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NEWSLETTER

of the Coal Research Forum

EDITOR'S MUSINGS:

You know what, this part of the newsletter is always the hardest for me. How can I come up with something interesting to say that is relevant to our readership, is topical and has not been said many times before. I know I have always had something to say about the weather but I am English so what do you expect? At least I tried to link it to increased CO2 emissions! I have often railed against the seeming inability of our government to decide on an energy plan and then to implement it. My other hobby horse is that although the cost of low carbon and renewable based energy will be inevitably and unavoidably much higher than conventional energy supply, the view of the authorities seems to be that the general public must not be told.

All these old 'chestnuts' got me wondering about just how long I had been trying to come up with something new and whether things had really changed that much since I first started editing the newsletter. Digging back into the archives confirmed some things but other things I discovered did surprise me. I did not realise that I am now the longest serving CRF Newsletter Editor! Checking back I find that I have served as editor for 10 years starting with Issue 38 in 2003 and that Issue 67 is my thirtieth newsletter. The second longest serving editor was Alan Walker from 1993 to 2001 with 25 issues. Interestingly, there have only been five editors in 24 years. Not so surprising was that when I looked at Issue 38 I found warnings of "power cuts in the UK in 20 years" and statements urging the government to "develop a sustainable solution that incorporates a mix of all types of generation, including renewable sources like wind and wave power, nuclear and cleaner coal and gas-fired power stations" and the desire of the US government to "learn more about natural causes of climate change".

I guess the two things I have learnt are that time really does pass quicker than you would want it to, and that progress for many of the burning issues seems to be glacial at best (pardon both puns!).

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Student Bursaries for 2013-2014

Up to six travel and subsistence bursaries for up to £300 are on offer to bona-fide full-time students wishing to attend appropriate National and International coal and energy-related conferences and event. To apply, please complete a CRF Student Bursary Form obtainable from,

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Please submit your completed form together with the abstract submitted to the conference and a brief supporting letter from your supervisor.

The requirements for eligibility for award of a bursary are that the recipient will submit a short report about his or her impressions of the conference to the Newsletter Editor for inclusion in the next edition. In addition, the report will provide some brief details of the beneficiary, their topic of study and the reasons for wishing to attend the conference.

24th Annual Meeting and Meeting of the Environment Division held in collaboration with the Royal Society of Chemistry Energy Sector.

Cranfield University

10th April 2013

The joint meeting of the CRF Environmental Division and the RSC Energy Sector incorporating the AGM of the CRF went ahead as planned on an unusually warm and sunny day given the unseasonably cold we had recently become used to. Despite that it is fair to say that preparation for the event had at times been difficult. A late resignation of the erstwhile Environmental Division chairman and a number of unexpected late changes to the programme gave the stand-in organiser David McCaffrey headaches which, from past similar rescue situations, he was able to cope with, in the end, comfortably.

With the permission of the presenters it is the intention to make the presentations available on the Coal Research Forum website.

The event was opened by John Oakey, Professor of Energy Technology at Cranfield University, who gave a short but comprehensive view of what Cranfield is and what it does. He highlighted the unique nature of the university in that it caters only for the post-graduate study of science, technology engineering and management, which is unlike any other establishment in the United Kingdom. He provided a deeper insight into Cranfield's energy research capabilities and described some of the large-scale energy research facilities. The themes illustrated included the combustion of solid fuels; bioenergy and energy-from-waste; CO2 capture and transport; chemical and calcium looping; gas turbine engineering (including fuels and materials); surface science and engineering; sub sea energy systems; offshore structural integrity and renewable energy; solar energy and a Masters courses which is offered in energy technology. John also had arranged for a tour of part of the laboratories which took place during the break for lunch.

The seminar opened with session 1, "The Emissions Control of NOx, SOx and Particulates". The session was chaired by the newly-appointed chairman of the Environmental Division, Dr Bill Nimmo of the University of Leeds. Bill gave us a brief summary of his own work interests and then introduced the keynote presentation.

This was give by Dr Nigel Burdett of Drax Power Ltd. and was entitled "Environmental Control Issues in Industry". Nigel acknowledged that the title of his talk was very wide-ranging and that he would have to confine it to certain aspects of particular relevance to his company. Nigel explained that Drax Power Ltd., a FTSE-listed company since 2005, comprises a 4,000MW, six boiler, coal-fired generation plant that consumes 10 million tonnes of coal per year and produces 22 million tonnes of CO2. It is a wholesale retailer of electricity, supplying between 7% and 10% of the UK's electricity needs. The plant has been fitted with FGD since 1990 and is actively seeking to expand its biomass firing capability and aiming to be able to generate 2,000MW by 2016. Clearly Drax is a plant which had 'opted-in' to the Large Combustion Plant Directive (LCPD) and as such will be operational for the foreseeable future.

Nigel then summarised the legislative changes that had taken place to NOx, SOx and particulate limits from the 1990's. These changes (i.e. reductions) were mainly, we were told, incremental and well telegraphed and were implemented through the LCPD and the Industrial Emissions Directive, (IED). For those plants opting into the LCPD there was a new low carbon challenge to be faced. During the period 2000 to 2009 there were three separate unlinked Directives in place in the UK. These were the Integrated Pollution Prevention & Control (IPCC) Directive, which developed sectoral and other BREFs (Best Available Technology Reference Notes); the National Emissions Ceilings Directive (NECD) which imposed national ceilings on SO2 and NOx and the LCPD which imposed site specific limits for dust, SO2 and NOx.

The EU appears to have been unhappy with this set of disparate Directives and from 2003 had been investigating improvements. Any one of these Directives would be sufficient but there are three, none of which works as intended, the NECD ran out in 2010 and is largely irrelevant in UK as there is no legislation and no active monitoring. Due to errors in the original baseline data the UK may be non-compliant. The LCPD sets out fairly relaxed limits for plant, intended by EC as a 'backstop' rather than the norm. It was fixed using 1990's performance and there are several derogations. IPPCD was slow to be implemented as, for example, Drax's permit was obtained one month before deadline, other countries are still overdue. Many countries ignore BREF notes and regard them as guidance rather than being mandatory. BREF documents are long, inconsistent and focus on the very best plant. EC started the revision process in 2003, 'proved' that IPPCD was not being implemented correctly and initiated several new initiatives. The EC is trying to identify where the permit does not reflect EU BAT.

The new EC proposals are two-fold. The first is a revamp of NECD with proposals for 2020. This is aimed as an adjunct to CO2 reduction and as a means of implementing Kyoto 2 by closing fossil-fired plant. It is highly controversial since it relies on projections of each countries' energy mix in 2020 combined with tough ELV and is currently stalled. The UK coal-fired power sector 2020 limits are anticipated to be 20-45kt for NOx and 15-35kt for SO2 (Note: Drax NERP limits 2008-2016 are 41.9 and 33.5kt respectively). Gas plant will contribute as significantly to UK NOx as coal plant, also biomass.

The second is one in which IED merges seven sectoral Directives (LCPD,WID). It keeps most of the LCPD ELV but originally removed derogations and introduced ELV update mechanism and it ties BAT with ELV.

IED effectively forces all EU plant to use limits in any new BREF. It allows EC to further change limits and introduce other issues during BREF production. Compliance with any new BREF is to be implemented in permits within 4 years (max). The EC is potentially restructuring the BREF to a shorter, more focussed document and to better address the key issues of integrating IED and BREF. This is EC's opportunity to rewrite Annex V in IED and to introduce other features (dioxins, heavy metals (mercury), start up/shut down). The question Nigel posed was "Is the BREF is to become an IED implementation document?" Potential new areas may therefore be unit/plant, start up/shut down, operational hours, daily AEL/monthly ELV, upper/lower BAT. The first draft of new version is expected in May 2013.

Nigel described the difficulty a plant operator such as Drax has in making a technology investment decision to address SOx and NOx limits when there are two different levels of BAT. There is a similar dilemma facing plant operators regarding low carbon legislation. Although there is certainty in emission standards up to 2019, beyond this date there is none. Uncertainty and potential constraints to SO2 or NOx exist beyond 2019 but felt to be technically manageable through available equipment (SCR/SNCR), fuel choice, burner management and FGD enhancement.

However, coal plant is ageing and the cost of retrofit can be high. There is a need for a definition of BAT for 'mid-merit' plant. Fitting SCR requires £3-4/MWh for 10 years in payback. The UK carbon price floor effectively limits coal operations. Existing plants are vital to provide sufficient capacity and flexibility but will experience output reductions and then closure as new low carbon capacity is completed.

The implications for UK generation, assuming current carbon price floor plans persist, are that for all existing coal plant there will be minimal environmental investment but low load post 2016, there will be retrofits with SCR/SNCR but at reducing load factors and will convert wholly/partly to biomass to manage both NOx/ SOx and carbon issues

Environmental impacts of a boiler biomass conversion are that emission levels in BREF similar to coal, it is generally low sulphur so possibly no need for FGD, generally reduced NOx although SCR may be difficult to retrofit. Particulate emissions should be amenable to standard technology although there are technical engineering issues to overcome and major safety/ dust management issues. There are upstream investments to be made and supply chain concerns. In summary, it is believed to be a viable medium term transitional technology.

Nigel made reference to the large investment that Drax and other was putting into the Oxy-fuel CCS project in conjunction with Alstom and BOC for the Oxy-fuel plant and with the National Grid for the transportation and storage of CO2.

Nigel provided an update on the status of the route planning for the transport and disposal of the CO2. In regard to the onshore route planning two rounds of public consultation have been completed and for the offshore route planning the route options are in preparation.

In regard to storage development, a prime storage target site and backup has been identified, offshore facilities conceptual design studies have been completed. An appraisal drilling pre-drill data package has been defined and appraisal drilling is expected to begin in summer 2013

Nigel drew his very interesting address to a close by identifying the key messages that he wanted to leave with us. These were that the BREF process is driving standards forward. There will now be regular updates of standards and the investment programmes will be driven by BREF. Biomass conversion is new to the BREF process and CCS is judged to be an 'emerging technique' with no formal standards as yet. Low carbon requirements are dictating a new generation of plant which in turn raises a different set of environmental concerns which include biomass and CO2.

Optional tutorials

-What are BREF'S?

The BREFs are a series of reference documents covering, as far as is practicable, the industrial activities listed in Annex 1 to the EU's IPPC Directive. They provide descriptions of a range of industrial processes and for example, their respective operating conditions and emission rates. Member States are required to take these documents into account when determining best available techniques generally or in specific cases under the Directive.

– What is a carbon floor price and why is it needed?

Creating a carbon floor price in the UK essentially requires our industries to pay a top-up if the market price for carbon falls below a certain level. A carbon floor price is a regulatory/taxation policy that states that polluters must pay a minimum amount of money for the right to pollute. This is likely to take the form of a tax that requires those who qualify to make a payment to the treasury. It is expected to

replace the existing Climate Change Levy, which is a downstream tax on energy use rather than a direct upstream tax on greenhouse gas pollution. Roughly half of Europe's emissions are covered by a European regulation that caps emissions (the EU Emissions Trading Scheme) requiring them to submit sufficient permits to cover their emissions. Permits, known as allowances, can be freely traded and the price someone is willing to pay to acquire them determines the price of pollution. At present because there are too many allowances available in the market compared to the demand prices are relatively low- at around €15 per tonne of carbon dioxide equivalent. This low price is not necessarily enough to deter polluters from continuing to emit and does not provide an attractive enough return for would-be investors in low carbon solutions. There is also the risk it could fall even lower. This lack of price certainty is seen as a potentially important barrier to investment. One way to overcome this barrier and provide stronger incentives would be to issue fewer allowances so that there is more scarcity in the market – this is best achieved at an EU level where discussions are under way to do just that, however, this may take some time and is not guaranteed to happen. A carbon floor price is therefore primarily designed to attract low carbon investment into a country by making the price of pollution higher and increasing the rewards for low carbon projects. For more see: http://www.sandbag.org.uk/site_media/pdfs/reports/CarbonFloorPriceBriefing.pdf

The second paper in this session was given by Dr Chris Satterley of E.ON New Build & Technology Ltd. who provided us with "A Review of FGD Chemistry and the IED Regulations". Chris began by summarising the current status of emissions regulations for SO2 in the UK followed by a brief history of FGD and its development in the UK. An interesting slide was presented which compared the cost of capital and O&M for FGD from its launch in the late 1960's up to the mid 1990's. Similar trends were seen for each which showed that costs rose very steeply at the start and then by the early 1980's the cost began to fall steadily. This indicated that initial designs were improved upon and development of the technology helped to reduce costs.

Chris then described the three main technologies that have been used in the UK. These are the Dry/Semi-dry NID Process; the Sea Water Process and the Limestone Forced Oxidation Process. The suitability of each technique was described and compared and the chemistry of each was explained. Chris concluded his talk with the following observations: FGD is a technology with a well-established history in the UK; a range of FGD techniques are currently applied by the UK power sector with varying degrees of complexity of chemistry; understanding the process chemistry is key to optimising performance and diagnosing operational issues and IED compliance is likely require better control of chemistry as well as potential engineering modifications.

The next paper was given by Mr Guy Sharp of SSE who gave us his views on "NOx Control Issues for a Power Generator". Guy told us that Ferrybridge C, which is situated on the River Aire in West Yorkshire, is the third coal-fired power station to be built on the site since 1924. The station, which consists of 4 x 500MW pulverised fuel units, first fed electricity into the national grid in February of 1966. Each unit consumes 200Te/hr of coal and the site has a coal storage capacity of approximately 1 million tonnes. The boilers are of single furnace front wall fired Babcock and Wilcox design using natural circulation and balanced draught. Each unit has eight vertical spindle mills of which six are required for full load and each mill provide PF to six burners. Residence time for burnout is about one second and particulates are removed by a six pass electrostatic precipitator. Units 3 and 4 have FGD installed to reduce SOx emissions unlike Units 1 and 2 which will be forced to close in 2014 due using the remaining hours allowed by the LCPD.

Guy then explained the consequences of fitting NOx control to the Ferrybridge units, which were: relatively poor combustion (high carbon-in-ash [CIA]) due to the nature of the burner design and the installation of a boosted overfire air (BOFA) system; inability to operate fans on 'auto' as the windbox pressures are low due to the size of the burners; long unattached flames which impinge on the rear wall due to the PF to primary air velocity being greater than that of the secondary air ; inability to improve combustion by increasing air flow – diverting BOFA air results in increases to CIA, carbon monoxide and NOx and delayed combustion as up to 5% of

the fuel is being burnt in the convective sections of the boiler. Guy then showed two pictures of burners which had suffered severe metal loss around the nozzle area and also tube failures.

A programme of full furnace CFD modelling analysis was undertaken in which the CO concentrations were modelled. An illustration showed the changes to CO concentrations predicted between the existing burners and the proposed new RJM burners. The new burners, because of their shorter flame length, appear to restrict CO concentration to within the furnace envelope unlike the original ones where CO concentrations still remained high outside of the furnace envelope.

Unit 3 was chosen for a full retrofit of 48 RJM Ultra Low NOx (ULN) burners and the results appear to have shown a significant improvement in NOx and CO emissions. It is intended that further work is carried out to the BOFA system in 2016 and by 2020 Guy informed us that secondary NOx control, such as SCR, was under consideration.

Guy concluded his talk by saying that although good progress had been made there still remained significant challenges and listed them as: fuel distribution; air distribution; mill performance; air heater performance; ID fan capacity; fuel characteristics; feed heating issues; frequency response and tube leaks

Due to the unavailability of two of the original presenters the opportunity was taken for Dr Pedro Otero to provide an overview of the exciting and new Spanish government-sponsored research centre Fundación Ciudad de la Energía (CIUDEN). Dr Otero is the CO2 Capture & Transport Programme Director and CIUDEN has recently joined the Coal Research Forum.

Dr Otero explained that CIUDEN, standing for city of energy, ciudad de la energia in Spanish, was founded in 2006 to promote economic development through activities related to energy and the environment in the relatively poor region of El Beirzo in North West Spain. It is leading Spain's carbon capture and storage research efforts, with programmes covering the whole CCS chain, as well as founding a National Museum of Energy and collaborating with universities on post-graduate training. It is also developing a site at Hontomin which will become the best equipped CO2 storage plant in the world.

Dr Otero explained that the philosophy of CIUDEN was to “focus on doing the doable” offering complete carbon capture, storage and transport capability using pre-industrial size installations and comprehensive technological development. The facilities at CIUDEN incorporates the following units: - fuel preparation system, pulverised coal boiler (20 MWth) capable of operating from air-mode to full Oxy-combustion mode, circulating fluidised bed boiler (15 MWth air-mode, 30 MWth full oxy-mode), biomass gasifier (3 MWth), flue gas cleaning train to remove dust, NOx and SOx, CO2 compression and purification unit (Oxy-mode) and CO2 transport test rig. A full spectrum of coal qualities, as well as petroleum coke and sustainable biomass, has been tested.

One of CIUDEN´s objectives relates to onshore geological storage of CO2 in deep saline aquifers (SA) in which it intends to demonstrate its feasibility and safety, to develop methodologies and technologies, to facilitate technical criteria for Regulating Authority’ and to increase scientific knowledge through R&D programmes. The selected location fulfils the internationally established geological criteria for installations of this kind and it follows the guidelines suggested by ZEP*. [* *Accelerating the demonstration of CO2 geological storage in Europe (March 2013).]*

In October 2012 CIUDEN successfully completed the first CO_2 capture process using Oxy-combustion in a circulating fluidised bed (CFB) boiler at its pilot facility. The milestone was achieved after the commissioning of a CO2 Compression and Purification Unit (CPU). The development costs have been financed by the European Economic Recovery Program of the EU. This is one of the five European projects selected to develop CCS technology.

CFB boiler operation of more than 3,000 hours was achieved using several fuels and blends, e.g. anthracite, sub-bituminous coal, petroleum coke and biomass. In-situ NOx and SOx removal was also achieved with good results. Higher thermal power was obtained for the same size boiler and CO_2 concentration in flue gases over 85%, dry, were measured. However, some issues still need to be resolved such as problems with solids feeding, cold spots – acid condensation, air infiltration/gas leakage (tightness), materials erosion in refractory and metallic components and solids agglomeration.

Dr Otero then described the Oxy CFB 300 Compostilla project. The consortium comprises CIUDEN, Endesa and Foster Wheeler. Carbon dioxide (CO_2) is currently being captured using Oxy-combustion technology based on a 30 MWth circulating fluidised bed boiler to validate the technology. A new 300 MWe power plant will be constructed in a second phase. The mass of CO_2 to be captured at full scale is approximately 1.1 million metrics tonnes per annum. The CO_2 would be compressed then transported approximately 150 km by pipeline for storage in onshore deep saline formations.

A Storage Technology Development Center/Pilot is to carry out R&D activities at a site separate from the commercial storage site where less than 100,000 tonnes of CO_2 will be injected starting in 2013 at about 1,500m depth over a period of 5 years. The project has completed the full CO_2 capture process, using Oxy-combustion in circulating fluidised bed (CFB).

The project is currently constructing the Storage Technology Development Center/Pilot to carry out extensive R&D activities with injection of CO_2 starting in 2013. Extensive data acquisition campaigns have already taken place including obtaining baseline data since 2010.

A final investment decision is expected to be made in 2013 for commercial operations to start in 2015. Project has been awarded 180 million Euros in funding by the European Recovery Programme for the first phase of the project. The project proponents' main interest is to validate a flexible and competitive CCS technology at industrial level that will enable existing fossil thermal plants to be renovated from 2020, using a wide range of domestic coals as well as imported fuels (e.g. coal, petroleum coke) and biomass.

At this point in time CIUDEN is about to finalise the front end engineering design (FEED), Phase 1 of the EEPR (European Energy Programme for Recovery) of the EU, is about to be completed and the experimental phase has been successfully completed.

CIUDEN's on-going R&D programmes are extensive and, in addition to OXYCFB 300 includes FLEXIBURN (flexible high efficiency CFB combustion technology); MACPLUS (advanced materials for Oxy-capture); BRISK (biomass gasification); RELCOM (Oxy PC firing); BiOxySorb (Co-combustion of 2nd generation biomass under air and Oxy-fuel conditions in PC boilers and emission control by sorbent injection); IMPACTS (CO2 quality for transport and storage); O2GEN (2nd generation Oxy-fuel power station); ECCSEL PPI (European distributed and integrated research infrastructure) and R&DIALOGUE (social perception of low carbon technologies).

Dr Otero concluded his talk by restating the capabilities of CIUDEN in CO2 capture, transport, storage and permitting and their alignment with EU objectives in the deployment of CCS technologies. He invited delegates to the next Oxy Combustion Conference in Ponferrada, Spain in September 2013.

Following the last formal presentation the CRF AGM was held.

After a visit by some of the attendees to the laboratory facilities an excellent lunch was provided by Cranfield University which I am sure was enjoyed by all!

Suitably refreshed, and necessarily so given the challenge of the afternoon programme(!), Session 3 opened and was chaired by Chris Satterley.

The first offering was from Niall Moroney of RWEnpower plc who talked to us about "Particulates Control in the Power Industry". He began by providing some key facts and figures about the RWE group. RWE in the UK is mostly CCGT based with only one coal-fired unit at Aberthaw, one biomass unit at Tilbury and an opted-out oil-fired station at Littlebrook. Niall described the sources of particulate emission during power generation and their harmful effects on human health. Niall explained the available particulate control options, their performance and relative costs. He than moved specifically to a case study of Aberthaw which is unlike any other coal-fired plant in the UK being down-shot fired and designed for low volatile coal. The plant comprises three 520MWe direct cooled units which fire semi-anthracite. Seawater FGD has been fitted to all units.

A three phase approach was devised to reduce particulate emissions, combustion optimisation, ESP removal? (Improvement? Ed.) and sea water FGD. The planned reduction of particulate emissions was to be achieved by minimising CIA and excess air. Firing coal and achieving low NOx emissions is always an operational balance. Low NOx can mean high CIA and CO and vice versa. The coal diet suitable for Aberthaw is controlled within a set specification and dynamic classifiers have been fitted to all mills. PF pipe coal flow balancing has also been carried out.

Improvement to ESP performance targeted optimising collection efficiency and minimising duct in-leakage. Ammonia and sulphur trioxide are injected before the ESP to help collection efficiency which is exacerbated when firing low sulphur coals. The ESP, which is a 3 pass collector each with 4 fields, was fitted with an upgraded transformer voltage rectifier system. Air ingress measurements are performed routinely but the particulate loading is typically less than 50mg/Nm^3 at the FGD inlet.

The aim with the seawater FGD plant was to ensure efficient gas/liquid distribution and to act as a 'polishing' stage for the final effluent. Sulphur dioxide removal by the FGD is 97%. Total suspended solids which are added to the cooling water is less than 1mg/l which produces a range of suspended solids of between 50 and 100mg/l in the cooling water inlet. Particulate stack emissions are typically less than 10mg/Nm^3.

Current challenges to efficient plant operation include poor quality coal which can cause combustion issues; plant faults such as blocked burners, damper faults, fans, ESP failures and FGD issues – demister, operational issues. Other issues include the co-firing of biomass and the management of ESP rapping.

Future challenges yet to be faced include ageing plant – plant degradation and failures; PM 10s and PM 2.5s becoming more of a concern; implementation of the IED will introduce more stringent "backstop" ELVs; the BREF may impose yet tighter ELVs.

In conclusion, Niall summarized his talk with the following statements; RWE is one of Europe's five leading electricity and gas companies; particulate control is important for large combustion plant (LCP) to maintain a license to operate and for local health effects; Aberthaw Power Station uses a combination of combustion, ESP and FGD optimisation to achieve dust emission compliance; and future legislation will require LCP to comply with more stringent particulate ELVs.

The next paper was by Professor Alan Williams of the University of Leeds who presented a paper entitled "Modelling and experimental studies relating to gases and particulates emission from coal/biomass combustion". Alan provided a thorough review of many of the important aspects of coal/biomass combustion. He discussed the large scale combustion equipment that the University of Leeds has at its disposal. This includes the Air Combustion Plant (ACP) which is a cylindrical design, 250kWth down fired pulverised fuel combustion system with interchangeable coal/biomass burners, fuel (coal/biomass) feeding system, a dedicated air metering skid, flue gas filter, heat exchanger and temperature and flow monitored water cooling system for the combustion vessel and flue ducts. The plant is operated and monitored

using a dedicated control system connected to an industry standard SCADA system in a central control room for system monitoring, operation and data acquisition. This plant can also operate in Oxy fuel configuration with 2D and 3D flame imaging capability.

Alan then moved on to theoretical and fundamental studies and briefly mentioned coal biomass combustion and NOx formation mechanisms. He compared the structural differences between nitrogen in coal and nitrogen in various biomasses. When discussing the rationale used in this work Alan said that the approach was to assume that many aspects of the coal and biomass combustion processes are common, and that the key sub-models are the same as for coal, i.e. those applicable to drying, devolatilisation, volatile and char combustion. However, the biomass particles are large and physically complex and present a number of heat and mass transfer problems. Biomass char particles can have complex shapes making CFD modelling difficult. Alan discussed the partitioning of nitrogen between volatile matter and char and the equipment used for this is a drop tube furnace. Data presented showed that not only does the overall nitrogen content of biomasses vary considerably but also that the amount of nitrogen retained in the chars also varies.

The final sector that Alan discussed was combustion modelling. Zone modelling is a topic involving simple models but one which needs temperature input, however, it permits complex combustion calculations. CFD modelling is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyse problems that involve fluid flows. Depictions of CFD models of particle temperatures, temperature in the near-burner zone of a low NOx burner and the influence of intermittency in two turbulence models were provided. A full furnace modelling approach involves fundamental and CFD modelling of single flames (0.1-10 MWth) followed by CFD boiler modelling. After this a full plant model development in gPROMS would be undertaken and development of detailed models for heat transfer using data integrated directly from CFD results would follow. Alan then concluded his whistle-stop tour of combustion modelling with some CFD illustrations of burner flame shapes, temperature contours within the boiler under a range of conditions and velocity and heat transfer predictions.

Professor Steve Wilcox of the soon to be re-named University of Glamorgan (we were told that they were to be merged and re-named the University of South Wales on the next day) gave a presentation entitled “Monitoring co-firing and Oxycoal burners using optical sensors”. Steve’s talk was mainly made up of European funded project activities.

These included an RFCS project ‘Smartburn’ and an FP7 project called ‘Relcom’. The full title of the Smartburn project is ‘Intelligent Monitoring and Control of Large Burners Fired by Pulverised Coal and Coal/Biomass Blends’. In summary, its aims were the development of innovative, monitoring control and optimisation systems to improve the performance of burners and boilers fired by pulverised coal and coal/biomass blends. As a consequence CO2, NOx and SO2 emissions will be reduced and the project will also enhance the ability of utility boilers to burn coal/biomass mixtures. One of its main aims was the development of a system for monitoring and control of individual burners using low cost sensors and artificial intelligence. Preliminary data gathering was carried out by Steve’s team using sensors which can detect in the UV, visible and IR ranges of the spectrum. Full scale burner monitoring was carried out and the data was processed using self organising maps, (a version of a neural network). The project demonstrated burner control over wide range of conditions at 500kW and successfully controlled two 5MW co-firing burners on the Dolna Oldra Power Station. It was also able to detect burner instabilities.

The University of Glamorgan team were tasked with understanding whether any burner to burner interactions were occurring during boiler operation. Burner separations were made at 50cm and 100cm, the unit operated at air and Oxyfuel firing mode and a number of different flue gas recirculation rates were measured. Consistent trends were observed for all sensors, and for both burner separation distances which showed that increase in (excess air) λ showed an

increase in signal strength; increase in the flue gas recirculation rate gave a decrease in signal strength and no detectable burner interaction traits seen.

The final conclusions to the work describes were that the use of low cost photodiodes, through suitable signal processing, enables monitoring of flame condition- (coal, coal/biomass, Oxy combustion and gas; allows control of some characteristics (NOx and CO), allows detection of burner instabilities and could be integrated into boiler control system.

A paper presented jointly by Miss Nelia Jurado and Dr Hamid Darabkhani of Cranfield University then followed entitled "Process conditions in Oxy-fuel combustion". This talk was given jointly by the two authors. Dr Darabkhani described the 150kWth Multifuel Combustion rig at CERT (Centre of Energy Resource Technology) in Cranfield University and its use as an Oxyfuel combustion test facility. The fuels used were Daw Mill coal, the biomass CPC (Cereal Co-product) and a 1:1 Blend of each. Miss Jurado described the test programme carried out and the results were compared with mathematical modelling data. Experimental results obtained were in the range proposed by other researchers. The maximum concentration of CO2 reached in experiments was 56.7% (v/v on a wet basis) which compared well with other workers engaged in similar research. Ash deposit analysis has shown their high corrosion potential in the 100% CCP case due to potassium sulphate formation. On-going modifications to the layout of the rig were described i.e. water and SOx condenser; new measurements (Acid dew point, SO3, heat transfer, % burnout). A Kinetic Simulation Model has been developed with acceptable agreement with experimental results.

A replacement presenter for the next paper was Malgorzata Wiatros-Motyka from the University of Nottingham who delivered the offering of Dr Chenggong Sun namely "Materials and process for efficient removal of mercury and other impurities for advanced gas clean-up applications". Malgorzata began her talk by drawing attention to the highly toxic nature of mercury and the fact that coal burning is the second largest contributor to global mercury emissions. Furthermore, there are no EU limits for mercury emissions at this time. Mercury emission control strategies include improvements to plant efficiency, coal treatment, synergistic removal with other air pollution control devices, mercury-specific sorbents or currently under development multipollutant control.

Mercury sorbents are materials such as activated carbons (sulphur, bromine or iodine impregnated), zeolites, calcium species (lime), fly ash, transition metals, and their oxides/sulphides. Their performance is temperature restricted and they are usually of low capacities. They are easily deactivated by flue gas components (e.g. SO_2, H_2S) and cannot be regenerated.

The work undertaken at the University of Nottingham is based on using manganese oxides (MnOx). Over thirty different MnOx minerals have been identified. They are known to act as 'natural traps' for heavy metals and trace elements in waters & sediments.

Previous use and preparation of MnOx-based sorbents include the oxidative capture of mercury and arsenic in aqueous solutions and the removal of elemental mercury, NOx and SO2. They have been used as catalysts for the oxidation of methanol, ethanol, benzene, carbon monoxide and for the combustion of VOCs. Most research has been done on MnOx prepared via impregnation and precipitation.

The most effective mercury sorbent was produced by the co-precipitation of MnOx with zirconia. Without zirconia the pore structure of the MnO2 obtained by precipitation is dominated by macropores, and therefore the surface area remains relatively small.

Sorbent capacity of MnOx was highest when produced with zirconia - other sorbents using alumina and cerium oxide performed less well. The novel sorbent was tolerant to sulphur dioxide and was thermally stable. In addition, the sorbent was regenerable and the mercury could be recovered.

Malgorzata ended her talk by summarising her finding and said that co-precipitation is the optimal preparation method for MnOx-based sorbents which leads to high mercury adsorption capacities. MnOx/ZrO2 sorbents can be regenerated; able to operate in different atmospheres and temperatures at least up to 250°C. However, extensive testing is required to identify the limiting factors and to improve the operational conditions.

The next offering was entitled "Experimental research on the physics of coal combustion" was by a team from Imperial College London and was presented by Professor Yianni Hardalupas. Professor Hardalupas began his talk by showing how low NOx burners work and the importance of the trajectories and residence times of coal particles in the near-burner region. Knowing the particle size and velocity of a non-spherical shape of, for example, coal particles is clearly of great importance and a technique to do this, known as shadow Doppler anemometry was shown and described. Determining the temperature of the coal particles is also vital and to do this a technique known as spatially resolved two colour pyrometry was introduced and described. These two techniques are combined to measure velocity, size and temperature of the coal particles. Another intriguing question that Professor Hardalupas's team has been working on is whether a flame is derived from the combustion of volatile matter or char. Although some success has been achieved a more reliable technique is needed.

Investigation into the pressurised combustion of coal revealed two areas of research interest which Professor Hardalupas's team explored; near-burner coal combustion characteristics and the clean-up of pressurised combustion gases. The team used a pressurised coal-fired furnace with gaseous fuel support. In answer to the question "Does particle size matter?" it was found that different particle sizes reverse their motion at different distances from the burner exit, leading to different residence times in the recirculation zone. Therefore, different sizes contribute differently to NOx emissions. It was also found that there was a centrifugal effect where larger coal particles were thrown away from the centre line of the burner. Other areas of study included the effect of vitiated air on combustion and the reactivity of coal particles. How to distinguish between char and soot particles was also studied.

Dr Gang (Gary) Lu of the University of Kent gave his paper entitled "Measurement of particulate emissions through electrostatic sensing and digital imaging". Gary began by outlining the activities of the Instrumentation Research Group at Kent which has established a strong international reputation in developing innovative sensors and instrumentation systems for the power generation, healthcare, manufacturing and food processing industries. More specifically Gary mentioned pulverised coal/biomass flow metering, on-line particle sizing, flame imaging, on-line fuel tracking and monitoring of particulate emissions. The need for this technology was shown by reference to environmental legislation which included two EU directives on IPPC and the UK Air Control Strategy document of 2007. Industries having to ensure compliance with this legislation included combustion, incineration, mineral, metal, chemical and food processing.

Parameters to be measured included mass concentration, [mg/m^3], mass emission, [kg/h or g/h], particle velocity, [m/s] and particle size distribution, i.e. $PM_{2.5}$ and PM_{10}. The challenges to these measurements involve low level dust density, in the order of $1mg/m^3$, large stack size, variable particle size, hostile environment, installation, maintenance calibration and traceability issues. Four techniques were presented, opacity (light transmission), electrostatic (electrodynamic), light scattering and digital imaging. The electrostatic sensing principle works on the basis that moving particles which can be made to charges can then be collected by electro-rods inserted into the gas stream containing the particles. Particle velocity measurements can be measured based on electro-charges collected on downstream and upstream sensors thorough a method of correlation (like a speed camera on the road! Ed.)

Gary also touched on the use of digital imaging techniques where imaging and scattering techniques can be combined to give the particle concentration; also light scattering and digital imaging methods. Gary ended his talk by summarising the status of the technology. He noted

that it is difficult to measure particulate emissions on an on-line continuous basis and that substantial further research is required to meet environmental legislations. Electrostatic techniques for mass emission monitoring have many advantages over other techniques and the rod sensors are suitable for the measurement of both mass concentration and particle velocity for a wide range of stack sizes. The imaging technique may provide a suitable solution to on-line particle sizing and emissions monitoring. Imaging and scattering techniques can be combined to accommodate a wide range of particle sizes.

The final paper of the day was given by Dr Surjit Singh of the University of Leeds who described a "Novel application of bio-char as a catalyst in the low temperature SCR-deNOx process". Dr Singh began by explaining the function of conventional SCR. In this system the SCR unit is located up stream of the air pre-heaters, FGD and particulate control devices in order to meet the necessary temperature requirements (300 to 400^{o}C). In this temperature zone the SCR unit has the unwanted effect of aiding in the conversion of SO_2 to SO_3 and the production of ammonium sulphate $(NH_4)_2SO_4$ and ammonium hydrogen sulphate $(NH_4)HSO_4$. These salts are known for their respective corrosive and fouling nature. SCR unit replacement is costly and can only be performed during an outage. Low temperature SCR operates in a temperature range of 100 to 200^{o}C) and is down stream of air pre-heaters, FGD and particulate control devices. This process avoids conversion of SO_2 to SO_3 and the production of ammonia salts.

Dr Singh next described his work which involved the novel use of a waste-derived SCR catalyst. The approach represents a way of combining waste disposal, energy recovery and pollution control (NO) in one process. The technique was to use a waste material, cotton stalk in combination with oxides of manganese (Mn) and cerium (Ce). These transition metals are known to demonstrate excellent performance at low temperatures due to unique redox and acid-base properties.

Two methods were described for the preparation of the low temperature SCR catalysts using cotton stalk treated with phosphoric acid and then heated to 800^{O}C in nitrogen. This material was then exposed to manganese or cerium salts and the active elements became impregnated on the support material. This was then dried and then after calcinations at 500OC the catalyst was ready for testing. A variation on the substrate was also produced and tested using steam during heating to 800^{O}C.

The catalysts were tested on a fixed bed SCR reactor and NOx conversion rates were obtained of 48% to 68% for both types of catalyst. Dr Singh then discussed the theoretical issues and implications of his work. He then concluded his talk by summarising his findings as follows: The raw cotton stalk and pyrolysed char have shown a potential for possible application in the low temperature SCR-deNOx process.; NO reduction is far more dependent on the weigh t% of the metal loading rather than the physical parameters such as the pore size, pore structure and surface area; the addition of phosphoric acid significantly increased the BET surface area (m2g-1) for both catalysts and higher NO reductions can be realised by an increase in the metal loadings of manganese and cerium.

The marathon session was brought to a close when Professor John Patrick delivered Session 4 the closing address. He kept it quit short but stated that from his perspective it had been a very useful and informative day and one where industry and academe had been given the opportunity to meet and exchange ideas on topics of important and mutual interest.

RSC Energy Sector Early Careers Chemists Event, Cranfield University, 27th November 2012

A summary of the above event has kindly been provided by Anna Weston, who is a member of the RSC Energy Sector Executive Committee.

In 2011 the RSC set all attendees of their General Annual Assembly a challenge. This was to build a legacy for the International Year of Chemistry which would help to inspire people with chemistry in 2012. The Energy Sector committee decided to take on this challenge and set to work on the organisation of an event to celebrate and bring together early careers researchers working in all areas of energy research.

The RSC Energy Sector Committee held their Early Career Energy Sector Chemists Symposium on the 27th November 2012 at Cranfield University. The event formed part of the official opening of Cranfield's new £2million Energy Technology Laboratory funded by DECC as part of the UK CCS Research Centre. Cranfield's Energy Technology Laboratory houses a range of near industrial-scale equipment for the research and development of clean and renewable energy technologies. The facilities support research into carbon capture and transport systems, clean fossil fuel technologies, bioenergy and energy-from-waste. Cranfield University's energy laboratory was opened at the event by Jonathan Holyoak, Head of Policy for the Office of Carbon Capture and Storage, on behalf of the Department of Energy and Climate Change (DECC).

The Early Career Energy Sector Chemists Symposium attracted 43 delegates (including a couple of non-chemists!) from both industry and academia. The RSC Energy Sector was really thrilled to have people travelling as far as Edinburgh, Durham, Newcastle and Bristol to attend the event.

The key note speech was provided by Jonathan Holyoak from DECC who discussed the future of CCS on a global level and the UK's role in delivering this. The afternoon session was chaired by Professor Simon Pollard from Cranfield University and included presentations by:

- Harikrishna Erothu from Aston University on block copolymers and their application in organic solar cells;
- Liam France from Oxford University on lanthanum doped supported bimetallic carbide catalysts for dry methane reforming;
- Sian Green from E.ON New Build & Technology on the Wilhelmshaven post combustion carbon capture plant;
- Susan Jones from Cage Concepts Ltd on carbon capture and utilization using zeolite molecular sieves and catalysts;
- Jonathan Morrison from the University of Birmingham on the corrosion and deposition in nuclear reactors;
- Oluwafunimilola Ola from Heriot-Watt University on whether solar fuels can change our future energy options;
- Emanuele Pagone from Cranfield University on future sustainable electricity generation;
- Nazanin Rashidi from the University of Oxford on solution-processed Si-doped ZnO thin films for photovoltaic applications.

Over lunch attendees had a chance to present their scientific posters. An award panel closely inspected the posters and selected their top posters based on the scientific content the poster contained and the ease in which this scientific content had been communicated to the viewer. Prizes were awarded by Philip Sharman (Board Chair of the UKCCS Research Centre) and Mercedes Maroto-Valer (Chair of the RSC Energy Sector Committee) for the top scoring posters. There were 8 prizes in total awarded by the RSC Energy Sector Committee and the Coal Research Forum. Prize winners included:

1st Prize : Nazanin Rashidi, (University of Oxford).
2nd Prize : Jack Rowbotham, (University of Durham).
3rd Prizes : Robert Mitchell, (University of York).
On Ying Wu, (University College London).
Sian Green, (E.ON New Build & Technology).

CRF Prizes for the Best Three Fossil Fuel Posters were awarded to:-
Nelia Jurado, (Cranfield University).
Janthanee Dumrongsak, (Cranfield University).
Chechet Biliyok, (Cranfield University).

All award winners received a cash prize which we hope will help to support their educational endeavours into R&D or at least pay for some well deserved R&R!

An article by the Director General of CoalPro Mr David Brewer

CoalPro, or the Confederation of UK Coal Producers to give it its full title, is the Trade Association which represents Britain's coal producers. CoalPro's member companies produce over 90% of UK coal output and this proportion is similar in England, Scotland and Wales.

CoalPro's membership comprises ten companies who are coal producers covering both deep and surface mines. In addition, there is about the same number of Affiliate Members covering a variety of related businesses ranging from suppliers to coal traders and distributors, including representation from rail freight operators.

It is CoalPro's job to represent the interests of the industry with government at all levels, from European, to national, to devolved and to local. In so doing, CoalPro works through and with other organisations such as Euracoal and the CBI Minerals group. Whilst forging and maintaining relationships with the UK Government remain vital, in recent years the importance of also doing so with the European Commission and the devolved administrations in Scotland and Wales has greatly increased. It is becoming an increasingly complex matrix to handle.

But CoalPro is not just concerned with coal production issues. The coal industry is extremely dependent on the electricity generating industry which accounts for well over 80% of coal output. We have nowhere else to go but our customers, the electricity generators, have multiple options. If government policies – and politics generally – drive them towards gas, or renewables, or nuclear, then that is where they will go. CoalPro therefore also has to make the case for coal-fired generation and often finds itself almost alone in doing so. Nevertheless, maintaining relationships with the generation industry is a key area towards which resources need to be devoted.

Whilst working hard to try and make sure there continues to be an adequate market for our product, a great deal of effort needs to be devoted to maintaining production capacity. It is not generally appreciated that the greater part of UK coal output is now from surface mines and this has been so since 2004. At any one time, there are over 30 surface mines producing coal and output has increased by over 20% in recent years. However, the average life of a surface mine is less than five years and hence, on average, the entire production capacity of the industry has to be replaced every five years even to stand still, let alone increase output. One of CoalPro's major tasks therefore is to make sure the planning system is fit for purpose and this means dealing with over a hundred local authorities.

But CoalPro's greatest concern at present is that the great uncertainty about the future market is causing the investment necessary to finance operations to dry up, despite the strongest current market for coal for years. Investors are naturally concerned that they will not be able to

get their money back. As a result a number of projects are held up and output depressed which is frustrating beyond belief when the market is so strong.

However, to conclude, the UK has ample coal reserves capable of being mined at competitive prices. Whatever happens, coal-fired generation will not fall to zero and, with the development of carbon capture and storage, may increase later in the 2020s after falling in the meantime. Similarly, coal production will not fall to zero. If the market is there, the reserves are there for coal production to continue into the 22nd Century. It is CoalPro's job to make sure this comes about.

ARTICLES FROM THE TECHNICAL PRESS

News alerts in coal and energy research

Please be aware that links to some of the news articles are not retained on the web indefinitely. Consequently, links which were active when the newsletter was written may, in time, become unavailable. It is hoped that this will not detract from the value of the article.

China to dominate the 2013 coal market

4th January 2013, John Daly, Energy Tribune

China is the world's largest coal producer and consumer and currently accounts for about half of the global coal consumption. The U.S. Energy Information Agency noted in its 2012 country analysis brief on China, "Coal supplied the vast majority (70 percent) of China's total energy consumption of 90 quadrillion British thermal units (Btu) in 2009," adding, "EIA projects coal's share of the total energy mix to fall to 59 percent by 2035 due to anticipated higher energy efficiencies and China's goal to reduce its carbon intensity (carbon emissions per unit of GDP).

However, absolute coal consumption is expected to double over this period, reflecting the large growth in total energy consumption." The World Energy Council reported that China held an estimated 128 billion short tons of recoverable coal reserves in 2011, the third-largest in the world behind the United States and the Russian Federation, or roughly 13 percent of the world's total coal reserves. Chinese coal production rose to over 3.8 billion short tons in 2011, making China the largest coal producer in the world. Currently 27 Chinese provinces mine coal, and the country's coal consumption is approximately three times higher than it was in 2000, with more than half of China's coal is used for power and heat generation.
http://www.energytribune.com/69797/china-to-dominate-the-2013-coal-market

New technology turns leaves to coal in hours

6th January 2013, Unattributed, The Local

German scientists have developed a new technology to transform garden waste into fuel overnight, *Der Spiegel* magazine reported over the weekend. The resulting brown pellets can be used to fire conventional power stations. German scientists have developed what could prove to be a revolutionary green technology to help solve the energy supply problem. Garden waste such as grass, leaves or plant clippings, is placed in a kind of pressure cooker which can transform it into a form of coal, wrote the magazine, completing in a matter of hours a process which takes millions of years in nature.
http://www.thelocal.de/sci-tech/20130106-47169.html

Methane emissions undermine switch from coal to gas

7th January 2013, Mat Hope, The Carbon Brief

Questions are being asked about the emissions benefits of shale gas after new research shows high levels of methane emissions leaking from two gas fields in the United States. Natural gas has about half the carbon emissions of coal when it is burnt, so burning gas instead of coal can significantly lower emissions. But there would be less benefit in switching to gas if significant

amounts of greenhouse gases like methane leak into the atmosphere when gas is extracted from unconventional sources like shale.
http://www.carbonbrief.org/blog/2013/01/methane-emissions-undermine-switch-from-coal-to-gas

Aberpergwm coal mine to close with the loss of nearly 300 jobs

8th January 2013, Unattributed, WalesOnline

Nearly 300 workers at Wales' largest underground coal mine are to lose their jobs. US owner Walter Energy has ended its consultation over the suspension of mining operations at its Aberpergwm Colliery in the Vale of Neath. Aberpergwm opened in the late 19th century, and at its height during the 1930s employed more than 1,500 workers. It closed in 1985 and reopened a year later under private ownership.
http://www.walesonline.co.uk/news/wales-news/2013/01/08/aberpergwm-coal-mine-to-close-with-the-loss-of-nearly-300-jobs-91466-32566716/

New material harvests energy from water vapour

10th January 2013, Unattributed, Science Daily

MIT engineers have created a new polymer film that can generate electricity by drawing on a ubiquitous source: water vapour. The new material changes its shape after absorbing tiny amounts of evaporated water, allowing it to repeatedly curl up and down. Harnessing this continuous motion could drive robotic limbs or generate enough electricity to power micro- and nanoelectronic devices, such as environmental sensors.
http://www.sciencedaily.com/releases/2013/01/130110142127.htm

Coal-fired power dominates UK generation mix

10th January 2013, Jill Ambrose, Energy Tribune

UK electricity generation shifted further from gas-fired power towards coal-fired generation in 2012, a trend that looks set to continue in 2013 as rising gas prices erode the profits of combined cycle gas turbine use — allowing coal burn to soar in line with falling fuel and emissions allowance costs. In addition, growing renewable energy capacity has increased the variability of the energy mix due to the intermittent nature of wind generation to allow for a year of record lows and highs for gas-fired power as well as oil-fired generation late in the year. Official figures from the UK's Department of Energy and Climate Change showed that gas burn had fallen 40.9% to 22.83 TWh by the third quarter of 2012, paving the way for ever higher year-on-year coal burn. For more….
http://www.energytribune.com/70343/coal-fired-power-dominates-uk-generation-mix

Spreading coal plant byproduct on fields could fight Lake Erie algae

11th January 2013, Unattributed, Farm & Dairy

An Ohio State University scientist says an abundant byproduct from coal-burning power plants, if spread on farmers' fields, could help control Lake Erie's harmful algal blooms. Warren Dick, a soil biochemist in the university's College of Food, Agricultural and Environmental Sciences, said applying fluidized gas desulfurization gypsum to crop fields can keep soluble phosphorus, the main nutrient feeding the algae, from getting washed from the soil by heavy rains, then running off into streams and rivers and eventually into the lake. "And FGD gypsum, which is a synthetic form of gypsum, can improve both the soil and the crops," he said. "Naturally occurring, mined gypsum has a long history as a soil amendment and fertilizer for farming." For more see….
http://www.farmanddairy.com/news/spreading-coal-plant-byproduct-on-fields-could-fight-lake-erie-algae/46427.html

Coal-fired unit powers through world record run

15th January 2013, Unattributed, PennEnergy

Tennessee Valley's Paradise coal-fired power plant in Kentucky set a world record for the longest continuous run for its type. Paradise Unit 2 beat out Unit 1's world record for the

longest continuous run for a sub-critical, cyclone-fired boiler at 255 days, eight hours and 50 minutes on Jan. 12. The run started May 1, 2012. During the run, Unit 2 generated 3,951,180 MW of power. Unit 1 had held the record since 1993.
http://www.pennenergy.com/articles/pe/2013/january/coal-fired-unit-powers-through-world-record-run.html

'Rock-dissolving' method of geo-engineering to mitigate climate change would not be easy

18th January 2013, Unattributed, Science Daily

The benefits and side effects of dissolving particles in our ocean's surfaces to increase the marine uptake of carbon dioxide, and therefore reduce the excess amount of it in the atmosphere, have been analysed in a new study. The study, published Jan. 22 in IOP Publishing's journal *Environmental Research Letters*, assesses the impact of dissolving the naturally occurring mineral olivine and calculates how effective this approach would be in reducing atmospheric CO_2.

The researchers, from the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany, calculate that if three gigatonnes of olivine were deposited into the oceans each year, it could compensate for only around nine per cent of present day anthropogenic CO_2 emissions. This long discussed 'quick fix' method of geoengineering is not without environmental drawbacks; the particles would have to be ground down to very small sizes (around one micrometre) in order to be effective. The grinding process would consume energy and therefore emit varying amounts of CO_2, depending on the sort of power plants used to provide the energy. Lead author of the study Peter Köhler said: "Our literature-based estimates on the energy costs of grinding olivine to such a small size suggest that with present day technology, around 30 per cent of the CO_2 taken out of the atmosphere and absorbed by the oceans would be re-emitted by the grinding process."
http://www.sciencedaily.com/releases/2013/01/130121192017.htm

Just add water: How scientists are using Si to produce H2 on demand

22nd January 2013, Unattributed, Science Daily

Super-small particles of silicon react with water to produce hydrogen almost instantaneously, according to University at Buffalo researchers. In a series of experiments, the scientists created spherical silicon particles about 10 nanometers in diameter. When combined with water, these particles reacted to form silicic acid (a nontoxic byproduct) and hydrogen -- a potential source of energy for fuel cells. The reaction didn't require any light, heat or electricity, and also created hydrogen about 150 times faster than similar reactions using silicon particles 100 nanometers wide, and 1,000 times faster than bulk silicon, according to the study. The findings appeared online in *Nano Letters* on Jan. 14. The scientists were able to verify that the hydrogen they made was relatively pure by testing it successfully in a small fuel cell that powered a fan.
http://www.sciencedaily.com/releases/2013/01/130122143224.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy%2Ffossil_fuels+%28ScienceDaily%3A+Matter+%26+Energy+News+--+Fossil+Fuels%29

Analysis of fracking wastewater yields some surprises

22nd January 2013, Unattributed, Science Daily

Hydraulically fractured natural gas wells are producing less wastewater per unit of gas recovered than conventional wells would. But the scale of fracking operations in the Marcellus shale region is so vast that the wastewater it produces threatens to overwhelm the region's wastewater disposal capacity, according to new analysis by researchers at Duke and Kent State universities.

Hydraulically fractured natural gas wells in the Marcellus shale region of Pennsylvania produce only about 35 percent as much wastewater per unit of gas recovered as conventional wells, according to the analysis, which appears in the journal *Water Resources Research.* "We found

that on average, shale gas wells produced about 10 times the amount of wastewater as conventional wells, but they also produced about 30 times more natural gas," said Brian Lutz, assistant professor of biogeochemistry at Kent State, who led the analysis while he was a postdoctoral research associate at Duke. "That surprised us, given the popular perception that hydraulic fracturing creates disproportionate amounts of wastewater."
http://www.sciencedaily.com/releases/2013/01/130122102104.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Watchdog under fire for allowing loch to be drained for coal mine

27th January 2013, Rob Edwards, Herald Scotland

A plan to drain an entire loch to make way for an opencast coal mine has been given the go-ahead by the Scottish Government's green watchdog, despite advice from its own experts that it would damage the environment. The Scottish Environment Protection Agency (Sepa) has approved a scheme by Scottish Coal to empty Loch Fitty, near Dunfermline in Fife, to dig up 3.4 million tonnes of coal from underneath its bed. Sepa's experts initially warned the plan would have a negative impact on people and the water environment. But internal emails show their initial advice was revised to make it more favourable to the development, at the request of senior managers.

Environmental groups and local residents, appalled by the "massively destructive" plan, have appealed to Scottish ministers to intervene and review the plan. If that fails, they are threatening to complain to the European Commission. "This looks like a desperate attempt by Scottish Coal to generate extra profits by ripping out every last ounce of coal from beneath Fife that it can," said Lang Banks, the new director of WWF Scotland. "It would be wrong to drain Loch Fitty to extract additional coal, at the cost of causing environmental damage and depriving the local community of its amenity value. Scottish ministers must review this proposal with a matter of urgency."
http://www.heraldscotland.com/news/environment/watchdog-under-fire-for-allowing-loch-to-be-drained-for-coal-mine.20021958

Coal milling technology reduces emissions according to new report

28th January 2013, Unattributed, PennEnergy

Techinomics, Inc. today released a final report on late 2012 testing conducted at a major coal-fired power plant in the Western United States. The data analysis and combined final report were issued by Consol Energy R&D Laboratory in South Park, PA.

During the study, Consol Energy analyzed the pyritic rejects of two pulverizers sharing the same coal and primary air supply. One was equipped with Techinomics rotating throat technology, the second with another rotating throat technology.

Consol found that the Techinomics equipped pulverizer consistently rejected two to ten times more total pyritic rock during each test period. In addition, Techinomics rejects averaged less than 10% carbon (coal) content while the other pulverizer rejects contained between 30% and 35% coal content. Because of the strong correlation between pyretic rock and mercury/arsenic concentrations, significantly larger volumes of these toxic metals were removed pre-combustion by Techinomics in comparison to the competing throat technology. Consol Energy's testing also documented Techinomics rejects having significantly higher concentrations of limestone, sandstone and silicon, substances that not only cause breathing difficulties but also equipment damage and increase maintenance costs if not removed.

The utility plant's testing department validated that the Techinomics technology used 7.9% less primary air flow than the other system and significantly reduced pulverizer system amperage required during the milling process. The related reduction in pulverizer system amperage usage means more than two additional megawatts of available power with Techinomics - every hour of operation.

The full report can be seen at: www.techinomics.com
http://www.pennenergy.com/articles/pennenergy/2013/january/coal-milling-tech-reduces-emissions-according-to-new-report.html

Fuel of the future: Cheap hydrogen from water one step closer

30th January 2013, Unattributed, Science Daily

Hydrogen has tremendous potential as an eco-friendly fuel, but it is expensive to produce. Now researchers at Princeton University and Rutgers University have moved a step closer to harnessing nature to produce hydrogen for us. The team, led by Princeton chemistry professor Annabella Selloni, takes inspiration from bacteria that make hydrogen from water using enzymes called di-iron hydrogenases.

Selloni's team uses computer models to figure out how to incorporate the magic of these enzymes into the design of practical synthetic catalysts that humans can use to produce hydrogen from water. In this latest paper, Selloni and co-authors present a solution to an issue that has dogged the field: the catalysts designed so far are susceptible to poisoning by the oxygen present during the reaction. By making changes to the catalyst to improve the stability of the structure in water, the researchers found that they had also created a catalyst that is tolerant to oxygen without sacrificing efficiency. What is more, their artificial catalyst could be made from abundant and cheap components, such as iron, indicating that the catalyst could be a cost-effective way of producing hydrogen.
http://www.sciencedaily.com/releases/2013/01/130130184414.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Giant carbon molecules for sustainable technologies

31st January 2013, Unattributed, Science Daily

Scientists in the joint research project "FUNgraphen" are pinning their hopes for new technologies on a particular form of carbon: They have developed new carbon macromolecules and molecular carbon composite materials with special properties. The molecules are derived from graphene, a substance that consists of individual layers of carbon atoms arranged in a honeycomb-like pattern. The process previously necessary to make use of this substance was complex and expensive and thus of little value for most plastics applications.

A research group at the Freiburg Materials Research Center (FMF) of the University of Freiburg led by the chemist Prof. Dr. Rolf Mülhaupt, managing director of the FMF, has now succeeded in combining graphene with polymers, making them fit for plastics applications, and preparing them for material optimization on a kilogram scale. The project "FUNgraphen," funded by the Federal Ministry of Education and Research, is being coordinated at the FMF with support from an industrial advisory board. The other project partners besides the FMF are the University of Bayreuth, the Federal Institute for Materials Research and Testing (BAM) in Berlin, and the Fraunhofer Institute for Mechanics of Materials in Freiburg.

In the FMF processes individual layers of carbon atoms, derived from natural graphite and also renewable carbon sources, are physically and chemically attached to polymers. The result is giant molecules of carbon, so-called macromolecules, which are less than a millionth of a millimeter thick but can achieve widths of more than a hundredth of a millimeter. The resulting carbon macromolecules and carbon polymer hybrid materials are light, durable, environmentally friendly, and electrically conductive. Moreover, they are resistant to heat, chemicals, and radiation and are impermeable to gas and liquids. "They have the potential to vastly improve resource and energy efficiency of plastics," says Mülhaupt.
http://www.sciencedaily.com/releases/2013/01/130131095145.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Routes towards defect-free graphene

1st February 2013, Unattributed, Science Daily

A new way of growing graphene without the defects that weaken it and prevent electrons from flowing freely within it could open the way to large-scale manufacturing of graphene-based devices with applications in fields such as electronics, energy, and healthcare. A team led by Oxford University scientists has overcome a key problem of growing graphene -- a one atom-thick layer of carbon -- when using an established technique called chemical vapour deposition, that the tiny flakes of graphene form with random orientations, leaving defects or 'seams' between flakes that grow together. The discovery, reported in a paper published in *ACS Nano*, reveals how these graphene flakes, known as 'domains', can be lined up by manipulating the alignment of carbon atoms on a relatively cheap copper foil -- the atomic structure of the copper surface acts as a 'guide' that controls the orientation of the carbon atoms growing on top of them.

http://www.sciencedaily.com/releases/2013/02/130201132332.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

New coal technology harnesses energy without burning, nears pilot-scale development

6th February 2013, Unattributed, Science Daily

A new form of clean coal technology reached an important milestone recently, with the successful operation of a research-scale combustion system at Ohio State University. The technology is now ready for testing at a larger scale.

For 203 continuous hours, the Ohio State combustion unit produced heat from coal while capturing 99 percent of the carbon dioxide produced in the reaction. Liang-Shih Fan, professor of chemical and biomolecular engineering and director of Ohio State's Clean Coal Research Laboratory, pioneered the technology called Coal-Direct Chemical Looping (CDCL), which chemically harnesses coal's energy and efficiently contains the carbon dioxide produced before it can be released into the atmosphere.

"In the simplest sense, combustion is a chemical reaction that consumes oxygen and produces heat," Fan said. "Unfortunately, it also produces carbon dioxide, which is difficult to capture and bad for the environment. So we found a way to release the heat without burning. We carefully control the chemical reaction so that the coal never burns—it is consumed chemically, and the carbon dioxide is entirely contained inside the reactor."

Dawei Wang, a research associate and one of the group's team leaders, described the technology's potential benefits. "The commercial-scale CDCL plant could really promote our energy independence. Not only can we use America's natural resources such as Ohio coal, but we can keep our air clean and spur the economy with jobs," he said. For more see....

http://www.sciencedaily.com/releases/2013/02/130206093547.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Carbon sponge could soak up coal emissions

11th February 2013, Unattributed, Science Daily

Emissions from coal power stations could be drastically reduced by a new, energy-efficient material that adsorbs large amounts of carbon dioxide, then releases it when exposed to sunlight.

In a study published Feb. 11 in *Angewandte Chemie*, Monash University and CSIRO scientists for the first time discovered a photosensitive metal organic framework (MOF) -- a class of materials known for their exceptional capacity to store gases. This has created a powerful and cost-effective new tool to capture and store, or potentially recycle, carbon dioxide.

By utilising sunlight to release the stored carbon, the new material overcomes the problems of expense and inefficiency associated with current, energy-intensive methods of carbon capture. Current technologies use liquid capture materials that are then heated in a prolonged process to release the carbon dioxide for storage.

Associate Professor Bradley Ladewig of the Monash Department of Chemical Engineering said the MOF was an exciting development in emissions reduction technology.

"For the first time, this has opened up the opportunity to design carbon capture systems that use sunlight to trigger the release of carbon dioxide," Associate Professor Ladewig said.
"This is a step-change in carbon capture technologies."
http://www.sciencedaily.com/releases/2013/02/130212100602.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Scientists explore new technologies that remove atmospheric CO2

16th February 2013, Unattributed, Science Daily

In his Feb. 12 State of the Union address, President Obama singled out climate change as a top priority for his second administration. "We can choose to believe that Superstorm Sandy, and the most severe drought in decades, and the worst wildfires some states have ever seen were all just a freak coincidence," he said. "Or we can choose to believe in the overwhelming judgment of science -- and act before it's too late."

Four years ago, the president addressed rising global temperatures by pledging a 17 percent cut in carbon dioxide (CO_2) and other greenhouse gas emissions in the United States by 2020, and an 80 percent cut by 2050. The administration has taken a number of steps to meet those goals, such as investing billions of dollars in wind, solar and other carbon-neutral energy technologies.

But reducing CO_2 emissions may not be enough to curb global warming, according to scientists at Stanford University. The solution, they say, could also require developing carbon-negative technologies that remove large amounts of CO_2 from the atmosphere. Their findings are summarized in a report by Stanford's Global Climate and Energy Project (GCEP).

"To achieve the targeted cuts, we would need a scenario where, by the middle of the century, the global economy is transitioning from net positive to net negative CO_2 emissions," said report co-author Chris Field, a professor of biology and of environmental Earth system science at Stanford. "We need to start thinking about how to implement a negative-emissions energy strategy on a global scale."

In the GCEP report, Field and lead author Jennifer Milne describe a suite of emerging carbon-negative solutions to global warming -- from bioenergy technologies to ocean sequestration. Many of the examples cited were initially presented at a negative carbon emissions workshop hosted by GCEP in 2012. For more see....
http://www.sciencedaily.com/releases/2013/02/130217084214.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

UK coal tax "could raise over £1 billion"

21st February 2013, Jonathan Rowland, Energy Global

According to Jonathan Lane, head of consulting for power and utilities at GlobalData, a research consultancy, taxes on power generation are, if not widespread, then becoming increasingly popular in Europe, as governments target utilities making significant profits from burning cheap coal in a low carbon price environment.

January 2013 saw the Netherlands introduce a €13.73/t tax on coal in an aim to reduce coal consumption, raise revenue and target generators profits. The Spanish Government has also proposed a 6% tax on all power generation to help pay for its "tariff deficit" – the subsidy that the government uses to keep regulated electricity prices below cost. "Whilst the utilities cry foul, and argue that it is the government's policy to keep regulated prices low, the government also knows that the utilities make significant profits on generation, especially coal-fired generation in the present environment," claims Lane.

"The UK's utilities make far more profit in their generation businesses than their retail businesses. The industry regulator, Ofgem, introduced a license condition in 2009 requiring the major energy suppliers to produce accounts segmenting their supply and generation activities 6 months after their financial year end. The Big Six energy companies made a whopping £2.6 billion total profit on their combined generation businesses in 2011 (with EDF Energy making £1 billion on its nuclear generation alone) compared with a paltry £646m in their retail businesses."

It is therefore clear that there are substantial profits for the government to target through implementing generation taxes, which could raise over £1 billion for the government on an annual basis. However, the financial benefits must be weighed against the ability of utilities to invest and raise finance, and there are concerns that the tax would be passed through into the wholesale electricity price.

"A coal tax would be interesting, as it would have environmental benefits as well. A coal tax would increase the cost of coal-fired generation but may not overly influence the electricity wholesale price." According to the Digest of UK Energy Statistics (DUKES), major power producers consumed 40 million t of coal in 2011, so a tax equivalent to that in the Netherlands could raise around £500m. This would impact the profits of the largest coal generators, while not significantly impacting consumers.

Lane states that a tax on fossil fuel is the most likely energy tax to come about: "It is doubtful that the government would look at a nuclear generation tax given its reliance on EDF Energy for nuclear new build, although its threat may prove a handy negotiating tool."
http://www.energyglobal.com/news/coal/articles/Jonathan_Lane_GlobalData_considers_a_UK_coal_tax-168.aspx

Renewable energy: Nanotubes to channel osmotic power

28th February 2013, Unattributed, Science daily

The salinity difference between fresh water and salt water could be a source of renewable energy. However, power yields from existing techniques are not high enough to make them viable. A solution to this problem may now have been found. A team led by physicists at the Institut Lumière Matière in Lyon (CNRS/Université Claude Bernard Lyon 1), in collaboration with the Institut Néel (CNRS), has discovered a new means of harnessing this energy: osmotic flow through boron nitride nanotubes generates huge electric currents, with 1,000 times the efficiency of any previous system. To achieve this result, the researchers developed a highly novel experimental device that enabled them, for the first time, to study osmotic fluid transport through a single nanotube. Their findings are published in the 28 February issue of Nature.
http://www.sciencedaily.com/releases/2013/02/130228093509.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

UKERC creates new on-line guide to critical materials

5th March 2013, Unattributed, UKERC

The UK Energy Research Centre (UKERC) today launches a new guide highlighting the availability of materials that are critical components in low carbon energy technologies.
In recent years concern has grown regarding the availability of a host of materials critical to the development and manufacturing of the low carbon technologies required to decarbonise the

global economy. The UKERC Materials Availability Handbook visits 10 materials or material groups, presenting the pertinent facts regarding their production, resources, and other issues surrounding their availability. Three pages of summary are devoted to each material or material group, expressing the key points, available data, and latest insights in a clear and accessible way. The Handbook has been created by researchers from UKERC's Technology and Policy Assessment team, as part of a wider project investigating the availability of such materials which are critical for low carbon energy generation.
Find out more and Download the Handbook
http://www.ukerc.ac.uk/support/article2715

UK Coal closes Daw Mill, as the industry goes up in flames

7th March 2013, Emma Rowley, The Telegraph

As an underground blaze forces the closure of Daw Mill Colliery, Britain's largest remaining coal mine, the future of coal in the UK hangs in the balance. Almost three quarters of a kilometre below the Warwickshire countryside, an inferno rages with no sign of stopping. A fortnight since the heat underground sparked a blaze at Daw Mill, Britain's biggest coal pit, management warn the fire could burn for months to come, even though they have shut down ventilation to starve it of oxygen.

How long before the deep mine could be made safe for evacuated workers to return - and breathe - is anyone's guess. As a result, its operator UK Coal, the largest still working in Britain, on Thursday called time, closing the pit and putting 650 miners out of a job. Kevin McCullough, the chief executive, did not sugar-coat the impact. "This has been a terrible week, not just for the company and its employees, but also for the energy security of the country, as it brings an end to 47 years of coal production at Daw Mill," he said. "This ferocious fire has dealt a blow to everything we tried to achieve over the last 12 months - in just 10 days."
http://uk.finance.yahoo.com/news/uk-coal-closes-daw-mill-173743739.html

New material using doped carbon allows fuels to be produced while reducing CO_2 emissions

7th March 2013, Unattributed, Science Daily

After more than 10 years' work, scientists at the University of Granada have a developed a carbon gel that enables carbon dioxide to be turned into hydrocarbons by electro-catalytic transformation. Researchers from the University of Granada (UGR) have developed a new material using doped carbon that allows low-cost energy to be produced and also reduces the amount of CO_2 released into the atmosphere. The recently-patented material is a gel that enables the CO_2 to be turned back into hydrocarbons via electro-catalytic transformation, with great savings both in time and money. For more see...
http://www.sciencedaily.com/releases/2013/03/130307124550.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Cockenzie coal-fired power plant closes

15th March 2013, Unattributed, BBC News

The coal-fired power station at Cockenzie in East Lothian has been closed. The station's huge chimneys are a well-known local landmark, but the station does not meet modern environmental standards. ScottishPower wants to convert the plant to burn gas, rather than coal. There have been no compulsory redundancies, with workers offered other jobs, redundancy or early retirement. Bill Kelly, Cockenzie Power Station manager, said: "It was a hugely emotional moment for me. I have been here for 27 years. "I'm an engineer to trade, but not an operational engineer. So was a big thrill for me for the guys to let me push the button." Neil Clitheroe, ScottishPower's CEO of energy retail and generation, said it was an important day for the workforce and the local community. He added: "It is the end of an era for ScottishPower and for the people at Cockenzie Power Station, who I would like to thank for all of their hard work and commitment over the last 45 years.

http://www.bbc.co.uk/news/uk-scotland-edinburgh-east-fife-21788332

Industry battling owing to lack of coal research laboratories and skills

15th March 2013, Yolandi Booyens, Mining Weekly

Ongoing coal-quality issues have forced State-owned power utility Eskom to undertake extensive research in coal because its power stations are grappling for coal with highly variable qualities from a variety of sources, which affects power station performance and electricity output, states Fossil Fuel Foundation (FFF) director and industry stalwart **Rosemary Falcon.** She notes that South Africa's coal industry was in a stable condition during the late 1970s, 1980s and early 1990s owing to the low price of coal. Electricity costs were low and the economy was thriving because of the dominance by the gold sector.

"Eskom had an abundance of coal owing to 'tied' collieries. The coal fed to the utility was, therefore, relatively consistent in quantity and quality, requiring little need for research. Eskom's own research started later, in 1990, when the Lethabo power station, near Vereeninging, in Gauteng, started having problems with the quality of the coal it was receiving," states Falcon.

Exporting coal in the 1970s and 1980s was simply a case of washing the abundant Witbank No 2 Seam coal to produce a low-ash coal for export to Japan and a high-grade steam coal for export to the European Union. For more see....
http://www.miningweekly.com/article/industry-battling-owing-to-lack-of-coal-research-laboratories-and-skills-2013-03-15

Region poised to host 'clean coal' power station

21st March 2013, Jack Blanchard, Yorkshire Post

Yorkshire is poised to host one of the world's first 'clean coal' power stations after the Chancellor confirmed the White Rose project at Drax is in line for hundreds of millions of pounds of public funds. George Osborne used his Budget speech yesterday to announce that two carbon capture and storage (CCS) schemes have been put forward into the final stage of the Government's £1bn funding competition, designed to help get the fledgling green energy technology off the ground.

Drax's plan for a 425MW 'clean coal' power station at its existing site near Selby now looks almost certain to go ahead, along with Scottish and Southern Energy's proposal for a similar-sized gas-fired CCS power station at Peterhead in Aberdeenshire. A final funding decision will not be confirmed until 2015, but Ministers made clear yesterday they are hopeful both projects will be up and running before the end of the decade – creating thousands of construction jobs in Yorkshire and in Scotland.
http://www.yorkshirepost.co.uk/news/at-a-glance/general-news/region-poised-to-host-clean-coal-power-station-1-5515002

Multi-purpose wonder can generate H2, produce clean water and even provide energy

23rd March 2013, Unattributed, Science Daily

A new wonder material can generate hydrogen, produce clean water and even create energy. Science fiction? Hardly, and there's more -- It can also desalinate water, be used as flexible water filtration membranes, help recover energy from desalination waste brine, be made into flexible solar cells and can also double the lifespan of lithium ion batteries. With its superior bacteria-killing capabilities, it can also be used to develop a new type of antibacterial bandage.

Scientists at Nanyang Technological University (NTU) in Singapore, led by Associate Professor Darren Sun have succeeded in developing a single, revolutionary nanomaterial that can do all the above and at very low cost compared to existing technology.

This breakthrough which has taken Prof Sun five years to develop is dubbed the Multi-use Titanium Dioxide (TiO_2). It is formed by turning titanium dioxide crystals into patented nanofibres, which can then be easily fabricated into patented flexible filter membranes which include a combination of carbon, copper, zinc or tin, depending on the specific end product needed.
http://www.sciencedaily.com/releases/2013/03/130320094856.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Ash from refuse could become hydrogen gas

25th March 2013, Unattributed, Science Daily

Every year, millions of tons of environmentally harmful ash is produced worldwide, and is mostly dumped in landfill sites or, in some countries, used as construction material. The ash is what is left when rubbish has been burnt in thermal power stations. A researcher from Lund University in Sweden has now developed a technique to use the ash to produce hydrogen gas. The method is presented in a new thesis.

The technique has significant potential: 20 billion litres of hydrogen gas a year, or 56 gigawatt-hours (GWh). Calculated as electricity, the energy is the equivalent of the annual needs of around 11 000 detached houses. Hydrogen gas is valuable and is viewed by many as an increasingly important energy source, for example as a vehicle fuel.

"The ash can be used as a resource through recovery of hydrogen gas instead of being allowed to be released into the air as at present. Our ash deposits are like a goldmine," said Aamir Ilyas, Doctor of Water Resources Engineering at Lund University and the developer of the technique. Refuse incineration is a widespread practice in Europe. The technique involves placing the ash in an oxygen-free environment. The ash is dampened with water, whereupon it forms hydrogen gas. The gas is sucked up through pipes and stored in tanks.

It is the heavy, grit-like bottom ash that is used. In combustion, a lighter fly ash is also formed. The bottom ash remains in quarantine, in the open air, at the site for up to six months to prevent leaching of environmentally harmful metals and the risk of hydrogen gas being formed, since accumulation of hydrogen during indoor storage can result in explosion.
http://www.sciencedaily.com/releases/2013/03/130325093536.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Discovery may allow scientists to make fuel from CO2 in the atmosphere

26th March 2013, Unattributed, Science Daily

Excess carbon dioxide in Earth's atmosphere created by the widespread burning of fossil fuels is the major driving force of global climate change, and researchers the world over are looking for new ways to generate power that leaves a smaller carbon footprint.

Now, researchers at the University of Georgia have found a way to transform the carbon dioxide trapped in the atmosphere into useful industrial products. Their discovery may soon lead to the creation of biofuels made directly from the carbon dioxide in the air that is responsible for trapping the sun's rays and raising global temperatures.

"Basically, what we have done is create a microorganism that does with carbon dioxide exactly what plants do-absorb it and generate something useful," said Michael Adams, member of UGA's Bioenergy Systems Research Institute, Georgia Power professor of biotechnology and Distinguished Research Professor of biochemistry and molecular biology in the Franklin College of Arts and Sciences.
http://www.sciencedaily.com/releases/2013/03/130326112301.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

'Waste heat' may economise CO2 capture

28th March 2013, Unattributed, Science Daily

In some of the first results from a federally funded initiative to find new ways of capturing carbon dioxide (CO_2) from coal-fired power plants, Rice University scientists have found that CO_2 can be removed more economically using "waste" heat -- low-grade steam that cannot be used to produce electricity. The find is significant because capturing CO_2 with conventional technology is an energy-intensive process that can consume as much as one-quarter of the high-pressure steam that plants use to produce electricity.

"This is just the first step in our effort to better engineer a process for capturing CO_2 from flue gas at power plants," said George Hirasaki, the lead researcher of Rice's CO_2-capture research team. The researchers hope to reduce the costs of CO_2 capture by creating an integrated reaction column that uses waste heat, engineered materials and optimized components. Hirasaki's team was one of 16 chosen by the Department of Energy (DOE) in 2011 to develop innovative techniques for reducing greenhouse gas emissions from power plants.
http://www.sciencedaily.com/releases/2013/03/130329090631.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Discovery opens door to efficiently storing and reusing renewable energy

28th March 2013, Unattributed, Science Daily

Two University of Calgary researchers have developed a ground-breaking way to make new affordable and efficient catalysts for converting electricity into chemical energy. Their technology opens the door to homeowners and energy companies being able to easily store and reuse solar and wind power. Such energy is clean and renewable, but it's available only when the sun is shining or the wind is blowing.

The research by Curtis Berlinguette and Simon Trudel, both in the chemistry department in the Faculty of Science, has just been published in the journal *Science*. "This breakthrough offers a relatively cheaper method of storing and reusing electricity produced by wind turbines and solar panels," says Curtis Berlinguette, associate professor of chemistry and Canada Research Chair in Energy Conversion.
http://www.sciencedaily.com/releases/2013/03/130328142356.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy%2Ffossil_fuels+%28ScienceDaily%3A+Matter+%26+Energy+News+--+Fossil+Fuels%29

Energy research wins £2m boost

28th March 2013, Unattributed, Bath Chronicle

Almost £2 million of funding is making Bath a world-leading centre in energy harvesting and generation. The University of Bath is embarking on a new project called NEMESIS thanks to a 2.27 million euro, or £1.9 million, grant from the European Research Council (ERC) Executive Agency. The purpose of the project is to create new energy harvesting systems capable of converting mechanical vibrations and thermal fluctuations into energy.

Experts at the university will examine materials that could be capable of capturing the vibrations of machines and vehicles and convert them into electricity. Another focus of NEMISIS will be attempting to develop new methods of water splitting, which is separating water into hydrogen and oxygen so the hydrogen can be used to generate energy. Project lead, Professor Chris Bowen, the University of Bath's first ERC Advanced Investigator, said: "Setting up a world-leading research centre here in the UK will put us at the forefront of this increasingly important field of work.

"The new centre brings together experts in from different disciplines, including materials, physics, chemistry and electrical engineering, offering an ideal environment in which to develop new and innovative solutions to generating and harvesting energy."The centre will

fund visiting researchers at the university, and allow joint working with experts in Singapore and Russia. The ERC funding also allows the new centre to offer two postdoctoral positions and three PhD studentships over the course of the five-year project.
Updates about the project can be followed on Twitter at @BowenNEMESIS.
http://www.thisisbath.co.uk/Energy-research-wins-pound-2m-boost/story-18544177-detail/story.html#axzz2PrFZMbzD

UK's CO2 emissions up 4.5% in 2012

28th March 2013, Damian Carrington and Severin Carrell, The Guardian

The UK's emissions of climate-warming gases surged in 2012 as cheap coal replaced gas in power stations, official data revealed on Thursday. However, 2012 was a record year for renewable energy in Scotland, which produced enough electricity to power all of its homes. Fergus Ewing, the Scottish energy minister, said his government was now on track to meet its target of generating the equivalent of 50% of Scotland's own electricity needs by 2015 and 100% by 2020.

The UK's carbon dioxide emissions rose by 4.5% from 2011-12, with coal use in power stations jumping by 31%. Coal prices have dropped significantly as the US has exported the coal it no longer needs at home due to the shale gas boom. Another factor is that many of the UK's coal-fired power stations must close soon, due to European pollution regulations, meaning they have been using up their allotted hours. The gas used in power stations dropped by 31%. But there was a jump in the gas used to heat homes due to a cold last quarter of 2012, which the department for energy and climate change said had been 2.3C colder than Q4 2011. The cold weather in the UK in recent weeks led to gas reserve levels falling to just two days worth, with the price spiking as a result. For more see...
http://www.guardian.co.uk/environment/2013/mar/28/uk-co2-emissions-up-2012

"Emotional" day as Kingsnorth coal plant officially closes

28th March 2013, Vicky Ellis, Energy Live News

It was a sad and even emotional day for many workers at the Kingsnorth coal plant in Kent which officially closed today. After forty years of generating electricity, the 2,000MW plant – which pumped 1,940MW of that to the grid – has begun a two year-long decommissioning process which could lead to demolition.

Energy supplier E.ON's plant stopped generating before Christmas but today it officially closed with many workers packing up to go to new jobs or early retirement. Kingsnorth employed 150 people in its heyday but had been operating with fewer workers over the last few months as some left to take up other jobs in the industry. Twenty staff will continue working on site. Piles of cardboard boxes in office rooms and an empty control room testified the fact it is the end of the road for the coal plant which must shut to fall in line with EU legislation. The Large Combustion Plant Directive sets a limit on how much carbon dioxide power stations can emit.
http://www.energylivenews.com/2013/03/28/%E2%80%9Cemotional%E2%80%9D-day-as-kingsnorth-coal-plant-officially-closes/

Maltby deep coal mine set to close

29th March 2013, Unattributed, BBC News

A deep coal pit in South Yorkshire which employs more than 400 staff is to finally shut later. Hargreaves Services said Maltby Colliery, near Rotherham, was no longer viable on safety, geological and financial grounds. About 250 people will lose their jobs when the pit closes, with 150 redeployed, a union spokesman said. The company has previously said it is "committed to exploring alternative employment opportunities for staff". The pit produced coal for more than 100 years. Nick Harris, a miner and union official from the National Union of Mineworkers (NUM), said: "I'm devastated it's over". "We were trying to come up with plans to save it but we were too short of money. So I'm gutted." About 150 employees have been redeployed and the company is continuing to seek alternative opportunities for the remaining staff, Mr Harris added.

http://www.bbc.co.uk/news/uk-england-south-yorkshire-21974682

Breakthrough in H2 fuel production could revolutionise alternative energy market

3rd April 2013, Unattributed, Science Daily

A team of Virginia Tech researchers has discovered a way to extract large quantities of hydrogen from any plant, a breakthrough that has the potential to bring a low-cost, environmentally friendly fuel source to the world.

"Our new process could help end our dependence on fossil fuels," said Y.H. Percival Zhang, an associate professor of biological systems engineering in the College of Agriculture and Life Sciences and the College of Engineering. "Hydrogen is one of the most important biofuels of the future." Zhang and his team have succeeded in using xylose, the most abundant simple plant sugar, to produce a large quantity of hydrogen that previously was attainable only in theory. Zhang's method can be performed using any source of biomass.
http://www.sciencedaily.com/releases/2013/04/130403104104.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy%2Ffossil_fuels+%28ScienceDaily%3A+Matter+%26+Energy+News+--+Fossil+Fuels%29

Turning tyres into gas for energy and new, valuable materials

4th April 2013, Unattributed, Science Daily

Tire recycling represents an untapped opportunity, that may prove a success if processing costs do not become prohibitive

Europe's tire waste production is 3 million tonnes per year. Currently 65% to 70% of used tires end up in landfills. Not only are they causing environmental damage, but a loss of added value in the form of new products that recycling can generate. One of the approaches for recycling tires is now being investigated in a EU funded project called TyGRE. tires offer recycling potentials because they have a better heating value than biomass or coal, and they contain a high content of volatile gasses. They can therefore be an interesting source of synthetic fuels, also called synfuels, according to Sabrina Portofina, a researcher at the Italian national agency for new technologies, energy and sustainable economic development, ENEA, in Portici, near Naples. As part of the project, she is conducting an experiment to analyse a thermal process to recuperate synthesis gas, also called syngas, and solid materials from the tire scrap.
http://www.sciencedaily.com/releases/2013/04/130404081548.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

New emissions standards would fuel shift from coal to natural gas

5th April 2013, Unattributed, Science Daily

The cost of complying with tougher EPA air-quality standards could spur an increased shift away from coal and toward natural gas for electricity generation, according to a new Duke University study.

The stricter regulations on sulfur dioxide, particulate matter, nitrogen oxide and mercury may make nearly two-thirds of the nation's coal-fired power plants as expensive to run as plants powered by natural gas, the study finds.

"Because of the cost of upgrading plants to meet the EPA's pending emissions regulations and its stricter enforcement of current regulations, natural gas plants would become cost-competitive with a majority of coal plants -- even if natural gas becomes more than four times as expensive as coal," said Lincoln F. Pratson, a professor of earth and ocean sciences at Duke's Nicholas School of the Environment.

"This is a much higher fraction of economic vulnerability than has previously been reported," said Pratson, an expert on carbon capture and storage, energy resources and energy systems.

http://www.sciencedaily.com/releases/2013/04/130405134859.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

CO2 released from burning fuel today goes back into new fuels tomorrow

8th April 2013, Unattributed, Science Daily

The search for ways to use megatons of carbon dioxide that may be removed from industrial smokestacks during efforts to curb global warming has led to a process for converting that major greenhouse gas back into the fuel that released it in the first place. Research on the project was a topic in New Orleans on April 8 at the 245th National Meeting & Exposition of the American Chemical Society (ACS).

It may seem like trying to put the genie back into the bottle," Wojciech Lipiński, Dr. Sc.Techn.,said. "But it already has been proven with laboratory scale equipment. The process uses three of the world's most abundant and inexpensive resources. Sunlight is the energy source and carbon dioxide and water are the raw materials."

Lipiński also discussed another project that uses inexpensive calcium oxide, made from ordinary limestone, to capture carbon dioxide (CO_2) before it leaves the smokestacks of coal-fired electric power stations. The CO_2 reacts with calcium oxide, forming calcium carbonate, the same material in blackboard chalk, some calcium dietary supplements and some antacids. The calcium carbonate then goes into a reactor that removes the CO_2 and regenerates the calcium oxide for another encounter with CO_2.
http://www.sciencedaily.com/releases/2013/04/130408152855.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Hydrogen from methane without CO2 emissions?

8th April 2013, Unattributed, Science Daily

The production of hydrogen from methane without carbon dioxide emissions is the objective of a project in which KIT is a major partner. At KALLA, the Karlsruhe Liquid-metal Laboratory, researchers are setting up a novel liquid-metal bubble column reactor, in which methane is decomposed into hydrogen and elemental carbon at high temperature.

In this project, KIT cooperates with the Institute for Advanced Sustainability Studies (IASS). Today, the initiator of the project and scientific director of IASS, Nobel Prize laureate Professor Carlo Rubbia, met KIT scientists working at KALLA, the Institute for Pulsed Power and Microwave Technology (IHM), and the Institute for Applied Materials -- Material Process Technology (IAM-WPT).

Energy production from fossil fuels without emissions of climate-affecting carbon dioxide -- this vision might come true through the research program "Combustion of Methane without CO2 Emissions." Since late 2012, KIT has been partner in the program that is part of the Earth, Energy, and Environment (E3) Cluster of the Institute for Advanced Sustainability Studies (IASS), Potsdam. "This is the truly pioneering experiment with the ambition of using fossils without CO2 emissions," said the scientific director of IASS and physics Nobel Prize laureate Professor Carlo Rubbia when visiting KIT today.
http://www.sciencedaily.com/releases/2013/04/130408084900.htm?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy+%28ScienceDaily%3A+Matter+%26+Energy+News%29

Solar booster shot for natural gas power plants

11th April 2013, Unattributed, Science Daily

Natural gas power plants can use about 20 percent less fuel when the sun is shining by injecting solar energy into natural gas with a new system being developed by the Department of Energy's Pacific Northwest National Laboratory. The system converts natural gas and sunlight into a more energy-rich fuel called syngas, which power plants can burn to make electricity.

"Our system will enable power plants to use less natural gas to produce the same amount of electricity they already make," said PNNL engineer Bob Wegeng, who is leading the project. "At the same time, the system lowers a power plant's greenhouse gas emissions at a cost that's competitive with traditional fossil fuel power." PNNL will conduct field tests of the system at its sunny campus in Richland, Wash., this summer.
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CO2 removal can lower costs of climate protection

12th April 2013, Unattributed, Science Daily

Directly removing CO_2 from the air has the potential to alter the costs of climate change mitigation. It could allow prolonging greenhouse-gas emissions from sectors like transport that are difficult, thus expensive, to turn away from using fossil fuels. And it may help to constrain the financial burden on future generations, a study now published by the Potsdam Institute for Climate Impact Research (PIK) shows. It focuses on the use of biomass for energy generation, combined with carbon capture and storage (CCS). According to the analysis, carbon dioxide removal could be used under certain requirements to alleviate the most costly components of mitigation, but it would not replace the bulk of actual emissions reductions.

"Carbon dioxide removal from the atmosphere allows to separate emissions control from the time and location of the actual emissions. This flexibility can be important for climate protection," says lead-author Elmar Kriegler. "You don't have to prevent emissions in every factory or truck, but could for instance plant grasses that suck CO_2 out of the air to grow -- and later get processed in bioenergy plants where the CO_2 gets stored underground."
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Surprising findings on hydrogen production in green algae

12th April 2013, Unattributed, Science Daily

New research fuels hope of efficient hydrogen production with green algae being possible in the future, despite the prevailing scepticism based on previous research. The study changes the view on the potential of green algae – which is good news. The world must find a way of producing fuel from renewable energy sources to replace the fossil fuels. Hydrogen is today considered one of the most promising fuels for the future and if hydrogen can be produced directly from sunlight you have a renewable and environmentally friendly energy source. One biological way of producing hydrogen from solar energy is using photosynthetic microorganisms.

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The future of our energy

15th April 2013, Unattributed, Science Daily

When it comes to sustainable energy supplies hydroelectric plants are usually the best solution, according to researchers who have reviewed the economic, social and environmental impact of fuel provision. However, Western Europe has run out of suitable locations to create large plants and micro-hydro power (small-scale generation of energy using falling water) is not sufficient to support the electricity need.

Coal and nuclear could be a good alternative although each type of plant has its strengths and weaknesses. On the contrary, gas-fired plants and in particular oil power plants are usually not a suitable option.

Dr Giorgio Locatelli, from the School of Engineering at the University of Lincoln (UK) which was created in partnership with Siemens, and Mauro Mancini, of Milan Polytechnic (Italy), are leading the research which provides a unique evaluation of all sustainability factors in the power plant industry.

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Plasma device could revolutionise energy generation and storage

16th April 2013, Unattributed, Science Daily

University of Missouri engineer Randy Curry and his team have developed a method of creating and controlling plasma that could revolutionize American energy generation and storage. Besides liquid, gas and solid, matter has a fourth state, known as plasma. Fire and lightning are familiar forms of plasma. Life on Earth depends on the energy emitted by plasma produced during fusion reactions within the sun.

Curry's device launches a ring of plasma as far as two feet. The plasma doesn't emit radiation, and it is completely safe for humans to be in the same room with it, although the plasma reaches a temperature hotter than the surface of the sun. The secret to Curry's success was developing a way to make the plasma form its own self-magnetic field, which holds it together while it travels through the air.

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Scientists discover new materials to capture methane

16th April 2013, Unattributed, Science Daily

Scientists at Lawrence Livermore National Laboratory (LLNL) and UC Berkeley and have discovered new materials to capture methane, the second highest concentration greenhouse gas emitted into the atmosphere.

Methane is a substantial driver of global climate change, contributing 30 percent of current net climate warming. Concern over methane is mounting, due to leaks associated with rapidly expanding unconventional oil and gas extraction, and the potential for large-scale release of methane from the Arctic as ice cover continues to melt and decayed material releases methane to the atmosphere. At the same time, methane is a growing source of energy, and aggressive methane mitigation is key to avoiding dangerous levels of global warming.

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Biomass and Fossil Fuel Research Alliance (BF2RA) – Updated project list

The original nine projects funded by the BF2RA were described in the May 2012 issue of the newsletter. This update indicates new projects added to this list.

Grant 10 - Low Temperature Ignition of Biomass (2012 to 2013)
University of Leeds. Academic Supervisor – Professor Jenny Jones
The overall aim of this one year post-doctoral research study is to characterise and measure the ignition properties and temperatures for a range of relevant biomass fuels. The influence of (i) moisture (ii) particle size (iii) oil content (iv) oxygen concentration in the ambient atmosphere, on ignition and reaction will be studied. The data will be used to categorize the biomass in terms of its ignition risk in both storage, milling, and transport in entrained flows.

Grant 11 - Development of Novel Coatings to Resist Fireside Corrosion in Biomass-fired Power Plants (2012 to 2015)
Cranfield University. Academic Supervisor – Professor John Oakey
The fundamental research challenge to be addressed in this PhD project, and its overall aim, is to use a novel, rapid coating development methodology to identify coating compositions that will resist the fireside corrosion environments found on superheater and reheater tubes in combustion plants firing a high proportion of biomass fuels.

Grant 12 - Integrity of Coated Ferritic Alloys under High Temperature Creep and Fatigue (2012 to 2016)
University of Nottingham. Academic Supervisor – Dr Wei Sun
The overall aim of this project is to concentrate on investigating the integrity of coated samples subjected to high temperature exposure and steady/cyclic mechanical loadings. Specific objectives will include gaining a better understanding of presently developed coatings and the associated key failure mechanisms, ranking of the potential coatings based on testing results and provision of generic understanding of factors limiting coating service life.

CALENDAR OF COAL RESEARCH MEETINGS AND EVENTS

Date	Title	Location	Contact
Thursday 9th May 2013	**Minerals Engineering 2013, organised by the Minerals Engineering Society, (MES), and co-sponsored by the Coal Research Forum, (CRF), and the South Midlands Mining and Minerals Institute, (SMMMI).**	**Yew Lodge Hotel, Kegworth, East Midlands, UK**	**Mr. Andrew Howells, Secretary of the MES, E-mail : hon.sec.mes@lineone.net Tel : 01909-591787 Mobile : 07510-256626.**
12th to 16th May, 2013	Clean Coal Technologies Conference (CCT)	Thessaloniki, Greece	See Web link: http://www.cct2013.org/ibis/CCT2013/home
24th May 2013	"Biomass fuelled power generation with CO2 capture", organised by the British Section of the Combustion Institute and the Institute of Physics	Moller Centre, Cambridge	For more information, please contact: Kaysha Banton cmcl innovations <e>: kbanton@cmclinnovations.com <t>: +44 (0)1223 37 00 30 <f>: +44 (0)1223 37 00 40 <i>: www.cmclinnovations.com
16th to 19th September 2013	30th International Pittsburgh Coal Conference	Beijing International Convention Centre	For details visit:- http://www.engineering.pitt.edu/PCC.aspx?id=2147488856
29th September to 3rd October 2013	ICCS&T 2013, International Conference on Coal Science & Technology	Penn Stater Hotel & Conference Center 215 Innovation Boulevard State College, PA 16803	For details visit:- http://www.iccst.info/live/index.php?c=k
Monday 7th October 2013	**The 2013 Coal Science Lecture Organised by the Biomass and Fossil Fuel Research Alliance, (BF2RA), with sponsorship from the Coal Research Forum, (CRF), to be given by Professor Colin Snape, University of Nottingham.**	**The Institute of Physics , 76, Portland Place , London , W1B 1NT**	**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**
Early Autumn 2013, date to be advised	**BF2RA Project Review Seminar Organised by the Coal Research Forum in collaboration with the Biomass and Fossil Fuel Research Alliance, (BF2RA).**	**Venue to be advised**	**Dr. David J.A.McCaffrey Secretary of the Coal Research Forum Tel : 01242-236973 E mail : mail@coalresearchforum.org**