

No.44

September 2005

NEWSLETTER



of the
**Coal Research
Forum**

EDITORIAL

Summer 2005 is almost history now and what will we remember about it. Undoubtedly it has to be the London bombings. Any hope that serious progress to tackle climate change would be made after the Gleneagles summit was completely and understandably overshadowed by the terrorist attacks. These desperately sad and tragic events not only wiped out the brief euphoria of London's successful 2012 Olympics bid but took away the focus from climate change deliberations. So, looking back, what did emerge? Well, the delayed final communiqué described climate change as a "serious long-term challenge". It said that human activities contribute "in large part" to increases in greenhouse gases and that "we know enough to act now and put ourselves on a path to slow and, as science justifies, stop and then reverse the growth of greenhouse gases". What had been deemed a "threat" in earlier speeches had now become a "challenge". And we would take action only "as science justifies". Not too impressive, is it? No real sense of urgency about the situation and what next? Apparently, there is an agreement to talks on technology in London in November, which will follow on from the G20 meeting of energy and environment ministers that took place, also in London, in March. As one seasoned observer at the summit was quoted as saying "You get to the end, and you turn the final page, and you ask yourself 'where is the rest?'". Quite!

Closer to home, the Coal Research Forum held its 16th AGM and re-launch of its Environment Division at the IChemE Office in Rugby in May and arrangements for the 6th biennial coal conference to be held at the University of Kent in Canterbury in September 2006 are now in progress.

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16th Annual General Meeting & Re-launch of Environment Division

held at the Headquarters of the Institution of Chemical Engineering, Rugby, 18th May 2005

The 16th AGM and re-launch of the Environment Division was held at the Rugby Headquarters of the Institution of Chemical Engineering on May 18th and was opened by the Chairman of Academe, Professor John Patrick. John welcomed around 30 attendees, which was a little disappointing given the central location chosen for the meeting.

The first business of the day was the presentation of the Report for 2004 by Secretary, David McCaffrey and actions arising from it. For further details of this section of the meeting, please see the Report of the Annual General Meeting issued to members by David McCaffrey with Coal Research Forum E-mailshot No. 12 (2005), on 27th May 2005.

The re-launch of the Environment Division, with Dr Michael Whitehouse at the helm, then followed with the opening section addressing "The Environment: Where are we at present? Setting the scene in the UK". First up was Professor Denis Dugwell who offered an academic perspective, which was a little out of sequence due to the late arrival of one of the speakers.

Denis began by summarising his perception of the status of coal and power generation in the UK. The current situation is that most of the deep mines have been closed and the UK fleet of coal-fired boilers is all at least 30 years old. The lack of new plant orders combined with increasingly stringent environmental legislation has meant that there has been a decline in coal burn with an increase in the use of natural gas. So what future, if any, is there for coal? Nuclear plant in the UK is also old and there is little likelihood of new build in the near future. There has also been a realisation that renewables such as wind, biomass and wave power will not be able to replace existing nuclear plant let alone meet the expanding demand for energy. North Sea gas reserves are now depleted and it is necessary to maintain supplies by importing from countries such as Russia and Algeria. So, maybe there is a future for coal.

When relative prices of power are compared it is clear that coal cannot be ignored. The following figures all refer to a price per kilowatt-hour. With coal the price ranges from 3.0 to 3.5. Gas power prices range from 2.5 to 3.5 and nuclear 2.5 to 5.0. For renewables, the most competitive is onshore wind at 3.5 to 4.5. Offshore wind is currently at 7.0 but is expected to fall to 4.5 in the future. Hydroelectric power is 5.0 to 6.0 but there seems little scope for further expansion in the UK. Wave power is 5.0 to 7.0 but is technologically unproven at commercial scale as yet and finally solar power at 12.0 to 16.0 seems unlikely to offer much scope for exploitation in the UK. From this it is clear that the EU will need a broad energy mix based on natural gas, coal, renewables and nuclear. If one accepts that key issues are economic performance, security of supply and low environmental impact then coal will have to be a major component. It is recognised that carbon dioxide emission is a factor which will need to be addressed if coal is to continue as a major player.

Current technical options for coal include sub and supercritical (>250 bar; 600°C) PF combustion; sub and supercritical bubbling FBC and circulating FBC. The BFBC option is strongly focused on using biomass. In the near future further development of IGCC with improved efficiency and hydrogen production is likely. USC (>300 bar and 700°C) PF combustion and advanced supercritical CFBC are areas where development will continue. In the longer term, oxyfuel firing and pressurised versions of PF, BFBC and CFBC are expected to attract development funding. Other more advanced technologies such as hybrid combustion-gasification systems and ZECA (zero emissions carbon alliance) cycles could also feature in future developments.

The requirements of the LCPD (see the David's Graham and Leich presentations) illustrate the difficulties of meeting emission regulations in the future. Combine this with the development of technically feasible but commercially unproven CO₂ abatement technologies and it is quite obvious that the universities have much to offer in helping to solve some of these challenges.

Denis provided a list of areas where UK universities could make major contributions to filling existing knowledge gaps. These include fundamental studies which provide the underpinning science and involve bench and small pilot scale reactors and models. Other topics include kinetic studies on char oxidation rates, gasification reactivity and pollutant formation rates. Thermodynamic predictions of trace element partitioning, nitrogen species and dioxins is important as is the development of new methods for the analysis of these entities. Universities may also provide sorption studies for substances such as mercury and a better understanding of deposit formation in power plant.

Denis then described a number of projects which had been carried out by Imperial College. In brief, these involved the assessment of coal and coal/biomass blends as power station fuels using small scale testing; trace element partitioning during combustion; the ZECA project in conjunction with the University of Cambridge and coal injection into a blast furnace.

Denis in his concluding remarks felt that UK coal-powered generation was at a "cross roads". The existing ageing PF-fired fleet of boilers is being threatened by the LCPD and by competition from gas and renewables. Technologies are in the pipeline to deliver higher efficiencies and which will allow coal to continue to be used. However, they need to be able to offer carbon capture and storage and although they can – at what price? There still remains a need to identify the most promising technologies and then demonstrate it (or them) and this will require significant R&D funding and huge commercialisation costs. Quite who will provide it and how it will be funded is not clear. The UK coal R&D base is also in decline and although industry and academe are trying to breathe life into it – it is a difficult task. Hopefully, Framework 7 will recognise the need to continue coal R&D.

The industrial perspective was given by Mr David Leich of International Power (IP). David, who is the Station Manager at Rugeley Power Station in Staffordshire, explained that IP had been formerly part of National Power and had split off from this company in 1999.

IP owns, controls or operates more than 15,000 MW of generating capacity worldwide. Since demerging, IP has built up its international presence by constructing new generating plant in the US, Oman and the UAE and through the acquisition of plants in Australia, the UAE and the UK. Within the UK, Rugeley Power Station and Deeside CCGT plant are wholly owned and IP has part ownership of the Dinorwig pumped storage system in North Wales and the Derwent CCGT plant near Derby.

David began by explaining what he felt were the major issues confronting a company such as IP which has Rugeley as its sole, UK, coal-fired electricity generator. The plant is very old and in need of refurbishment and it was said that non-environmental capital expenditure of £200M would be needed over the next 20 years. However, it was the Large Combustion Plant Directive (LCPD) that gave him the single largest headache! Rugeley has obtained Section 36 consent to fit FGD plant but has not yet made a final decision. FGD plant fitted to UK stations in the early days, it was claimed, did not perform well, some were late in completion and lost 'boatloads' of money for the suppliers. The other concern was what the UK and Europe is going to do on carbon issues. Rugeley is one of the top 20 carbon dioxide emitters. The NAP (National Allocation Plan) is based on the CO₂ emitted over the previous five years. But what will happen in the future with NAP2? There is also significant volatility in the price of CO₂ allowances, currently at £10-£11 / tonne.

David was pleased to note that both the DTI and DEFRA at last accept that this whole area is a 'big issue'. He understands that the CO₂ allocation will be made after a benchmarking exercise has been carried out but is not clear how it will be done. FGD and NO_x issues used to be about acid rain but now it is felt that there is much more concern over greenhouse gases and CO₂.

At present coal-fired stations such as Rugeley are reasonably profitable, which is felt to be linked to the high price of crude oil. This is, in turn, linked to the price of electricity.

If Rugeley chose to opt out of the LCPD it is likely it would burn low sulphur coals such as are available from Russia, (0.3% to 0.5% S). These coals are known to cause ash collection problems and SO₃ injection and upgrading of the precipitators would be necessary. In the case of NO_x, 500mg/m³ has to be achievable by 2008. At present 650mg/m³ can be achieved with UK coals but the low sulphur Russian coals produce 850 to 1,000mg/m³. If FGD is not implemented then upgraded low NO_x and precipitator system will be necessary. Improved NO_x emissions may be achieved using boosted overfire air systems (BOFA).

The LCPD was clearly a major issue to IP as David returned to the theme and revealed how they were struggling to understand what it is all about! They now have until the end of the year to make a decision on whether to opt in or out but the closing date seems to have been changing. It has also been very difficult to get answers on LCPD from the legislators. For example, opting out means that after 20,000 hours operation, by 2015 the plant will have to close. However, what seems unclear is how the 20,000 hours is defined – is it per boiler, per station, per flue or per stack? Also, if they chose to opt in which scheme would they have to comply with? is it the hybrid scheme proposed by the UK government or some other, possible European scheme.

Environmental legislation and Integrated Pollution and Prevention Control (IPPC) were also cited as areas of overly complex bureaucracy requiring the filling in of excessive numbers of forms.

Rugeley has also embarked on a modest biomass co-firing exercise using, it was said, a shed and bulldozer! It was started in mid 2003 and it is felt likely to continue for as long as the ROC's scheme is in operation. Of the materials available olive cake and pellets and wood pellets have been trialled. The olive waste was satisfactory except that the stones were too hard to mill. The material was easy to handle and produced only low dust levels, although some difficulties at the port of entry and with self-heating showed up. The wood pellets were easy to mill although more dusty. In addition they were of lower density and the dust could present health hazards. On balance though wood was a biomass fuel with which IP were fairly happy.

David then offered a view which he acknowledged was contentious but was, he felt, worthy of consideration. If a plant opted out, could it then be used to dispose of wastes such as sewage sludge, pyrolysis residues and other substances not presently allowed to be burned in power stations. Some contact with local authorities might be worthwhile to facilitate and take forward this suggestion.

Ash disposal is sometimes a problem for IP. PFA cannot always be sold and if not used in landfill may have to be disposed of at cost to IP. It is very important that authorities recognise the value of combustion residues and do not re-categorise it as a toxic waste, as some fear may happen. Also toxic metal emissions such as mercury are a concern – do IP need to invest in mercury capture technology?

IP are in the UK with Rugeley power station to make money but they are aware that more straightforward deals can be obtained in other parts of the world such as Indonesia, Thailand etc. The UK is a very competitive market and investment decisions need to be carefully made, for example the use of biomass with coal – how long for. Also mentioned was the nuclear option which is now being considered as a possible option to help achieve carbon emission reductions. New build would need special rates and concessions but this would be unfair to the non-nuclear operators.

New technologies such as gasification and carbon capture and sequestration will work technically but will they work commercially. IP are very wary of investing in these technologies and they claim to be users of technology and not developers. They do not see themselves as an R&D driven company. In a final comment that might have been only partly a joke David said maybe IP should knock Rugeley down and build a housing estate!

Suitably refreshed after an excellent lunch, the audience sat back to enjoy three papers on "Global Environmental Issues: Industrial and Strategic developments".

Mr Peter Sage of Future Energy Solutions opened the afternoon session by describing emerging carbon abatement technologies and strategies. Peter reviewed three major activities; the UK CAT strategy, the COORETEC project and the FENCO initiative. Peter had already provided background information on the UK CAT strategy and the FENCO initiative at the recent CRF meeting held at

Ferrybridge power station in November 2004. Details of Peters' earlier presentations are to be found in Newsletter No. 42 of January 2005. In terms of providing an update, Peter explained that the UK CAT Strategy had been formally agreed by UK Government and was ready for distribution but had been withheld until after the general election of May 5th. It was expected to be issued in mid-2005 (it was actually published by the DTI on June 16th – ed.), and the new CAT programme would be available in late 2005. It was suggested in the 2005 budget that there could be economic incentives for the CCS programme. The CAT programme would replace the Cleaner Fossil Fuel programme.

An update on the FENCO initiative revealed that the proposal submitted in October 2004 had fully met the technical criteria for support. Contract negotiations had started in early 2005 and a project start date of June 2005 was planned.

The next initiative described by Peter is called COORETEC which means **CO₂-Reduction-Technologies** for fossil fuelled power plants. The project is of German origin and was set up in 2003 following a workshop on power plant technologies held in Berlin in February 2002. After this event the German Minister of Economics and Labour commissioned leading experts from research and industry to provide recommendations for a research and development concept for power plant technologies. The concept should cover the time span until 2020. In December 2003 an Advisory Board was set up which decided to form five working groups, each of them being responsible for one special topic:

- : Oxyfuel processes
- : Gasification processes
- : Combined cycle processes
- : Steam power plant
- : CO₂ storage

The annual budget is €15 to €20M and some projects are already running, others are to start soon. For further information visit the following webpage: http://www.cooretec.de/index_cooretec.php?index=1365

Peter completed his presentation by describing a conference held in Brussels in April 2005 on carbon capture and storage. It was entitled 1st EC Carbon Capture & Storage Conference – Towards Zero Emissions Power Plants and 350 attendees from 26 countries registered for the event. The EU DG's of TREN, RTD and Environment affirmed their support of CCS and CCT especially within the forthcoming Framework 7 Programme (budget €4 billion). Also stressed at the conference was the need for a Technology Platform for Zero Emission Power Generation and a credible regulatory and fiscal framework for CO₂ emissions and CCS.

Dr Michael Whitehouse, then of Casella CRE Energy Ltd. now of RWEnpower plc., gave his presentation on the cleaning up of emissions from low volatile coal plant. He began by describing in general terms the options for plant improvement in areas such as energy, legislation and technology. It was clear that in many countries many of the most basic steps to improve efficiency and emissions have not been taken. For example, average plant efficiency in China and Russia was in the low to middle 20's % compared with a world average of just under 30% and an average in Germany of just under 40%. New technologies offer efficiencies of over 50%. If the basic improvements were carried out it would bring huge

benefits locally and globally affecting both the health of the populace and the environment. However, without addressing these basic steps advanced equipment and techniques for improving efficiency and reducing pollution would be futile.

The presentation reviewed power plant improvements worldwide but focused on Asia and specifically on two European Commission funded projects, one evaluating Russia and the other China. One of these was the exploration of the prospects for EU industry to work together with local and regional organisations to improve the efficiency of low volatile coals in power plants. The focus was specifically on China to demonstrate (via business plans) approaches for cost-effective improvements that can be applied within the Chinese regulatory framework and market context comprising a technical study, a socio-economic study and brokerage events for enhancing EU-China industrial co-operation.

One key question to be asked is whether it is worth upgrading the coal-fired power plant? To do this one must review current power use and future need for increased energy production by determining the role currently played by coals in the candidate region's energy mix and understanding the region's future energy demands based on economic forecasts of growth. The identification of alternative power production options should also be undertaken.

In addition, regional issues play a part. Both countries have huge reserves of low volatile coal, some of which is used in Russia and the Ukraine in power plant which it was not originally designed. As a result gas support is necessary and this impacts on the economics of the process. Investment prospects are judged to be limited in this region. In China there are better prospects for using this type of coal with the added advantage of locally available plant engineering and boiler design support. Environmental issues such as NO_x emissions however, remain a challenge although on balance the investment prospects are felt to be better in China than in Russia. The subject of implementation is linked to factors many of which are political. They relate to policy matters on energy, the environment, economic and investment.

China needs strategies for restructuring its energy consumption in terms of more sustainable development, including the reform of the power system, stabilisation of the coal supply chain and improvements in the efficiency of energy utilisation during production. At source it must establish policies for monitoring energy consumption and emissions monitoring. For coal, strategy requires plant re-powering and/or implementation of low cost clean coal technologies.

The review of technology options involved wide-ranging discussions with European technology and service providers to identify possible solutions.

In addition, plant operational issues such as a better understanding of coal properties and the choice and use of available fuel options together with optimised settings for mills, coal/air flows, damper positions and burner firing patterns can give very worthwhile benefits. Pollutant emissions such as NO_x and SO_x need to be addressed but certain issues were found to be different in these regions. For low volatile coals down shot firing is often used which provides particular challenges in NO_x control. In the case of SO_x control fuel switching is not always possible due to the large distances involved. FGD is an option but the cost and age of the existing plants need to be considered.

Improvements to the steam cycle, for example, optimising steam conditions i.e. reheat temperature, checking operation of safety valves, and protection against water tube damage such as corrosion are all worthwhile options.

A consideration of plant re-powering can give benefits. Upgraded turbine sets can improve efficiency and flexibility to load changes. The retrofitting of upgraded LP turbine components and the replacement of HP turbine blades are beneficial, as is the reuse of components and the use of waste heat.

Prospects for EU Industry include realistic options for low volatile coal-fired plant but inward investment is needed in some countries, particularly Russia and Ukraine. The latter has good short-term prospects due to the urgent need to replace existing plant and because coal is the only realistic thermal energy source. Elsewhere in Russia much depends on future gas prices.

South Korean government policy encourages coal use although emissions regulations are tight, giving rise to an export market for more advanced EU technology. Prospects are high in Vietnam – here higher emissions limits apply in less populous areas and mines will develop because of growth in the steel industry providing a market for plant construction and refurbishment.

However, the greatest market will be China - here there is a need for additional capacity and the most economical technology over the lifetime of the plant is favoured.

Michael concluded his presentation by asserting that the promotion of cleaner coal technologies in developing countries is essential for a balanced, cost effective global climate change response, especially in countries where coal combustion efficiencies are low and alternatives to coal-based generation limited. By upgrading plant and improving efficiency there are significant prospects for improving plant in emerging economic states, especially that burning low volatile coals. China is the key target country for such improvements.

Mr David Graham of E.ON UK plc gave a presentation in which he described some of the challenges of meeting the Large Combustion Plant Directive (LCPD) and also on continuous emission monitoring (CEM). One of the issues, unresolved at this time was whether each boiler, or in the case of a common flue, each flue constitutes a 'unit'. Emission limits for NO_x, SO₂ and dust are laid down by the LCPD and these differ depending upon the age of the boiler. So-called Part A limits apply to existing power plant (>300MWe) from January 1st 2008. Part B limits apply to similar plant built post November 2002. Part B limits are more stringent in almost all cases. David then described some of the complicated rules governing flue gas monitoring, reporting and quality assurance requirements. In particular BS EN14181, entitled Stationary Source Emissions – Quality Assurance of Automated Measuring Systems, is a document designed to ensure that the emitting location has suitable monitoring equipment, which is correctly set up and which stays working correctly. The first requirement, i.e. suitable equipment, is covered by the first Quality Assurance Level, QAL1, which specifies a minimum standard of fitness for purpose. QAL2 relates to in-situ calibration of the equipment and requires extensive and costly field-testing. QAL3 stipulates

regular zero and span drift checks in order to demonstrate the on-going performance of the equipment.

David also briefly described the arrangements for CO₂ monitoring and reporting under the EU carbon-trading scheme. CO₂ is calculated simply from (Fuel burn x Emission factor x Oxidation factor). For large plant, the emission factor is based on fuel analysis and the oxidation factor is based on carbon-in-ash measurements. Fuel consumption must be metered with sufficient accuracy to meet target uncertainty levels ($\pm 1\%$ for large plant).

David concluded his presentation by saying that the situation concerning the resolution of a number of issues i.e. the LCPD and related matters is on-going and unresolved as yet.

After a welcome break for tea, three more papers were presented. Professor Nick Syred posed the question 'Coal, Energy and Environmental Pressures – Where are we being driven? Where do we want to go?' This was a personal view of the future as Nick saw it. He covered a lot of ground and I have tried to encapsulate what I thought he said! If I got it wrong, Nick, I apologise!!

In Nick's view, the situation we face is due to a combination of background pressures, EEC legislation and politics. Gas and oil will not be economic as they become more expensive and UK reserves are depleted. North Sea output has been falling since 2000 and is likely to be very low by 2020-2030. This will affect the UK economy. The question is 'Should we use natural gas for power generation?' CO₂ emissions are seen to have increased when account is taken of the decline in UK manufacturing industry, increasing consumption and imports. CO₂ emission by source showed that power generation topped the list at 29%, followed by transport at 24%, industry at 17% and domestic use at 16%. Nick chose to focus firstly on the domestic situation which is a higher emitter of CO₂ than some might imagine. Here energy conservation had made slow but steady progress as it was felt difficult to force the pace for political reasons. Reasons for this were said to be the long times to replace existing housing stocks, generally poor investment returns on energy savings and other various forms of taxation.

Nick then chose to consider the hydrogen economy and how this might be used to address another high CO₂ emitter transport. Summarising a large scale European test programme involving 27 hydrogen fuel cell buses in nine cities, Nick concluded that only hydrogen from very cheap renewable electricity or nuclear (sodium/iodine cycle with a high temperature reactor), would be viable. It would seem inevitable that conventional diesel and gasoline will be around for many years to come. This presents a serious problem for Government where as before forcing change will be difficult and unpopular. The wider use of natural gas for transport may be desirable but this is likely to result in much higher prices which could equal those of diesel. Biodiesel and bioethanol may be an option but yields are not great and the efficiency of conversion is uncertain. Nick feels the best option may be to optimise fuel consumption by the use of improved technologies applied to engines transmissions, the use of hybrid propulsion systems, better batteries, etc.

Where does this leave the power generation industry? Nick felt that a coal, biomass, nuclear alliance may be the way forward. Both coal and nuclear have to

be able to demonstrate proven long-term storage for their wastes, which they have not done as yet. Biomass for power generation needs to be developed more successfully in the UK. Sweden, Finland and Austria have been successful by developing technology strands to suit local needs. What has made biomass a success in these regions has been a large supply of biomass, a small population, widespread use of CHP due to climatic conditions, disincentives and taxes away from fossil fuel use and a generally higher cost of electricity than in the UK.

Much work has been done in the UK in recent years but climate and housing type do not favour CHP. Availability and consistency of supply have also been problematic in new installations, for example, in chicken litter firing. Low efficiencies are due to highly slagging and/or high ash fuels which preclude better steam conditions. There is also a lack of suitable small capacity, high efficiency steam turbines due to a small market demand.

Nick confirmed the view of many that biomass coal co-firing could and should feature extensively in the future as a way of reducing CO₂ emissions if linked to sequestration.

Nick described POWERFLAM to the audience which was an IFRF initiative of which the University of Cardiff had been a partner. Major EU generators, the VGB and three universities were also involved. Its aim was to develop methodologies to forecast effects of major parameters and give plant operators techniques to predict effects of new fuel mixes. Cardiff's activities included the development of a boiler simulator. Data from the 100kW two stage cyclonic simulator was encouraging and led to the development of a predictor model. Based on the thermodynamic state of eight ash elements and numerous associated compounds, the model predicts slagging and fouling and may be used by boiler operators to identify potential problem areas with given fuel mixes. The model is being extended to include corrosion modelling of superheater tubes and ultimately to provide concepts for a boiler performance predictor.

Nick rounded off his talk by summarising his thoughts on the need to maximise biomass use in order to combat CO₂ emissions, but that it should be used with coal, preferably in large, highly efficient boiler plant. Biomass is much less cost effective as a fuel in the transport sector. Nuclear power was, in Nick's view the obvious balancing technology – hence the coal, biomass, nuclear alliance!!

Professor Alan Williams enlightened the audience as to the formation of NO_x from the co-firing of coal and biomass. He began by reviewing the formation and mechanisms by which NO_x results from the combustion of pulverised coal. In the early stages of PF combustion the coal particles decompose into volatiles and char, each of which contains fuel nitrogen. The ultimate flue gas NO_x levels are determined by the efficiency of conversion of these fractions. Interestingly, the form of nitrogen in the coal does not appear to influence the NO_x forming tendencies of the coal. Models for volatile and char combustion have enabled good prediction of flue gas NO_x levels to be achieved.

Moving on to biomass, Alan explained that it was very different from coal in many ways. Biomass contains less nitrogen but much more oxygen and volatile matter than coal. This volatile matter contains very little nitrogen as most is retained in the small amount of char that is produced. Biomass also shows much wider

variation in nitrogen content which may also be seasonal in some cases. For example, leaves from a tree may contain 1 to 2% nitrogen; bark, 0.2% to 0.5% and the trunk 0.05% to 0.2% nitrogen. Olive stones contain about 0.3% nitrogen but rape seed contains 4% to 7%. Proteins are the main source of nitrogen in biomass but as the plants age they convert in part into cyclic compounds.

Alan concluded his presentation by describing the methodology for predicting NO_x from biomass or coal / biomass blends. He explained that was slightly different from that for coal in that the amount of protein in the biomass and the extent to which it splits into ammonia and HCN must first be determined. From this a modified form of the reaction equations are produced which are used to determine the extent of NO_x formation.

The final presentation was from Dr Steve Wilcox and was entitled 'Improving combustion control systems to minimise emissions'. Steve began by outlining the objectives of the work he was about to describe. The dual aims were to improve combustion by monitoring excess air and coal feed rate and to reduce emissions by optimisation of NO_x, carbon monoxide and unburned carbon. The approach used by the University of Glamorgan team involved intelligent computer systems. Computers are good at doing fast arithmetic and precisely what the programmer wants them to do. However, they are not so good at interacting with noisy data or data from the environment, fault tolerance or adapting to circumstances. Steve then explained that an intelligent computer system is one which should be able to mimic the abilities of humans. For example, neural networks, expert/fuzzy systems, genetic algorithms and intelligent agents and swarms are all ways in which such a system can be achieved., Steve used the concept of a supervised neural network and how it could be used for baking a cake. Input variables would be, ingredients, cooking temperature, cooking time and size of cake. Outputs were cake overcooked, undercooked or perfectly cooked. Various combinations of input are possible and one will give a perfectly baked cake. This system would learn from 'experience' what would be the optimum input parameters.

One successful system, which was described by Steve, was the use of an intelligent monitoring system for the control of PF burners. Using infra red sensors to watch the flame and a microphone to listen to its slag build up was monitored. By training the system with a number of different coals the reliable detection of slag eyebrows above the burner was achieved. A similar method was used to optimise NO_x, CO and unburnt carbon.

Such neural networks work well where there is much data and it is necessary to pick out the structure from existing data. Another tool used by the University of Glamorgan is the genetic algorithm. This is a computer model that simulates the evolution of biological organisms. It uses a simple model of DNA and starts with an initial population. It evolves the population selecting the fittest individuals. It also introduces random mutations to stop 'in-breeding'. It is hoped that this will lead to improved solutions to the problem. Steve then showed two short videos in which genetic algorithms had been successfully used.

The final segment of the talk involved optimisation of Dolna Odra power station in Poland. This tangential boiler has emission and burnout targets of <290ppm NO_x, <21ppm CO and <4% unburnt carbon in ash. A model of the boiler was created and fed with operating variables and combustion air data. The boiler performance

was assessed using an objective function evaluation (don't ask me, I don't know either, Ed!!!) and the results judged to be satisfactory or not. If satisfactory, optimal air setting have been achieved, if not the results are processed using an optimisation algorithm and new setting are fed into the model. Eventually, acceptable results were obtained and the boiler was able to achieve the desired targets.

Steve concluded his talk by emphasising that neural networks can be used with expert-based rules to control combustion; they can be used to diagnose burner faults and that, in combination with genetic algorithms, they can achieve full-size boiler optimisation.

This brought an end to the proceedings and Professor John Patrick was very happy to round off the day with his inimitable closing comments. He thanked speakers for their efforts in producing interesting and though-provoking presentations, the attendees for being there and, of course the organiser and Environment Division Chairman Michael Whitehouse. Thanks are also due to the IChemE for allowing us to hold the meeting at their Rugby Headquarters.

Embers are still glowing in kicked-over UK coal

July 21st 2005 The Daily Telegraph

Old King Coal was once a merry old soul. No longer. Nowadays he resembles one of those European monarchs who has been stripped of the trappings of office and spends his time bicycling around the streets of the capital he once ruled. Yesterday the old King's crown slipped a little further with the news that production at another mine (this time in Nottinghamshire) is stopping. There were the usual crocodile tears from the hard-hatted minister, uttering platitudes to keep the miners happy but doing nothing. The Government has previous form here, starting in the recent past with Prezza Hezza's decision to axe 31 pits in 1992. Since then, the industry's ageing deep mines have progressively run out of the shiny black lumps and shut.

Yet we are nowhere near to running out of coal. Of the estimated 200 billion tonnes with which the Almighty blessed the UK, we've extracted less than 15% in thousands of years of trying. Of the remaining 174 billion tonnes, 1 billion (half a century's current output) is commercially exploitable at current international prices of around \$60 a tonne.

King Coal is prevented from regaining his throne by the twin usurpers of impossibly tight planning rules and the short-term horizons of the power industry. Ten years ago, there was planning permission in England for extracting 20m tonnes of coal; last year the figure was 3m. this is especially frustrating given that in some parts the seams run only a few feet below the King Edward potatoes.

Meanwhile the industry is skewed against new mines because power stations are only willing to offer (at best) five-year contracts for coal supplies. Faced with investing £300m to bring in a deep mine to production, it's not hard to see why the City's coalmen are reluctant to invest without better terms, even if the new mine could produce for a century. The new factor in this familiar story is \$60 oil. Were this to become the benchmark (don't bet on it) coal would become profitable

enough to stand the expense of working out how to neutralise the carbon dioxide. Britain is now a net importer of gas, from places one would not want to rely on overmuch. A revolution in Ukraine might put the frighteners on people worried about the need to secure domestic supply. As the old King will know, it ain't over 'til the canary croaks.

Power station returned to service

BBC News, 16 August 2005

A power station in North East Lincolnshire which has been out of service for three years has reopened in a bid to cut greenhouse gas emissions. Killingholme station, near Immingham, was the second gas-fired power station to be built in the UK and is thought to be the first to be returned to service. The move has created 20 jobs and provided work for local contractors. Parent company E.ON UK said it hoped the site would provide "power supplies for years to come".

The plant closed in April 2002 after there was a switch to burning coal at power stations across the country which then led to an increase in emissions. E.ON UK hopes that by reopening plants like Killingholme it will lower its emissions in line with government policy which calls for a 23% reduction by 2010. Kevin Yorath, site manager, said: "This has been a fantastic achievement by the team, who have been working to bring the station back to service for a year. "They deserve special praise because we believe this is the first time, certainly in the UK and we believe anywhere in the world, that a gas-fired power station has been returned to service after it was withdrawn from service completely." The station's control system has also been updated allowing staff to remotely control the gas-fired Cottam Development Centre in Nottinghamshire. The two plants can produce enough power for more than one million homes.

Cloud whitener offered as global warming cure

Paul Lamarra, The Sunday Times, August 14, 2005

THE government is examining a British-designed system for spraying seawater into the air to make clouds whiter. The idea is that they would reflect more radiation away from the Earth and slow the worldwide rise in temperatures. The technique, invented by Stephen Salter, emeritus professor of engineering design at Edinburgh University, would involve using a fleet of small boats to produce the fine spray. As the water evaporated, tiny particles of salt would be carried into low-lying stratocumulus clouds by rising air currents. The salt would whiten the clouds, making them more reflective, and also create more water droplets, further reducing the amount of sun rays penetrating the atmosphere.

"The government is aware of Professor Salter's ideas and we are currently considering them," said a spokesman for the Department for Environment, Food and Rural Affairs. "It is important when dealing with potential solutions for climate change to think out of the box." The research by Salter, who invented one of the first devices to turn wave power into electricity, will be published in the next edition of the journal Atmospheric Research. He claims that by increasing the reflectivity of one third of clouds around the world by 4.5% he could prevent enough heat reaching the Earth's surface to negate all the forecast effects of global climate change.

Salter, who has collaborated with John Latham of the National Center for Atmospheric Research in Boulder, Colorado, believes a pilot project for his system could be operational within four years. Initially 500 unmanned radio-controlled boats, costing £1m each, would be deployed off the west coast of Africa and west of Peru, where the lumpy stratocumulus clouds are most prevalent.

The 70ft-tall vessels, placed 25 miles apart, would be tracked by satellite. The forward movement of the boats, driven by wind-powered rotors, would turn underwater turbines that would create a field of static electricity. Water sucked into the rotors would hit the electrostatic field, creating the fine mist of seawater. Around the world 40,000 tons of sea spray are whipped up into the atmosphere each second. Salter believes an additional half a ton per second would have to be generated to brighten clouds by 4.5%. Salter believes that companies could be persuaded to pay £10 per ton to the spray project to counteract corresponding amounts of their carbon emissions entering the atmosphere and creating heat. Salter this weekend denied his project was fanciful, saying: "Can you think of anything that did not appear complex before it started? The car must have seemed complex to those used to the horse and cart."

Coal-powered fuel cell aims for efficiency

Duncan Graham-Rowe, NewScientist.com news service, 23 August 2005

A new coal-powered fuel cell may lead to a more efficient way of extracting energy from the fossil fuel than simply burning it. "The idea was to look at a way of converting the chemical energy in coal directly into electrical energy," says Douglas Weibel, at Harvard University in Cambridge, Massachusetts, US. In conventional power plants, coal is burned to produce heat, which is then used to drive steam turbines and generate electricity. But during the conversion of one form of energy to another, about 65% of the coal's energy is lost, says Weibel. Efforts have been made in the past to use coal in fuel cells but these have required electrolytes of molten carbonate, involving temperatures between 600°C and 900°C. Not only do such high temperatures reduce efficiency but they also make the fuel cells prone to corrosion. Weibel's new design allows electricity to be generated at just 100°C, a temperature that is far easier to work with. But the efficiency of the current prototype device is "horrid", he admits. At 7%, it is roughly one-fifth as efficient as conventional power stations in extracting energy from coal, he says.

Weibel, working with colleague George Whitesides, created the new cell by adding iron ions to a slurry of coal powder, mixed into an electrolyte of sulphuric acid. The ferric iron ions are reduced by the coal, allowing a typical fuel cell reduction-oxidisation cycle to take place, generating electricity. The cells still produce the greenhouse gas carbon dioxide, but with coal this is essentially impossible to avoid, says Weibel. But if the efficiency of the fuel cell can be improved above that of power stations, then more energy could be harvested from the world's vast coal reserves, with no concomitant increase in CO₂ emissions. The US and other countries have substantial "clean coal" research programmes. Very simple and obvious improvements could make a huge difference to the efficiency of the cell, says Weibel – using a finer form of coal powder, for example, or enhancing the design of the electrodes and placing them closer together.

Such improvements would be crucial if the fuel cells were to have any chance of competing with conventional coal generators, says Matthew Leach, at the Energy Policy Management Group at Imperial College London, UK. Leach says we should not think of this technology as being analogous to hydrogen fuel cells, which might be used in cars, but as larger-scale power generation units. "There is research on using relatively large fuel cells in combination with gas turbines," he says. But Leach believes the portability of fuel cells is one of their real benefits. With coal fuel cells, he says, this seems limited given the difficulties of distributing a sulphuric acid-based coal slurry.

Journal reference: *Angewandte Chemie International Edition* (DOI: 10.1002/anie.200501192)

Journalists earn hush money from coal mine accidents

By David Stanway, Resource Investor, 22 Aug 2005

Shanghai (Interfax-China) -- Two fatal accidents at coalmines in Ruzhou, Henan Province have created a minor storm after it was revealed that the local government had bribed journalists to keep quiet. Some of the people receiving pay-offs, according to a report originally published in the *Henan Commercial News*, were not even genuine reporters.

A coalmine flood took place in Ruzhou on July 31, and while the authorities attempted to keep a lid on the accident, information quickly seeped out through mobile phone SMS. Within a fortnight, a large number of journalists had rushed into the area. A local official surnamed Yang said that 480 reporters received \$24,660 in hush money. The mine in question was said to be connected to a senior local official.

Yang was also quoted as saying that the amount was nothing compared with the money offered to reporters for covering up similar coal mine accidents in the cities of Dengfeng and Xinmi, also in Henan Province. When a second coal mine flood took place in the middle of August in Ruzhou, over 300 reporters were said to have claimed over \$12,330 from the local authorities. The official said that over two thirds of the people were not actually accredited as reporters, but were still capable of leaking the story to the real media.

Although the Chinese media have been permitted to report on the parlous state of China's mining industry for some years, they often remain subject to intimidation and violence. Nevertheless, many have also been offered bribes to keep their mouths closed.

Eleven reporters from the government news agency, Xinhua, were revealed to have accepted payments in cash and gold bullion from the owners of the Fanshi gold mine in Shanxi Province, where 46 were killed in an explosion in 2002. A Shanxi TV station journalist was quoted by *China Daily* as saying that many reporters often gather at disaster areas in order to extract payments from the local government.

Climate change: imagine a charging rhino

Aubrey Meyer, *The Guardian*, Monday August 22, 2005

In what was old Rhodesia, a steam train used to go daily between Salisbury and Bulawayo along a single track through rhino territory. Eventually, a cranky alpha-rhino took umbrage. As the train chugged south at 70mph, the rhino mounted the track and charged north. The smash derailed the train and killed the rhino.

So with global climate change. With greenhouse gas emissions still accelerating, we are now going down the tracks towards the oncoming rhino. The threatened impact challenges our economy and even our survival.

Peat-bogs are on the verge of out-gassing methane in Siberia and giving climate stability the coup de grâce. Yet we continue to change the climate faster than we act to stop it. Risk analysis suggests we are less than a decade from the point of no-return. Atmospheric CO₂ is now at 380 parts per million and on course for 400ppm within 10 years.

As frequently argued here and elsewhere, whatever else is true, the answer is "emissions contraction and convergence (CC)", markets that operate to a full-term concentration target. Fossil fuel emissions must contract globally while the international shares in emissions converge on equality per capita.

The United Nations framework convention on climate change now says this is "inevitably required". The Church of England says: "Anyone who thinks this is utopian has simply not looked honestly at the alternatives."

Support for CC grows relentlessly. Following the so-called Byers report, Greenpeace put out its own report in July advocating CC with a concentration target of 400ppm. Since 1997, CC has been the position of the Africa group of nations. Will the UK NGOs' new "avoid climate chaos" movement now adopt such a focus - one that has only severally and partially attracted its members so far? Africans would be pleased: African poverty is aggravated by climate change and CC addresses both together.

Everyone knew that Kyoto fell short. But now, apparently killing this baby before it had even crawled out of the cot, our prime minister as good as conceded so at the G8. In exchange for the disarming concession by the US president that we actually do have a problem called human-induced global climate change (as if we didn't know), Mr Blair arranged for five key developing countries to attend and informally succumb to this somewhat vacuous transaction.

Three weeks later Mr Blair learned the US had quietly been putting together a "clean-technology" deal with India, China and Australia behind his back. This deal not only ignores Kyoto, it also ignores the UN and tackles neither rising emissions nor atmospheric greenhouse gas concentrations.

More extraordinary still is the untold story of the corporations. Chief executives of the 23 largest corporations in the Davos World Economic Forum made a joint statement to the G8 leaders. It said governments must define an atmospheric greenhouse gas concentration that is stable and safe, and create a common global

framework to enable them to invest in markets that operate effectively to this purpose from now on.

UK building industry leaders wrote to Mr Blair saying that this framework-based market is contraction and convergence. They were all ignored. The rhino cometh, but Rome was not fazed. Washington's men appear to regard the whole matter as either above or below - but not actually at - their pay-grade. Preliminary climate change damages, already lethal at a local and regional scale, are growing globally at twice the rate of the economy. The buck stops either with UN-led CC or with the rhino.

Coking coal prices will ease back in 2006

From www.purchasing.com 1st August 2005

International prices for coking coal will fall in 2006 off the "unprecedented" level of \$125/metric ton, according to AME Mineral Economics. In its latest report, the Australian commodity analyst says. The coal shortage of last year has now eased with an increase in exports from Australia, Canada and the U.S., as well as a jump in Chinese coke exports.

The average price rose by 119% this year for coking coal, the bituminous coal that is baked for use in smelting iron ore and scrap in blast furnaces into molten pig iron. Supply is better although AME believes the market still isn't in balance. AME forecasts world demand for imported coking coal rising by 3.1% annually between 2004 and 2010. By next year, though, supply of premium quality hard coal should come closer to matching demand. That's because this year's increase in price has attracted new capacity investments in Australia and Canada. This may even result in the coking coal deficit evaporating sometime in 2007, even with the strong growth in global demand—especially in China and Brazil—that is predicted for the next few years.

Mining museum clinches arts prize

BBC News, Thursday, 26 May, 2005

A disused Welsh coal mine which reopened as a working museum has won a prestigious UK arts award. Big Pit, in Blaenavon, South Wales, beat three other short-listed attractions to scoop the £100,000 Gulbenkian Prize.

The museum, also known as the National Mining Museum of Wales, opened in 1983 - three years after closing as a working coal mine. Ex-miners work as guides, taking visitors on tours underground. Big Pit was nominated for the Gulbenkian Prize following a £7.1m refurbishment programme, completed in February 2004. That year, it pulled in a record 141,000 visitors, up from 112,000 in 2003. Staff at the attraction were told it had reached the final four in March this year. Big Pit is set in the former coal and iron town of Blaenavon, which was made a World Heritage Site in 2000 in recognition of the role it played in the industrial revolution. The museum attempts to recreate the authentic experience of a south Wales coal mine.

All the colliery buildings, including the pithead baths, the winding engine house and blacksmith's workshop, have been restored and brought back to life with the

sounds of the miners at work echoing from the past. The pithead baths house the main exhibition. The museum tells the story not only of the coal mining industry, but also of the communities that grew as a result.

One of the Gulbenkian Prize judges, journalist and novelist Victoria Hislop, said Big Pit was a "totally authentic" underground experience. "To be shown round 300ft below ground by somebody who was a miner was one of the top 20 experiences of my life," she said. Keeper and mine manager Peter Walker said: "We've wanted Big Pit to win this prize for so many reasons. "It proves that we've finally come of age as a national museum, and that we're offering a fantastic experience for our visitors - many of whom return time after time. "Big Pit is a special place to visit and I'm delighted that the judges in this year's competition feel the same way as we do about the museum." The Gulbenkian Prize aims to promote public appreciation of museums and galleries by highlighting the best work in the sector.

Sir Richard Sykes, chairman of the judges, said: "Any one of our four finalists would have been a worthy winner of this year's Gulbenkian Prize for Museum of the Year but Big Pit offers an exceptional emotional and intellectual experience. "It tells the individual stories of its community better than any museum I have visited and makes you contemplate the scale, and even the cruelty, of an industrial past that inspired a spirit of camaraderie and pride."

The three short listed nominees which lost out were the Coventry Transport Museum, Time and Tide: The Museum of Great Yarmouth Life, and Locomotion: The National Railway Museum in County Durham.

Tailings

Carron Energy is planning to build a £400m gas-fired power station next to its existing Uskmouth coal-fired plant in Newport by 2008, with the creation of 85 permanent jobs. 19-Jul-2005

Renew Tees Valley is in talks with Progressive Energy about plans to build an 800MW "clean coal" power plant on Teesside. 08-Jun-2005

Do you know how to confuse a coal miner? Show him two shovels and then ask him to take his pick.

Student Bursaries for 2005/2006

Up to six 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 BCURA Projects

B54 UNIVERSITY OF EDINBURGH,
"Arching Propensity in Coal Bunkers with Non-Symmetric Geometries", Dr.J.Y.Ooi and Prof.J.M.Rotter,
(01/09/01 to 31/08/05).

B56 THE UNIVERSITY OF BATH,
"Advanced Characterisation of Industrially-Important Coal-Based Carbons",
Dr.T.J.Mays,
(01/10/01 to 30/09/05).

B60 THE UNIVERSITY OF GREENWICH,
"Three-Dimensional Visualisation and Quantitative Characterisation of Fossil Fuel Flames using Digital Imaging Techniques"
Prof.Y.Yan,
(01/09/02 to 31/03/06).

B62 THE UNIVERSITY OF EDINBURGH,
"Large Scale Semi-Automated Tester for Rapid Assessment of Coal Handling Performance"
Dr.J.Y.Ooi and Prof.J.M.Rotter,
(01/09/02 to 31/08/05).

B65 THE UNIVERSITY OF NOTTINGHAM,
"The Partial Removal of CO₂ from Flue Gases using Carbon recovered from PFA"
Dr.M.Cloke, Prof.C.E.Snape, Prof.J.W Patrick and Dr.E.Lester,
(01/10/02 to 30/09/05).

B66 THE UNIVERSITY OF GREENWICH,
"Direct On-Line Measurement of Wall Friction of Coal as an Indicator of Handleability"
Dr.M.Bradley and Dr.R.J.Farnish,
(01/10/02 to 30/09/06).

B67 IMPERIAL COLLEGE,
"A Study of the Behaviour of Coal Injected into the Blast Furnace",
Prof.R.Kandiyoti and Prof.D.R.Dugwell,
(01/07/03 to 30/06/06).

B68 THE UNIVERSITY OF GREENWICH,
"On-line Measurement of Size Distribution and Concentration of Pulverised Fuel Using Digital Imaging Techniques",
Prof.Y.Yan,
(01/08/03 to 31/07/06).

B69 THE UNIVERSITY OF GREENWICH,
"Handling Characteristics of Biomass/Coal Mixes for Co-Firing: Measurement

Techniques and Establishing Benchmarks”, Dr.M.S.A.Bradley,
(01/10/03 to 30/09/06).

B71 THE UNIVERSITY OF GLAMORGAN,
“Improved Design of Sparge Pipe Air Distributors for Fluidised Bed Combustion Systems”,
Prof.J.Ward, D.R.Garwood, T.Maksoud and Mr.M.Fisher,
(01/07/03 to 31/03/06).

B72 TES BRETBY,
“The Maintenance of the BCURA Coal Bank”,
Mrs.P.D.Alexander,
(01/04/04 to 31/03/07).

B73 IMPERIAL COLLEGE,
“The Selection of Low Cost Sorbents and Process Conditions for Mercury Capture from Flue Gases”,
Prof.R.Kandiyoti and Prof.D.R.Dugwell,
(01/10/04 to 30/09/07).

B74 CRANFIELD UNIVERSITY,
“The Properties and Combustion Characteristics of Coal-Derived Fuels for Industrial Gas Turbine Applications”,
Prof.J.B.Moss,
(01/10/04 to 30/09/07).

B75 IMPERIAL COLLEGE,
“Effect of Coal Type and Oxyfuel Combustion Parameters on Pulverised Coal Ignition”,
Dr.C.Man and Dr.J.R.Gibbins,
(01/10/04 to 31/10/05).

B76 UNIVERSITY OF NOTTINGHAM,
“Microwave Pre-treatment of Coal and Coal Blends to Improve Milling Performance”,
Dr.S.Kingman and Dr.E.Lester,
(01/09/04 to 31/12/05).

B77 THE UNIVERSITY OF NOTTINGHAM,
“The Effect of Additions of Biomass on PF Combustion Efficiency and Ash Properties during Coal/Biomass Co-Combustion”,
Dr.E.Lester, Dr.A.W.Thompson and Dr.M.Cloke,
(01/10/04 to 30/09/06).

B78 IMPERIAL COLLEGE LONDON, (DEPT. OF MATERIALS),
“Coal-biomass Ash Deposition during Deeply-staged Combustion”, Dr.F.Wigley,
(01/01/06 to 31/12/07).

B79 UNIVERSITY OF LEEDS,
“Co-firing Coal/Biomass and the Estimation of Burnout and NO_x Formation”,
Prof.A.Williams, Dr.J.M.Jones and Prof.M.Pourkashanian,
(01/01/06 to 31/12/07).

CALENDAR OF COAL RESEARCH MEETINGS AND EVENTS

Date	Title	Location	Contact
Wednesday, 14th September 2005	The BCURA/CRF Research Event, "The Presentation of Current Projects Funded through the BCURA/DTI Programme"	British Sugar Conference Centre, Holmewood Hall, Near Peterborough	Dr D 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
Sunday, 9 th to Friday, 14 th October 2005	2005 International Conference on Coal Science & Technology	Okinawa, Japan	Japanese Representatives to ICCS Prof. I Mochida, Kyushu University Dr. O Yamada, AIST General Secretary http://www.aist.go.jp/ Ms. Yoshimi Kunugi , AIST E-mail: iccst@m.aist.go.jp Telephone:0081-29-861-8423 Facsimile: 0081-29-861-8417
Monday, 10th October 2005	54th BCURA Robens Coal Science Lecture, Dr.A.R.Jones, Power Technology Centre, E.ON plc., "Clean Coal - A Real Sustainable Option for Power Generation?"	The Royal Institution, Albermarle Street, London	Mr J D Gardner, BCURA Company Secretary, Gardner Brown Ltd., Calderwood House, 7 Montpellier Parade, Cheltenham, GLOS, GL50 1UA Tel : 01242-224886 Fax : 01242-577116 E-mail : john@gardnerbrown.co.uk
Tuesday, 22 nd to Wednesday, 23 rd November 2005	INDABA 2005 11th South African Conference on Coal Science and Technology	Johannesburg, South Africa.	Fossil Fuel Foundation - Indaba 2005, P O Box 411699, Craighall, 2024, South Africa Tel: +27 011 880 1237 Email: techevents@fossilfuel.co.za Internet: fossilfuel.co.za
Wednesday, 30th November 2005	"The Future of Coal in Power Generation with Carbon Abatement" joint meeting of the IChemE's Energy Conversion Technologies and Coal Utilisation Subject Groups in association with the Advanced Power Generation Division of the Coal Research Forum.	The Institution of Chemical Engineers Offices, No.1 Portland Place, London	The Conference Section Institution of Chemical Engineers Davis Building 165-189 Railway Terrace Rugby Warwickshire CV21 3HQ Tel : 01788-578214

March 2006	Provisional: Meeting of the Combustion Division, "Combined Cycle Gas Turbines"	Venue to be Announced	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
March/April/ May 2006	Coal Research Forum Annual Meeting and Coal Utilisation Subject Group Annual Meeting, Title to be Announced	Venue to be Announced	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
Monday, 15 th to Wednesday, 17 th May 2006	AshTech 2006: international conference on coal fired power station ash	Birmingham, UK,	AshTech 2006, UK Quality Ash Association, Regent House, Bath Avenue, Wolverhampton, West Midlands WV1 4EG, UK Tel: +44 1902 810087 Fax: +44 1902 810187 Email: Conference@UKQAA.org.uk Internet: www.ukqaa.org.uk/AshTech2006/
Wednesday 31st May 2006	Meeting of the Coal Preparation Division, Title to be announced	The Coal Authority Headquarters, Mansfield, Nottinghamshire	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
Tuesday 5th - 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