternative to crude oil and natural gas. However, the CO shift and H_2S/CO_2 gas separation systems are very complex and the handling of H_2S in the Claus sulphur plant and tail gas cleanup is also complex. There is, therefore, a requirement for the development of a simple, low-cost $H_2/CO_2/H_2S$ separation system. Coal-based IGCC systems have proven experience but are yet to show the same reliability as coal-fired steam turbine systems although steady progress is being made.

Rodney then described an interesting option, that of integrating IGCC with pulverised coal-fired boiler systems. Heat from the HRSG would be used to heat condensate and boiler feed water and a common steam system would be adopted. It is claimed that a better combined efficiency can be obtained from this system than separately optimised stand-alone systems. Such an option could provide a simultaneous upgrade to supercritical steam conditions with CO_2 removal and the maintenance (or increase) in power station electrical output using common services.

A new development known as Ion Transport Membranes (ITM) was also discussed. This is a high temperature ceramic process which is 100% selective for oxygen. It is a mixed-conducting, ceramic, non-porous membrane which operates at $800^{O}C$ to $900^{O}C$. Its crystalline structure incorporates oxygen ion vacancies which are used to allow oxygen to diffuse through the membrane. When integrated with an IGCC plant there is a reduction in oxygen plant costs (-35%) with a reduction in electricity costs of -7%. A 1 to 5 tpd ITM plant is in the process of start-up at present.

Rodney summarised his presentation saying that current development of IGCC (FutureGen Project) is targeting >50% efficiency with CO_2 capture using new technologies. USC steam conditions target 45% to 50% efficiency with CO_2 capture. Existing technology could be used for electricity production from coal with CO_2 capture now. Current studies are intending to identify costs for the retrofit of CO_2 capture and advanced supercritical steam conditions to existing UK coal-fired power stations. At present the efficiency reduction is from 38% to 36% and an LHV basis. More research and demonstration effort is required in the UK. (I think I've heard that somewhere before, Ed!!)

"IGCC – The GE Ecomagination Power Alternative" was the final presentation, of the day given by Terry Raddings, GE's Energy Technology Marketing Manager for Europe. Terry described some of the history and present structure of GE. It has so-called Power Generation Platforms in Thermal, Nuclear and Renewables technologies. The Ecomagination concept was said to involve GE allocating high levels of funding for R&D, introducing increasing numbers of products per year, reducing its GHG emissions, improving its energy efficiency and keeping the public informed.

Terry focused on IGCC and CO_2 capture readiness and the ability of GE gas turbines to operate using syngas. He also summarised the gasification technologies available from GE.

The tenor of his talk was, from where this reporter was sitting, very upbeat. So much so that I began to ask myself why we need to do all of the demonstrations that we had heard so much about throughout the day!!

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US facing pressure to sign up to future climate protocols

By Andrew Buncombe, The Independent & The Independent on Sunday
05 December 2005

The United States will this week face intense lobbying in an effort to force concrete action from the Bush administration over climate change when ministers from around the world meet at a United Nations summit in Canada. A failure to obtain some concession from the US would lead to further condemnation of both President George Bush and Tony Blair, who has said he believes a legally-binding commitment is achievable.

When the talks on climate change opened last week, the US chief negotiator made clear the US would not be part of a binding agreement to cut emissions of greenhouse gases once the Kyoto protocol expires in 2012. "We would certainly not agree to the United States being part of legally binding targets and timetable agreement post-2012," said Harlan Watson. But in this second week of talks, conducted by high-level ministers, the US will be strongly lobbied by conference hosts Canada and the EU, of which Britain currently holds the presidency. They believe that

Mr Watson's initial flat-out refusal may have been a negotiating tactic and that the US could be persuaded to move from that position. The talks are to discuss the second phase of the Kyoto protocol, established in 1997, which came into effect in February this year. Currently, 36 countries are bound to reduce carbon dioxide emissions by around 5.2 per cent below their 1990 levels by 2012.

Britain is on track to meet this target though not all of the 36 so-called "annex B" countries are. The US - which contributes 25 per cent of the world's greenhouse gas emissions - is not part of the protocol but is at the conference as an observer, and a signatory to a UN climate change convention dating from 1992.This week's talks in Montreal will focus on what happens after 2012. Campaigners want to see agreement to a new round of negotiations on fresh emission reduction targets and a timetable to reach that commitment.

In advance of the conference, Mr Blair sounded optimistic. Speaking to the Confederation of British Industry last month, he said: "I believe there will be a binding international agreement to succeed Kyoto when it expires in 2012 that will include all major economies." But some campaigners believe that efforts to persuade the US to act are a waste of time while the current administration holds the White House. They also believe that both the US and Britain could seek to take credit for even the slightest - and essentially meaningless - undertaking from Washington.

Reducing gas emissions from China's coal mines

http://www.iom3.org/materialsworld/sep05/news.htm#Reducing

A new project to reduce greenhouse gas emissions from China's coal mines has been launched by the UK Government's Global Opportunities Fund, which promotes action on global issues in areas of strategic importance to Britain. Engineering and environmental consultants Wardell Armstrong, based in the UK, will work with the China Coal Information Institute (CCII) to develop an advisory centre at the Institute of Beijing. The aim is to assist China in applying the Clean Development Mechanism (CDM) with regards to the use of coal mine methane (CMM). Methane gas released from coal mines is an anthropogenic source of green house emissions.

CDM was established by the 1997 Kyoto Protocol and promotes sustainable development in developing countries. Industrialised countries can invest in emission reduction projects in developing countries and in turn receive certified emission credits (CER). With regards to CMM, Senior consultant at Wardell David Creedy, says, 'CDM is important as it will provide a market mechanism to encourage coal mines in developing countries to utilise or destroy captured methane by converting it to less harmful carbon dioxide. 'Most CMM utilisation schemes are too small to attract investors and finance is often difficult for mines themselves to raise. The CDM therefore provides an additional source of financing, provided it can be demonstrated that the project would not have been feasible without CDM,' adds Creedy.

More than 95% of China's coal mines are underground, says Creedy, with 300 of the major state-owned mines being susceptible to outbursts, where emissions of gas occur without warning during mining. By 2002, 193 of these operations had a methane drainage system, draining about 1.15 billion cubic metres of methane, of which only half is used. The new advisory centre aims to provide coal miners, project developers, investors and carbon traders with information to increase awareness of how China's mining sector can contribute to global climate change. Current use of CMM varies from residential use and power generation to chemical manufacturing and vehicle fuel. Flaring of methane to maximise methane destruction, rather than venting it to the atmosphere, is also proposed for surplus or unusable CMM. There are currently five CDM for CMM projects in China awaiting the decision of the CDM Executive Board on the methodologies for the use and destruction of CMM. Once these have been approved, the CCI estimates that there are more than 50 potential projects to be raised in the country's main coal producing provinces.

Britain beats Brussels in CO_2 emissions court case

RedOrbit Breaking News, 23 November 2005
BRUSSELS (Reuters) - Britain will be allowed to propose more lenient limits on pollution from industry after a top European Union court ruled on Wednesday in its favour in a legal battle with the European Commission. Britain challenged the Commission after it blocked a move to allow more carbon dioxide (CO_2) emissions from its power stations and factories than originally proposed. The proposals are part of an EU-wide emissions trading scheme designed to cut pollution and meet the bloc's Kyoto Protocol climate change targets. "The United Kingdom was entitled to propose amendments to the plan submitted to the Commission, even though they increased the total quantity of emission allowances," the Court of First Instance in Luxembourg said in a statement. The EU's trading scheme was launched in January as the mainstay of Europe's effort to meet targets set under the Kyoto Protocol on climate change. Officials from some 190 countries will meet in Montreal, Canada next week to review the Kyoto deal. Wednesday's ruling means Brussels must reconsider revised proposals from the UK, which would allow British industry to pump out nearly three percent more CO_2 than originally planned in the first phase of the EU's trading scheme (2005-2007). Britain wanted to use softer reduction targets than in its original plan because of revisions to data on emissions and energy use. They have been implementing their original plan for several months while they push their case to bring in the revised proposals. "Today's ruling requires the Commission to consider the UK's amended plan and to make a fresh decisions on its compatibility with the EU emissions trading directive's requirements," said a spokesman for the Department of Environment, Food and Rural Affairs (DEFRA). "We are deeply committed to making a success of the EU's trading scheme and fighting climate change," he added. Britain is on course to meet its Kyoto targets on cutting greenhouse gas emissions but is struggling to meet its own tougher goals. The Commission was expected to comment on the ruling at around 11:00

a.m. British time. Analysts said prices for CO_2 allowances traded under the EU scheme could come under pressure if the UK gets the go-ahead to use its revised plan. Allowance prices were down 55 cents at 21.50 euros a tonne by mid-morning. "The upshot is that if the UK carries forward its revised plan then this will increase the number allowances in the market and cause downward pressure on prices," said Abyd Karmali, managing director of the London offices of ICF Consulting.
http://www.redorbit.com/news/international/312278/britain_beats_brussels_in_co2_emissions_court_case/

Yachts to spray away global warming

A fleet of giant yachts with chimneys instead of sails could be one answer to global warming, according to a British engineer. Stephen Salter's bizarre sounding plan is for the yachts to spray huge plumes of water droplets into clouds in order to dampen down the greenhouse effect. The idea is that this will boost the whiteness of low-level clouds so they reflect more sunlight back into space rather than down on to the planet. Salter, from the University of Edinburgh, says just 500 of the £1million sprayer yachts would cancel a year's worth of global warming from carbon dioxide emissions after operating for 20 years. The scientist presented his ambitious proposals at a climate change conference which took place in Edinburgh, Scotland last week. Instead of sails, the yachts would be propelled by spinning vertical cylinders, known as Flettner rotors, according to the New Scientist magazine. A similar system was successfully used for an Atlantic crossing in the 1920s. The rotors of the ship would double as chimneys, pouring out water droplets into the atmosphere".

As the remotely controlled vessels move through the water, the motion will drive propeller-shaped turbines that will generate electricity to power the water sprayers," said New Scientist. "The form the sprayers will take has yet to be decided, but Stephen Salter is investigating the use of a centrifuge or ultrasonic atomiser, like the nebulisers used for dispensing asthma drugs." Three years ago, Salter dreamed up the idea of rainmaking whisk-shaped wind turbines, but has yet to get his scheme of the ground. Although water vapour itself can cause global warming, the effect from the yachts would be negligible, he says.

http://www.westpress.co.uk/displayNode.jsp?nodeId=146278&command=displayContent&sourceNode=146274&contentPK=13308526

Mongolia in coal deal with China

BBC News, 30 November 2005
Mongolia has agreed to develop its coal fields with China, as its neighbour looks to feed a booming economy and rapacious appetite for energy. In return for its help, China will get coal to burn in power plants, helping it tackle a power shortage that has led to blackouts and factory closures. The deal will allow Mongolia to exploit valuable natural resources and help it finance economic expansion. Mongolia also has large oil, copper and gold deposits.

Economic growth has picked up over the past two years, mainly driven by foreign investment from mining firms. Growth was almost 11% last year, twice as fast as in 2003, and Mongolia's new president is looking to extend that run. During a visit to China, President Nambariin Enkhbayar moved to reassure foreign firms that the state did not plan to take stakes in any planned ventures. "The leadership in the country will do its best to make foreign investors feel happy about the money they are going to bring into the Mongolian economy," he said. Mongolia is currently planning an overhaul of its mining laws to foster investment.

Coal 'could ease energy crisis'

BBC News, 29 November 2005
The re-introduction of coal mining in Northumberland and Durham could ease Britain's energy crisis, unions claim. The National Union of Mineworkers (NUM) says hundreds of millions of tonnes of coal could still be retrieved from coastal areas of the region. The North East's last deep colliery at Ellington, near Ashington, closed earlier this year with 350 job losses. A government review of Britain's energy policy is under way amid fears gas supplies may run short. NUM chairman Ian Lavery said: "We can produce coal cheaply and burned with near zero emission levels, so why not begin production again? "Basically, we have to understand that coal is a fuel of the future and not a fuel of the past.

"We have people all over the North East who would love to be working back down the pit." Mr Lavery questioned the long-term cost effectiveness of nuclear and gas import options being considered by the government. He added: "I would suggest that the reopening of the coalfields and associated clean coal technology in power stations will produce electricity far cheaper than anything else that is currently being considered." Mr Lavery's comments come as the price of wholesale gas has almost doubled during the past week, prompting fears about winter supplies to industry in the UK. Prime Minister Tony Blair has not ruled out an expansion of Britain's civil nuclear generating programme. Thousands of gallons of water flooded into Ellington in January, prompting owners UK Coal to declare the mine economically unviable.

Meeting into opencast mine plans

BBC News, 21 November 2005
New plans for an opencast coal site in Northumberland are to be debated a year after the original plans were rejected. Last year, Northumberland County Council turned down proposals from UK Coal for a 110-acre extension to their site at Stobswood, near Morpeth. It said the plans would have an unacceptable impact on local people. Now UK Coal has revised its plans and the proposals will be discussed at a public meeting at Widdrington Station community centre on Monday evening. The revised plans would cover a smaller area of 96 hectares and the firm said it would transport an estimated 987,000 tonnes of coal by rail rather than road over four years. The company has also promised that when the work is completed it will restore the site to woodland and agricultural land. A

spokesman for the county council said: "The new plans include a reduced site area, the re-location of an underpass and amended restoration proposals."

£108 million to reduce sulphur from Welsh coal power station

Posted 6 December, 2005

A consortium of AMEC and ALSTOM has won a £108 million contract by RWE npower to fit new environmental technology to reduce sulphur emissions at the Aberthaw coal-fired power station near Barry in South Wales. The project is driven by the requirements of new European environmental regulations due to come into force in 2008. It involves fitting air pollution control technology that will improve Aberthaw's environmental performance, safeguard the station's future and provide a boost to the local economy. AMEC will be responsible for overall project management of on-site engineering and construction, detailed civil and structural design together with engineering design of the off-site utilities plant. ALSTOM is the process technology provider of the air pollution control equipment, which features a seawater flue gas desulphurisation (SWFGD) system for the power station's three 500-megawatt generators. Aberthaw produces around a third of South Wales' electricity. Design is underway, with civil engineering work at the power station scheduled to begin in the first quarter of 2006. The project will be completed in the first quarter of 2008.

"This is an important opportunity for AMEC and forms part of our overall strategy of providing specialist services across the energy spectrum from oil and gas through nuclear to renewables," said Steve Lee, managing director of AMEC's industrial business. "It is one of a number of potential similar environmental projects for AMEC's industrial business across the UK driven by the pressures from new European legislation to reduce CO_2 emissions by 2008". Flue gas desulphurisation plants remove approximately 95 per cent of the sulphur dioxide produced when generating electricity from coal. LINK Aberthaw Power station.

http://www.npower.com/education/powerstations/aberthaw.aspx

Tailings

Just a single item in this section for this issue but an important one nevertheless. It seems from what we read below that India, one of the developing nations, and thus exempt from the Kyoto Protocol, is addressing the important issue of sustainability and global warming as evidenced by the conference advertised below. The signs are looking up after all!

International Conference on Sustainable Power Development
'Green Power 5-
Development & Management of Resources and Energy Security'
February 2-3, 2006; New Delhi, India

Seasons Greetings from the entire team of IndiaCore.

IndiaCore, Council of Power Utilities and World Energy Council are pleased to announce the fifth edition of 'Green Power'- a biennial conference in the Green Power series focussing on sustainable energy development. The Green Power series offers a unique platform where optimum, eco-friendly & sustainable development issues are discussed amongst various stakeholders.

Green Power 5 will explore the latest, most relevant technologies and examine them in the context of current and future energy requirements while addressing the concerns related to energy security. It will analyze the numerous benefits of adopting these technologies even while it provides a realistic framework for incorporating them.

TOPICS FOR DISCUSSION

Hydro Power Development
Fossil Fuel, Hydro- Carbon and Nuclear Power Generation
Clean And Renewable Energy Resources
Transmission and Distribution
Environment and Ecology
Energy Security, R&D, Human Resources and Financing

Further information about Green Power 5, including a list of participating companies, will be updated regularly on the India Core website and the Conference website- www.greenpower5.com

Don't miss this opportunity to hear the Industry leaders and network with top industry players. There are also attractive business development and sponsorship opportunities to be explored. For further details, sponsorships, exhibit display, advertisement, speaking opportunities, registrations, please feel free to contact Priya Kapoor, Dy Team Leader, IndiaCore at 011- 2554 2551/ 4158 9329, email- indiacore@gmail.com / greenpower5@gmail.com / icoregp5@gmail.com

Student Bursaries for 2006

Up to 6 travel bursaries for up to £300 are on offer to bona-fide full-time students wishing to attend appropriate coal-related conferences. To apply, please send the abstract submitted to the conference with a brief supporting letter from your supervisor to:

Prof. J.W. Patrick

SChEME
The University of Nottingham
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 current EPSRC projects – subject Coal Technology,
(as of January 9th 2005).

Project Title Principal Investigator	Organisation	£ Value	Status
Clean Coal Technology: A Novel Process for the Combustion of Coal Using an Oxygen Carrier			
Dr J Dennis	University of Cambridge	260,761	Not yet started
Developing Novel Applications of PDF Based Models for Studying Turbulent Disperse Flows			
Dr D Swailes	University of Newcastle upon Tyne	243,014	Not yet started
Developing Effective Adsorbent Technology for the Capture of CO2			
Dr T Drage	University of Nottingham	208,610	Started
A Novel Application of Waste Tyres & plastics as Reburn Fuels for NOx Reduction in Large Scale Combustion Systems			
Professor P Williams	University of Leeds	293,057	Started
Can CO2 hydrate formation act as a safety factor for subsurface storage of CO2?			
Professor B Tohidi	Heriot-Watt University	297,599	Started
Development of a Process for the Production of Ultra Clean Coal			
Dr K Steel	University of Nottingham	126,162	Started
PLATFORM: Decentralised polygeneration of energy: Cross-disciplinary research at Imperial College London			
Dr M Leach	Imperial College London	420,153	Started
A study of the reaction chemistry in the production of hydrogen from coal using a novel process concept.			
Dr J Dennis	University of Cambridge	185,730	Started
A study of the reaction chemistry in the production of hydrogen from coal using a novel process concept.			
Professor R Kandiyoti	Imperial College London	163,538	Started
PPA:Renewable Energy: From Sunlight to Electricity			
Dr RJ Mortimer	Loughborough University	72,824	Started
Research Director Designate/Research Director UK Energy Research Centre			
Professor J Skea	Policy Studies Institute	1,046,052	Started

Fundamental studies of the behaviour of metals in solid fuels for sustainable energy			
Dr JM Jones	University of Leeds	223,419	Started
Monitoring and Characterisation of Coal,Biomass and Oil Fired Flames Using Digital Imaging Techniques			
Professor Y Yan	University of Greenwich	29,275	Completed
Modelling the Uncertainty and Risks Associated with the Design and Life Cycle of CO2 Sequestration in Coalbed Methane Reservoirs			
Dr A Korre	Imperial College London	126,960	Started
YAN-CE: Young Academics Network for Chemical Engineering			
Dr M Simmons	University of Birmingham	63,478	Started
Investigation of Synergistic Activity During the Co-Pyrolysis of Coal and Biomass.			
Dr JM Jones	University of Leeds	189,327	Started

Please ‘click’ on the Project Titles for more details

CALENDAR OF COAL RESEARCH MEETINGS AND EVENTS

Date	Title	Location	Contact
Wednesday 15th February 2006	McCloskey's 15th Coal UK	London, UK	Georgina Lucey, The McCloskey Group, PO Box 15, Petersfield, Hampshire, GU32 3HX, UK Tel: +44 1730 265 095 Fax: +44 1730 260 044 Email: georgina.lucey@mccloskeycoal.com
Wednesday, 8th March 2006	Meeting of the Coal Combustion Division, "Combined Cycle Gas Turbine Technology- now & in the future"	E.ON UK plc Killingholme Power Station, Near Immingham, Humberside	Dr A W Thompson, SChEME The University of Nottingham Nottingham, NG7 2RD Tel : 0115-951-4198 Fax : 0115-951-4115 Email : alan.thompson@nottingham.ac.uk
Thursday, 20th or 27th April	Coal Conversion Division Title to be announced	CORUS UK Ltd, Scunthorpe Works	Prof J W Patrick, SChEME The University of Nottingham Nottingham, NG7 2RD Tel : 0115-951-4175 Fax : 0115-951-4115 Email : john.patrick@nottingham.ac.uk
Wednesday 31st May 2006	Coal Research Forum Annual Meeting and Coal Utilisation Subject Group Annual Meeting, Coal Preparation Divisional Meeting Title to be Announced	The Coal Authority Mansfield Nottinghamshire	Dr David J A McCaffrey The Coal Research Forum P.O. Box 154 Cheltenham, GL52 5YL Tel: 01242 236973 Fax: 01242 516672 E-mail: info@coalresearchforum.org Mr Andrew W Howells Norec Ltd., Ings Mill Dale Street, Ossett West Yorkshire, WF5 9HQ Tel: 01226-730440 Fax: 01226-730688 Email: andrew.howells@norec.ltd.uk
Wednesday 31st May to Thursday	VGB Workshop 'Flue Gas Cleaning'	Nottingham, UK	Dr Hartmut Krueger, VGB Powertech e.V. Klinkestrasse 27-31 D45136 Essen, Germany

1st June 2006			Tel:+49 201 8128 324 Fax: +49 201 8128 364 Email: hartmut.krueger@vgb.org www.vgb.org/flue_gas_2006_e.html
Tuesday 5th to Thursday 7th September 2006	The Sixth European Conference on Coal Research and its Applications	The University of Kent, Canterbury	Conference Secretary Dr A W Thompson SChEME The University of Nottingham Nottingham NG7 2RD Tel : 0115-951-4198 Fax : 0115-951-4115 Email : alan.thompson@nottingham.ac.uk