No. 65 **September 2012**

NEWSLETTER

of the Coal Research Forum

EDITOR'S MUSINGS:

Well, here we are into August and still waiting for summer – a forlorn hope by now I feel. It would seem that the only warm glow that we are experiencing at the moment is that of British Olympic success in London 2012!

Also approaching fast is the 9th European Conference on Coal Research & Its Applications (ECCRIA 9 to those who cannot remember the whole title!) It is to be held in the Jubilee Campus of the University of Nottingham from 10th to 12th September.

As a departure from previous conferences we are intending to include a copy of this newsletter in the delegate bags for each conference attendee. We hope that it will encourage non-members of the Coal Research Forum to think about the benefits of being members. We think it is well worth the modest annual membership fee and allows significant reductions in the cost of attending the CRF conferences. Anyone who would like further information can see David McCaffrey who will be more than happy to provide details of costs and benefits.

This issue contains meeting reports from a Combustion Division visit to Drax Power Station in April and a Mineral Engineering Society seminar, organised jointly with the Coal Preparation Division, on Minerals Engineering in 2012. Articles are included on a new biofuels consortium called BRISK; a Spanish energy research establishment called the Fundación Ciudad de la Energía (CIUDEN); and an article about the Carbon Capture & Storage Association. Regular features such as articles from the technical press, news alerts and a calendar of relevant conferences are also included.

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Student Bursaries for 2012-2013

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

Prof. J.W. Patrick
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The 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.

23rd Annual CRF Meeting & Meeting of the Combustion Division

Drax Power Ltd, Drax Power Station,
Selby, North Yorkshire
Wednesday 25th April 2012.

This meeting was held during a spell of particularly inclement weather, (not unusual as it turns out for the summer of 2012) which resulted in bad traffic delays which in turn resulted in the late arrival of the main CRF executive committee contingent. This meant that the first session was in progress before the editor arrived and so the notes are not complete for the first presentation. However, the slides are available on the CRF website.

The meeting was hosted by Robert Ghent who welcomed the attendees to Drax Power station for the combined annual CRF meeting and seminar of the Combustion Division.

Jon Gibbins chaired the first session and the first presentation was given by Richard Dean of Alstom Power UK Ltd and was entitled “Future Developments at Drax Power Station, (Oxyfuel and Biomass). Richard began by explaining the rationale behind the biomass project which was to include a turbine retrofit and to increase biomass co-firing capability. He then gave a summary of Drax and its capability in terms of its generation capacity, the amount of biomass it will be consuming and the corresponding amount of CO2 that will be avoided. Richard then outlined the experience that Alstom has gained in recent years in similar biomass conversions in the UK, Sweden and the Netherlands.

The conversion was to be carried out with no interruption of existing plant performance or operation during construction and commissioning. This was achieved and the plant has been fully commissioned and operational since April 2010 with CO2 savings per year of more than 2million tonnes (based on 100% capacity. Greenhouse gas reduction of >70% compared with coal has been achieved and the plant consistently delivers its rated output. It is capable of processing 40 tonnes of biomass per hour on each of the six boiler units, alongside some 230 tonnes per hour of coal. Multiple fuels can be handled, i.e. involving being received, stored, processed, sampled and fired. These include forestry residues, agricultural by-products and energy crops including UK grown materials.

The project was a success and was delivered safely, on time and on budget. It forms the basis for further (increased) biomass firing and makes a significant contribution to the UK renewables target. It is a viable and economic means of CO2 reduction.

Richard then went on to describe the Oxyfuel project which Alstom had been involved at Drax. Richard explained that this project had arisen because of Alstom's global ambition to develop CCS technology and the long term vision of Drax which is focussed around low carbon electricity generation. The view was that retrofitting an existing coal-fired with CCS was unlikely to deliver a competitive power plant in the UK market.

The aim of the project is the creation of a new modern supercritical 426MWe Oxyfuel power plant having the capability to remove CO2 from the entire flue gas stream (~2 million tonnes per year). The use of biomass for co-firing will lead to zero or negative CO2 emissions and the plant will be located conveniently for undersea disposal in the North Sea. A New Entrants Reserve (NER 300) funding application under EC evaluation has been made and UK Demo funding application is planned. The plant will have a 390MWe output in air mode and 304MWe output in full Oxyfuel firing mode. Gross efficiency is expected to be in the range 44% to 46% and net efficiency 35% to 36%. CO2 capture will be 90% and the steam quality 260bar/600^{o}C/620^{o}C.

The timescale from initial concept studies in 2006 to commercial operation, planned for 2016 to 2018 indicated the extensive testing and planning necessary to bring this technology to reality. Pilot studies at 30MWe have been completed at Schwartze Pumpe and Lacq as have 15Mwe tests at Alstom's Boiler Simulation Facility in Windsor, USA. Tangentially-fired Oxyfuel firing at up to 250Mew is also planned, both indirectly and directly, using both dried lignite and hard coals as fuels.

The project consortium comprises four companies: Drax Power Ltd. The owner and operator of the UK's largest, cleanest, most efficient coal-fired power station which provides 7% of the UK's electricity needs; Alstom, a global leader in the world of power generation, power transmission and rail infrastructure and a pioneer in large-scale and efficient CCS technologies; BOC, the largest provider of industrial gases in UK and a member of the Linde group and the National Grid, who are an international electricity and gas company and one of the largest investor-owned energy companies in the world. The first three project partners are developing the Oxyfuel power plant and the other, the National grid, are developing the CO2 transportation and storage systems.

As a demonstration project it is expensive on a £ Sterling/MW basis but has significantly less risk when scaled up to commercial size. Alstom view this technology as exciting but accept that there are many hurdles to overcome before success is assured. However, they believe that there is a solid group of companies supporting the project and there is Government backing for the CCS it will provide. Richard feels the project is an excellent opportunity to demonstrate that coal can be used for clean power generation for years to come.

The second presentation was given by Dr. David Couling of E.ON New Build & Technology Ltd. (ENT) and was entitled "The Oxyfuel Research Rig at E.ON New Build & Technology Ltd." David began by introducing himself and E.ON and, in particular, ENT. This is the group whose mission it is to add value to the E.ON group via operational support, by supporting the new build programme and in the future by research, development and innovation. Its main facilities are at Ratcliffe-on-Soar and Gelsenkirchen, Germany.

The main research tool used by ENT for Oxyfuel development is located at Ratcliffe and is the 1MWth Combustion Test Facility (CTF). This test facility was originally commissioned in the 1990's and was used for a range of different combustion-related R&D programmes. Over the years the CTF has been upgraded and enhanced to allow R&D into new areas as they appeared. Low NOx combustion technology has been an area of interest especially in the 1990s as Low NOx Burners were retrofitted to UK plant. Corrosion has been one of the primary research areas given the high chlorine content of some UK coals. In order to obtain data a toxic metals reduction system has been developed. This uses a flue gas slip stream with separate coolers and ports for measuring trace elements and also for injecting sorbents. Corrosion continues to be an important area of interest in Oxyfuel combustion systems. The corrosion implications of firing biomass, either alone or as a blend with coal, is also of interest in Oxyfuel firing systems.

A description of the CTF in Oxyfuel mode has been provided by Ben Goh of E.ON in an earlier CRF presentation, (Recent Developments in CCS held at Imperial College London on 17th April 2007), see CRF website for the presentation.

A range of world coals has been tested on the CTF and a number of projects looking at specific aspects of Oxyfuel firing have been completed.

A number of general conclusions can be drawn from the operational data obtained from the CTF during Oxyfuel firing conditions. These are that safe start up, change over and operations have been demonstrated. Early, low O2 enrichment tests demonstrated poorer combustion (CO, LOI, flame detachment) compared to air firing. More recent higher enrichment tests have shown similar to better combustion compared to than air (CO, LOI). High levels of CO2 in the flue gas (80%+ dry) are possible. A similar slight increase was noted in the concentration of NOx. An increase in the concentration of SO2 by a factor of 3 to 4 was observed. There were reduced mass rates of SO2 and NO formed (as mg/MJ fuel burnt). The ash composition was found to be similar but with increased sulphur compounds and trace elements. There was some evidence of increased superheater/reheater corrosion rates for austenitic stainless steels and nickel based alloys. Operational experience has allowed more complex operation and control via an expanded system with feedback loops.

This was followed by Dr Mark Flower of RWEnpower plc deputising for Dr Gerry Riley and was entitled "Oxyfuel Research at RWEnpower plc". Mark outlined the process of Oxyfuel combustion and the concept of recycle ratio and then went of to describe some of the work from recent research projects. These included a UK DTI project on Oxyfuel, two RFCS projects known as BOFCom and ECO-Scrub, an RWE project on fuel flexibility and an oxygen injection project with BOC. However, Mark then disclosed that there had been a strategic change in direction within RWE, in line with the decision not to proceed with the construction of Tilbury C power station during the work, which stopped the second phase of Oxyfuel and other coal–related R&D work from progressing further.

Mr. Karl Bindemann, Electric Power Research Institute, (EPRI) gave us a perspective from the US with his talk "Oxyfuel Activities in the USA and FutureGen Update". Karl began his talk by identifying some of the major CCS projects in the US. These were projects which involved Oxy-combustion, pre-combustion (IGCC), post combustion capture and two industrial solicitations.

Karl highlighted some specific Oxyfuel projects starting with one involving Alstom, the US Department of Energy (DoE) and it's National Energy Technology Laboratory (NETL). This project is one of 6 R & D Carbon Capture Projects funded by the Existing Plants, Emissions & Capture Programme (EPEC). It is focused on retrofit to tangentially-fired units of 500 – 600MWe generation capacity. There will be an optimised demonstration at 100 – 200MWe size, with pilot scale tests at 15MWth T-Fired BSF. Several oxy-combustion system designs are to be evaluated including techno-economic analyses. The project cost is circa \$18m (\$15m from the DoE).

Babcock & Wilcox and Air Liquide have been developing an oxy-combustion retrofit technology at their respective test facilities. There will a two-phased approach with phase 1 investigating the effect of coal rank and 2hase 2 looking into the engineering and economic assessment of the technology. A further strand to this project is the development of a 700MWe Oxy-Coal reference plant in conjunction with EPRI and the URS Group using subbituminous coal. The plant location is Kenosha, Wisconsin and the steam conditions are 259bar, 593^{o}C. This technology is to be supplied to FutureGen 2.0.

Karl then described a development from Air Products known as the Ion Transport Membrane (ITM) which allows oxygen to be separated from air. It works by transporting an ionised gas through a ceramic membrane. The ITM Oxygen process uses non-porous, mixed ion and electron conducting materials operating typically at 800-900 °C. It is selective, compact and can provide high volumes of oxygen for large scale applications.

Karl then outlined EPRI and its main areas of collaborative activity in the generation sector. In particular he concentrated on Advanced Coal Generation which comprised CoalFleet for Tomorrow and CO2 Capture & Storage.

CoalFleet for Tomorrow is a project which is preparing technologies for use in coal power plants of the 2020s, for example, advanced ultra supercritical PCs, IGCCs and Oxy-combustion power plants. It target is to have reliable and highly efficient new coal plant designs with near-zero emissions and CO2 capture available to industry by 2025. This will be achieved by the acquisition of timely and accurate engineering and economic information about advanced coal technologies which will support generators' decision-making processes. It will shorten the development time for promising CO2 capture technologies by co-sponsoring the US Dept of Energy's National Carbon Capture Center. In addition it will help validate materials needed for boilers and turbines to operate with steam conditions up to 1400°F (760°C) and 47% HHV efficiency. The 2012 R&D focus of CoalFleet is the identification and nurturing of technologies which can have a significant impact on the cost of electricity from new coal power plants.

CO2 Capture & Storage is a project designed to provide confidence that acceptable capture technologies and storage options will be available when needed. It will provide a basis for credible asset planning by reduced cost-of-electricity (COE) for post-combustion carbon capture; reduced parasitic energy demand and knowledge to enable CO2 underground storage to be understood by government bodies and the public. It will also provide independent information to develop regulations and legal frameworks for underground CO2 storage and reduce risk and cost of CO2 product impurities resulting in increased CO2 removal requirements, additional injection wells, or unacceptable storage sites. The 2012 R&D focus of this project is to develop improved post-combustion capture processes and confirm suitability of transport and storage.

EPRI's Oxy-Coal programme approach has five strands. Firstly, it aims to conduct engineering and economic evaluations of Oxy-coal with CO2 capture. This includes full scale, new-build plant evaluations (published and on-going) and Oxy-coal retrofit/repowering evaluations (pending). Secondly, its aim is to monitor world wide Oxy-coal with CO2 capture research, demonstration, and deployment. The format for this is by periodic critical reviews of worldwide activities. (published and on-going). Other areas of interest include pressurised Oxy-coal and chemical looping combustion. The third area involves conducting CO2 purification unit technology assessments. This involves achieving the zero-emissions coal-fired power plant. (preliminary assessment published), CPU process optimization (pending) and the effect of impurities on transport and storage of product CO2. Fourthly, to provide a platform to present industry (utility and vendor) views of Oxy-coal with CO2 capture RD&D needs. A Working group to produce a white paper is in progress) and finally to assist in development (and monitoring) of field demonstration projects. Karl then provided a list of publications pertinent to Oxy-combustion CO2 capture.

From a selection of EPRI and US DoE publications on Oxy-Coal engineering and economic evaluation Karl drew the following consistent conclusions: (a) Oxy-Coal power plants (with CO2 capture) can be built using technologies currently available; a viable technical option to Post-Combustion CO2 Capture and Pre-combustion CO2 Capture, and (b) Oxy-coal LCOE, cost of avoided CO2 emissions, and cost of CO2 captured are, at a minimum, competitive with Post- and Pre-combustion CO2 capture and may have economic advantages over these alternatives. LCOE, the levelised cost of electricity, is the price at which electricity must be generated from a specific source to break even.

Moving onto FutureGen 2.0 Karl presented the project objectives. The key objective is to prove the Oxy-combustion process at commercial scale. This will be done by establishing a cost and schedule baseline for the technology; considering equipment design, primarily boiler reliability and also component design and materials of construction. Maintainability, in terms of erosion, corrosion and outage cycles, is one of the key focuses but the design will not be optimised for high efficiency it will be aimed at flexibility of operation and knowledge acquisition. The aim is to prove the basic process and heat transfer parameters which can then be scaled to higher efficiency, larger capacity unite without the need for incremental steps. In essence the project aims to address; process design safety, functionality, operability, integrated operation of major components; the understanding of storage start-up, shutdown, load swings, capacity factors and system dynamics.

The unit chosen for the Oxy-combustion re-powering project is Ameren's 200 MWe gross Meredosia Unit 4 steam turbine. The plant is located in Illinois. The target is 90% CO_2 capture using cryogenic separation, which will lead to the extraction of 1,300,000 tons CO_2/year. Sequestration is into a deep saline aquifer in the Mount Simon formation. The total cost of the project is $1.3 Billion, US DoE Share: $1.05 Billion (81%). Completion of the front-end engineering and design (FEED) exercise is due for completion October 2012 with construction to begin November 2012 with operation in May 2016.

The benefits of the Meredosia host site are that it will provide an existing site infrastructure which conserves capital cost. It is the "right size" unit in that it demonstrates retrofit/repowering potential for existing coal units but it is a large enough test of the technology to support commercial deployment (e.g., 500-800 MWe, supercritical) without another, intermediate, scale-up step. It is also small enough to conserve capital expense for a large-scale integrated test and aims to capture and store ~3,500 tonnes per day CO_2.

A pipeline will be used to transport CO_2 from Meredosia to the preferred CO_2 storage site in north eastern Morgan County, Illinois; approximately 30 miles of pipeline. The pipeline will be 12-inches in diameter and 2,000 psi operating pressure. A four-mile wide corridor is to be studied as part of the environmental impact statement. The geological targets of this project are to design, build and operate a CO_2 storage repository capable of safely and permanently sequestering anthropogenic CO_2.

Karl closed his comprehensive presentation with a status report on progress to date on FutureGen 2.0. The position is that it is currently 6 – 7 months behind schedule; Ameren cannot participate as originally envisioned; Ameren announced plans to close the Meredosia plant; it is possible that the FutureGen Alliance may lease the unit, (currently seeking US DoE approval); preliminary engineering studies (Pre-FEED) are complete; test storage well completed; characterisation well indicates suitability of geology; geology data still being analysed; project cost estimates up for Federal Review; the Energy Department remains committed to demonstrating CCS. Watch this space!!

The CRF Annual Meeting was then held chaired by Greg Kelsall. Re-election of membership to the Executive Committee took place and an update on the activities of the CRF and of its Divisions was given by the CRF Secretary and Divisional Chairmen.

Professor Jon Gibbins of the University of Edinburgh then made an announcement concerning the new UKCCSRC PACT Facilities. Jon explained that the UK Carbon Capture and Storage Research Centre (UKCCSRC) is funded by the Research Councils UK Energy for a Low Carbon Future programme, with additional funding from the Department of Energy and Climate Change. The aim of the UKCCSRC is to provide a national focal point for CCS research and development in order to bring together the user community and academics to analyse problems, devise and carry out world-leading research and share delivery, thus maximising impact. A key priority is to help stimulate the UK economy by driving an integrated research programme focused on increasing the contribution of CCS to a low-carbon energy system for the UK.

Membership will be open to all academic researchers with shareable research projects, current or within last 3 years. It is intended to set up an industrial partner programme aimed at long-term research programmes and using common facilities. The group are working with range of stakeholders to establish pathways to impact delivery. It will be the focal point for UK CCS fundamental research and academic analysis. The total budget is £12.5M over 5 years divided approximately as: £4.5M flexible funding for UKCCSRC; £3M facilities and long-term projects; £2M networking and travel and £3M research coordination and administration.

The intention is to set-up administration centres at the Universities of Edinburgh, Cambridge, Cranfield, Durham, Leeds, Newcastle, Nottingham and Imperial College London, the British Geological Survey and the Plymouth Marine Laboratory.

The UK Pilot-Scale Advanced Capture Technology (PACT) shared facilities, based in Leeds, will offer one site for a unique set of pilot-scale combustion, gasification and post-combustion capture facilities that can operate in a wide range of modes. It will be the focal point for large scale experimental work undertaken by UKCCSRC and will also is available for use by UK industry, especially SMEs, for development and demonstration of products for the CCS supply chain.

Jon then introduced us to the concept of Rapid, or Research and Pathways to Impact Delivery (RAPID). The RAPID process will run throughout the course of the UKCCSRC. It will be led by the Research Area Champions, 18 in number and each will be responsible for a particular topic, e.g. Oxyfuel, transport or CO2 properties. Input will be gathered from a wide range of academic, industry and other stakeholders and the results will be summarised in a RAPID Handbook. The first draft of the Handbook will be published after an intensive 4 month exercise at the project outset and the Handbook will be updated annually.

Lunch was taken and the afternoon session on “Oxyfuel Combustion”, chaired by Peter Sage, began with at talk by Dr Vincent White of Air products plc entitled “Oxygen Production and CO2 Processing for Oxyfuel”.

By way of setting the scene for the detail of what Vince presented the Editor feels that a brief ‘revision course’ on some of the basics might be useful! If you are expert, please skip the next paragraph!

Optional tutorial!

Because cryogenic distillation requires extremely cold conditions to separate the air, all impurities that might solidify, such as water vapour, carbon dioxide, and certain heavy hydrocarbons must first be removed to prevent them from freezing and plugging the cryogenic piping. Dust-free air is compressed to about 5 to 10 bar gauge in a multi-stage compressor. It then passes through a water-cooled after-cooler to condense any water vapour. The air passes through a molecular sieve adsorber. The adsorber contains zeolite and silica gel-type adsorbents, which trap carbon dioxide, heavier hydrocarbons, and any remaining traces of water vapour. The pretreated air stream is split. A small portion of the air is diverted through a compressor, where its pressure is boosted. It is then cooled and allowed to expand to nearly atmospheric pressure. This expansion rapidly cools the air, which is injected into the cryogenic section to provide the required cold temperatures for operation. The main stream of air passes through one side of a pair of plate fin heat exchangers operating in series, while very cold oxygen and nitrogen from the cryogenic section pass through the other side. The incoming air stream is cooled, while the oxygen and nitrogen are warmed. The air stream of part liquid and part gas enters the base of the high-pressure fractionating column. As the air works its way up the column, it loses additional heat. The oxygen continues to liquefy, forming an oxygen-rich mixture in the bottom of the column, while most of the nitrogen and argon flow to the top as a vapour. The liquid oxygen mixture, called crude liquid oxygen, is drawn out of the bottom of the lower fractionating column and is cooled further in the sub-cooler. Part of this stream is allowed to expand to nearly atmospheric pressure and is fed into the low-pressure fractionating column. As the crude liquid oxygen descends down the column most of the remaining nitrogen and argon separate, leaving 99.5% pure oxygen at the bottom of the column.

Vince began by outlining the requirements for an Oxy-fuel combustion system- air separation units (ASUs), steam boiler and turbines, CO_2 purification and compression and CO_2 transport and sequestration. There are three methods of separating the oxygen needed for an Oxyfuel system from air, adsorption, (pressure swing adsorption PSA and vacuum adsorption VA), cryogenic distillation and other such as ion transport membranes (ITMs). Adsorption systems are relatively small, (200t/d – single train) and deliver limited purity (~93% O_2). Cryogenic distillation is much larger in scale (up to 5,000t/d) is more flexible and can supply higher purity oxygen. ITMs are under development but show promise and can deliver ~100t/d at present.

Vince described the component parts of the ASU, i.e. main and boost air compressors, air cooling and pre-treatment equipment, cryogenic separation plant and gas storage facilities. The plate-fin heat exchangers are made of brazed aluminium and care is taken to optimise the performance of the distillation columns by structuring the packing. This can lead to a lower pressure drop which result in a 10% reduction in air compressor power, better turn-down and higher plant capacity.

The oxygen requirements for use in an Oxycoal plant with CO_2 capture are that its pressure should be low as the boiler runs close to atmospheric pressure. Its purity does not need to be too high (<97%) as there is air in-leakage into the boiler and any impurities must be removed from the CO_2 before its transport and sequestration. The removal of any argon present is more easily done from CO_2 rather than oxygen. Oxygen requirements are high with a 500MWe plant needing ~10,000 tonnes/day. There is no use for co-products from the air separation process. Opportunities to improve efficiency and lower capital cost are desirable and if achieved will be of significant benefit. These requirements can be met by the use of Air Product's 'Low Purity Low Pressure Dual HP Column Cycle for Oxyfuel' system.

The ASU may be integrated with the power island, within the Oxycoal complex, to improve its overall efficiency and reduce costs. These types of integration, however, do add complexity to the design and operation of the plant. Vince's view is that integration is not always required or desirable. With no integration, the three column cycle is preferred due to its minimum power input and high O_2 recovery. However, the three column cycle still ideal for integration as a result of its option for adiabatic compression with heat recovery and the provision of nitrogen at 2.5 bar(a) if it can be used. As a result the Reference ASU plant is based on three column cycle.

Machinery and drives are a significant part of ASU capital and power cost and it is therefore critical to optimise efficiency versus capital cost. It is likely that referenced machinery limits will be reached and it is possible to use multiple trains for a single cold box. Centrifugal (up to ~5,000 tonnes/day O_2) or axial (~8,000 tonnes/day O_2) air compressors are available although gas turbine-derived units will be even larger. Electric motors simplify operation but may have starting issues and steam turbines are more suitable for power generation than mechanical drives in that higher electrical losses are outweighed by efficiency gains.

Vince then showed a range of reference ASU plants with a range of outputs from 3,000 to 10,000t/day O_2, highlighting machinery options and power requirements. In terms of Oxycoal ASU flexibility turndown is limited by compressors not the cold box and is normally 75-100%. The range can be increased but with an efficiency penalty. More compression trains or multiple plants give a wider, more continuous range. Rapid ramping is possible and an instantaneous back-up system for plant trip and peak shaving can be provided.

In conclusion, Vince summarised the benefits of the Air Products Oxycoal ASU as having low specific power (both with or without power cycle integration) offering single cold box capability up to 10,000 tonnes/day O_2 and single train machinery up to about 8,000 tonnes/day O_2, both with modest only scale up. Rapid load change is possible and heat integration is beneficial, depending on specific requirements.

Vince then moved on to describe the techniques in use to improve the quality of CO2 following Oxy-combustion and the nature of such residual impurities. The impurities arise from air-in-leakage from the boiler, residual oxygen and products of combustion such as SOx, NOx and metallic impurities from the coal. The technologies used are known as 'Sour Compression' which removes SOx, NOx and mercury; 'Auto-Refrigerated Inerts Removal' to eliminate argon, nitrogen and oxygen and use of the Air Products PRISM© membrane for enhanced CO2 and oxygen recovery. Sour compression is a technique which still requires engineering data, Auto-refrigerated Inerts Removal is a mature technology that still needs more data and PRISM is a commercial technology. The scale-up of the technologies involved batch testing at Imperial College London, 6kWth testing at Doosan Babcock, 0.3MWth slipstream testing at Alstom, Windsor, USA up to the present day where a 1MWth slipstream test at Vattenfall's Schwarze Pumpe is currently operating. The Vattenfall tests were the first demonstration of Sour Compression in representative equipment and the first demonstration of auto-refrigerated inerts removal. Many lessons are being learned that will be relevant to full-scale plant design and operation.

Vince brought his talk to a close by stating that purification of the CO2 from Oxyfuel-fired coal power plants is a technology ready for commercialisation. Several advances in CPU technology have been described which will improve the performance of the CPU and the power plant. Air Products is developing commercial offerings for CPU plants on demonstration plants.

This was followed by Professor Mohamed Pourkashanian of the University of Leeds who presented his talk entitled "UK CCS Research PACT Facilities: Pilot–scale Advanced Capture Technology". Mohammed began by expanding on the outline given by Jon Gibbins on PACT earlier in the day. He explained that PACT will offer large-scale shared facilities for CCS technologies. The EPSRC in its delivery plan recognises that internationally-leading engineering and physical sciences research cannot be done without access to large-scale infrastructure, facilities and equipment and that for the future it may be preferable to support fewer facilities in a more sustainable way rather than more facilities at a sub-optimal level. Their aim is to encourage research facilities to provide complementary services to industrial users (where there is a market), thereby securing leverage on public investment, the profit from which will be reinvested into service improvements for all users. It will reform the provision of equipment with a national prioritisation of needs. PACT will increase the strategic use and sharing of capital items whilst working in partnership with universities.

The PACT consortium comprises the universities of Leeds, Nottingham, Edinburgh, Sheffield, Cranfield and Imperial College London. The role and added value of large-scale CCS research facilities includes providing a positive impact on the reputation of research groups, research centres, hubs, and even whole research fields. It will help to facilitate an exponential increase in the number of observations and experiments via linking to a large infrastructure network, contribute to a more efficient way of working and enable the achievement of set scientific goals within a given timeframe. It should help to combine and integrate complex, linked research and improve UK competitiveness (especially for EU projects). It will also enhance existing funding structures for large-scale facilities.

It is expected UK academics, including those from research institutes, those with RS and RAE fellowships and UK postdoctoral researchers and those with EU funding will exploit the PACT facilities. Other potential users include international, commercial and contractual users (SMEs) and the UK private sector in collaboration with a UK academic partner.

Mohammed described some of the facilities that would be available to users of PACT. The first, which was provided by the University of Edinburgh, is known as the Advanced Capture Testing in a Transportable Remotely-Operated Mini-lab (ACCTROM). Solvents and solid materials for CO2 capture need to be tested for many months to get the same levels of degradation that will occur on real plants. This would be expensive on a pilot-scale unit for a single test and also multiple tests are required to cover ranges of possible operating conditions, solvent blends etc. A number of small-scale test units from different UKCCSRC partners can be operated in parallel in the proposed facility for advanced capture testing in a transportable remotely-operated mini-lab. ACTTROM is to be run on power plant sites using real flue gases. Funding for the equipment has been offered by DECC. Additional funding from UKCCSRC will be used to develop and test the unit and operate it on site (host site operators providing a supply of conditioned flue gas). The unit will be designed to run unattended for up to a month between servicing and sample collection visits.

The integration of a variety of large-scale core PACT facilities, believed to be at Beighton near Sheffield, was shown on a rather 'busy' slide. The system components were divided into three categories. The first, (upstream of the test modules), included control units and system integration, gas mixer facilities (up to 250 KW ex-RWE), and the capability to handle fuels and gases such as oxygen, air, coal, biomass, natural gas and syngas. The second category, (the test facilities themselves), comprised an Oxy-fuel/air solid fuels combustion test facility (CTF) with exhaust gas recirculation (EGR), located at the University of Leeds and rated at 250KW; a coal – biomass air/Oxy-fuel fluidised bed reactor rated at 150KW; a rig simply described as Coal – Biomass blend Fuels 50KW; a planned IGCC reactor (200 KW) and gas turbine APU & Turbec 150Kw at the University of Leeds. Downstream of the test units will be an Amine Post Combustion Capture Plant (150 KW) ex-RWE, gas cleaning and shift and system monitoring via Internet. Further details of the facilities will be available on the PACT website.

Mohammed then moved on to describe the work that he and his team at the University of Leeds had carried out in the field of Oxy-fuel carbon capture technology. His team, based in the Faculty of Engineering, Energy Technology & Innovation Initiative group, comprises 18 PhD students and 7 research fellows. It has active projects with a value of £6.8m in areas such as Oxy-fuel (coal/biomass); whole CCS system simulation; techno-economic analysis; nitrosamine emission from ACP; gas CCS and biomass CCS.

The basic objective is to accelerate the commercialisation of carbon capture technology. The system currently being examined by Mohammed's team is a concept known as 'virtual reality system simulation'. The aim is to identify promising concepts (TRL 1 to 3), reduce the time for design and trouble shooting (TRL 4 to 6), laboratory- to commercial-scale and technology risk assessment (TRL 6 to 7) and finally to achieve commercial deployment (TRL 9).

Technology Readiness Level *(TRL) is a measure used by some United States government agencies and many of the world's major companies (and agencies) to assess the maturity of evolving technologies (materials, components, devices, etc.) prior to incorporating that technology into a system or subsystem. Generally speaking, when a new technology is first invented or conceptualized, it is not suitable for immediate application. Instead, new technologies are usually subjected to experimentation, refinement, and increasingly realistic testing. Once the technology is sufficiently proven, it can be incorporated into a system/subsystem. The system uses a scale from a low of TRL 1, i.e. Basic principles observed and reported; to TRL 9, i.e. Actual system "flight proven" through successful mission operations.*

In this programme, process modelling and advanced Computational Fluid Dynamics (CFD) techniques will be employed to perform detailed simulations of power plant including the Oxy-fuel combustion processes. New Oxy-coal specific CFD sub-programmes will be developed and validated in order to achieve accurate modelling results. Investigations will be performed to develop and link process models to the CFD simulation for dynamic power plant system simulation. The other strand of this project is an experimental and modelling investigation of the chemical processes leading to oxidation and thus the removal of mercury in the flue gas stream.

Mohammed also introduced the concept of integrated multi-scale modelling in which 'multiscale' refers to the science of dealing with modelling and simulation of phenomena and models across multiple time and or length scales. For example, details were provided on the quantitative structure relationships and theory at the quantum, molecular, meso scale, continuum and macroscopic levels. To assist in the provision of data in the very complex modelling the use of a number of test facilities was necessary and some of these were mentioned. They included the E.ON 1MW Combustion Test Facility and the University of Leeds 250kW combustion test facility. These test facilities are equipped with very sophisticated sampling and analysis systems to collect and measure gas concentrations, particulate samples and laser in-flame diagnostic analysis. The project is on-going and further interesting developments will no doubt be presented at a later date.

The final formal presentation of the day was given by Jon Gibbins which was entitled “An Overview of Oxyfuel Carbon Capture”. Jon explained that within the Research Councils UK (RCUK), carbon capture and storage has been recognised as a priority area for the Energy Programme. It now supports over £38 million worth of funding for 36 current research and capacity-building projects in CCS. It includes four consortia groups researching carbon capture and transport, three jointly supported with E.ON, a £6.5 million investment.

One of these activities is the OxyCAP UK project whose objective is “to develop academic research capability for Oxy-fuel combustion in five key areas”. This will be achieved by: 1) New experimental techniques for Oxy-fuel combustion; 2) Advanced computer modelling techniques (Large Eddy Simulation (LES), integrated CFD/system); 3) Experimental data on coal ash/boiler material behaviour under Oxy-fuel conditions; 4) UK capacity in Oxy-fuel fluidised bed combustion (FBC) and 5) the training & development of new researchers.

Jon then described the links and information flows between the tasks and subtasks that make up this large project.

The University of Cambridge was tasked with the application of optical diagnostic techniques to particle laden flows. Specific goals were: a) Create a database of turbulent combustion experiments with coal particles, b) Analyse the difference between oxy-firing and air-firing and to c) Identify the limitations of optical diagnostic techniques to the coal combustion.

Cranfield University was tasked with the goals of: a) Study Oxy-fuel combustion, b) Ash transformation and c) Ash deposition and corrosion studies.

The University of Edinburgh’s goals were: a) Determine safe levels of O2 in O2/CO2 in FGR.
b) Mill safety and c) Ignition/combustion fundamentals under Oxyfuel conditions.

Imperial College London was given goals: a) Improve understanding of Oxy-combustion using LES and b) Model coal particles burning in oxy-combustion and other species.

The University of Kent’s goals were: a) 3D Flame imaging, b) Flow metering and on-line sizing of pulverised coal and c) Particle image characterization.

The University of Leeds was tasked with financial & technical coordination and its goals were: a) PF Oxy-combustion fundamentals (and fuel characterisation) and b) LES, CFD and global plant simulation.

The University of Nottingham’s goals were: a) Coal devolatilisation and subsequent char burnout characteristics, b) The effect of mineral matter and potential formation of carbonate species, c) Coal/biomass oxy-cofiring + char analysis and d) Water vapour content in FGR.

Jon then showed a number of slides which highlighted the difficult tasks of squaring the circle with all of the competing requirements from CO2 at its source to safe global containment. The issues were satisfying financial, environment, safety, public acceptance and regulation. The complex interlinking pathways to impact were also demonstrated with mention of the differences between academic impact and economic and societal impacts.

Jon brought his talk to an end by highlighting what are the important areas for future research. These key R,D&D challenges include: Improve the efficiency of coal fired power generation with effective removal of conventional pollutants such as SOx, NOx particulates and trace metals; Improve the use of more advanced steam cycles, for which the need to improve performance through materials selection is critically important; Improve plant integration, together with enhanced fuel and operational flexibility; Establish near zero emissions systems such that CO2 can be prevented from being released to atmosphere, with any adverse technical impacts on such efficiency and environmental performance being minimized in as cost effective manner as possible. This will require large scale demonstrations of the first generation CO2 capture systems and offshore CO2 storage within a complete CCS chain; Improve effectiveness and costs of the first generation CO2 capture systems and the development of second generation systems that will overcome some of the inherent disadvantages of the first; Gain a better understanding of the properties of CO2 to ensure the provision of robust transport systems; Improve assessment and modeling of CO2 storage capacity in various geological formations, together with the development of improved monitoring and verification techniques.

After the presentations the attendees were invited to make a visit to the power station. The group reconvened for the concluding remarks which were made by Professor John Patrick.

The 3rd Annual Minerals Engineering Society Symposium "Minerals Engineering 2012"'

Co-sponsored by the Coal Research Forum and the South Midlands Mining and Minerals Institute

Hilton East Midlands Hotel,
Thursday 24th May 2012

The Opening Address was given by Greg Kelley who is the President of the Minerals Engineering Society (MES).

The Chairman for Session 1 was Mike Richards and he introduced the first speaker Mick Naylor of Parnaby Cyclones International who presented his talk entitled "78 Degrees North, the World's Most Northerly Coal Preparation Plant". As the title of the talk hinted, the installation and commissioning of the coal preparation plant was likely to present certain difficulties not met in more temperate zones. The plant is in Svalbard which is an archipelago in the Arctic, constituting the northernmost part of Norway. It is located north of mainland Europe, midway between mainland Norway and the North Pole. Spitsbergen is the largest island.

The coal preparation facility at Svea Mine is currently the most northerly operational coal washing plant in the world. There is a more northerly mine with a washing plant but it is not producing coal at the moment.

The plant is designed to wash -50mm raw coal to produce either a PCI or Thermal Coal product. Historically the coal from the Svea Mine was of a sufficient quality that it was sold un-treated for power station use. However due to changing underground conditions it became increasingly obvious that a cleaning plant will have to be utilised to remove a dirt band that was expanding in the coal seam.

A bulk sample of the feed was sent to the UK in summer 2010 for analysis and the first coal introduced to the plant on the 6th June 2011, within 12 months from the receipt of the official order. From the analyses it was determined that a dense medium system would give the client the desired flexibility to control the ash values and hence product qualities. A small internal design study was carried out and a large single dense medium cyclone was selected to wash the +1mm coal fractions. The -1mm material is classified and the coarser fraction cleaned.

Feed to the plant is screened and any oversize crushed to minus 50mm and re-circulated. The same oversize protection screen is also used to remove a portion of the minus 6mm material. This -6mm material can be stockpiled separately or allowed to rejoin the main plant feed, depending upon market requirements and the feed quality. A nuclear ash monitor is mounted on the -6mm stockpile conveyor. The -50mm raw coal feed is deslimed at 1mm with plenty of water. The nominally -50+1mm raw coal is discharged from the desliming screen directly into a specially designed Cyclone Feed tank. The cyclone selected is a 1000mm diameter dense medium cyclone with sufficient flexibility to pass more discard if the raw coal feed deteriorates further.

The two cyclone products are dewatered on individual banana screens and the cleaned coal further dewatered in a large 1500mm diameter small coal centrifuge. The screens drain as much of the adhering medium off the products prior to the rinsing sections of the screen. All spray water is gathered together and pumped to high efficiency magnetic separators. The -1mm is first classified in a bank of hydrocyclones and the coarser fraction is cleaned in a bank of spirals. The coal and middlings products from the spirals are gathered together and pumped to a further bank of thickening cyclones to partially dewater the recovered fine coal prior to it being dewatered in a high “G” centrifuge. The cyclone overflows can be used for balancing purposes or discharged to the thickener. Fine discard is dewatered on a designated fines dewatering screen. All effluents are gathered in the thickener and the suspended solids treated with flocculent to aid its settling. The thickened solids removed from the thickener are stored in a buffer tank and then metered into a multi roll filter press. The subsequent filter cake can be out loaded to a separate stockpile, included with the discard or placed with the cleaned coal. All cleaned coal products are gathered together on one conveyor and conveyed to radial stockpile. The cleaned coal collection conveyor is equipped with a nuclear ash monitor to determine and record the product ash value. A similar unit is mounted on the Fine Coal stockpile conveyor. All discards are also gathered on a single discard conveyor and stockpiled for removal.

All the tank levels are automatically controlled via individual sonic level detectors. These regulate the appropriate clarified water make up valves. In addition to these a nuclear detector monitors and controls the density of the circulating medium. This adjusts the addition of clarified water or overdense to control the density of the circulating medium. The level of the circulating medium is further managed via a bleed system to allow a proportion of the circulating medium to be bled to the dilute medium tank should the level be too high. All of these functions are monitored via a Siemens S7 computer controlled system. This is one of the latest Siemens systems and will allow for future expansion and development. The Operator Interface is via two flat screen monitors which can each show either the full mimics, level control loops or the safety status of individual items and a designated keyboard and mouse. All management information is available via this system to simplify maintenance requirements and has data logging capacities. The plant can be set to produce a 7% ash or a 10% ash product by simply adjusting the density of the circulating medium. Normally the plant is set to produce a 10% thermal coal product. The small coal centrifuge product free moisture is approx 4.5% to 5% and the free moisture in the fine coal centrifuge product is approx 11%. Total product free moisture is therefore approx 5.5%. Magnetite consumption has been difficult to quantify. Normally around 8000 tonnes are washed per day on two shifts. The amount of magnetite added has varied between 2 tonnes per day down to zero tonnes per day depending upon tank levels and the density set point. Consumption has never exceeded 2 tonnes per 8000tonnes washed. The overdense produced by the magnetic separators is usually in excess of 2.4sg and the control of the circulating medium density is normally within plus/minus 0.01 of the set point when the plant is running under a stable state condition.

SNSG’s principal operations are in the Svea Nord mine, which is about 60 kilometers south of Longyearbyen. Most of the company’s employees work in Svea. Svea Nord has been in normal commercial operation since 2002 and accounts for most of the company’s production. Annual production in 2011 was about 1.7 million tons of coal. The coal seam in Svea Nord is up to five metres thick and is extracted with longwall equipment. This involves extracting the coal using a cutting machine that moves along coal panels that are 250 metres wide and up to 3.5 kilometers long. The miners follow the production beneath hydraulically powered supports that temporarily hold up the roof while coal is extracted. Behind the supports the roof is allowed to collapse in controlled goaf falls as the coal is extracted. The coal is transported on conveyor belts out of the mountain in Svea and from there by truck to large coal storage areas in the port at Kapp Amsterdam.

There is no road connection between Longyearbyen and Svea. All transport of personnel is done by plane. This has given rise to the creation of an extensive infrastructure, including canteen, accommodation units, airfield, roads, water supply, power plant and port facilities at Svea.

There have been mining operations at Svea since 1917, when the Swedish company AB Spetsbergens Svenska Kolfält established the Svea mine at the innermost end of the Van Mijen fjord. Store Norske bought Svea from the Swedes in 1932, since when there has been mining at Svea at irregular intervals, with only a guard force present during some periods. The Svea Vest mine was depleted and closed in 2000.

In the summer of 2005, there was a fire in the Svea Nord mine. The work of extinguishing the fire and preparing for a new start-up of mining operations took over eight months. No-one was injured in the fire.

Store Norske Spitsbergen Kulkompani AS (SNSK) was formed in November 1916, when the company took over coal mining operations in Longyearbyen from the US-owned Arctic Coal Company. Since then, Store Norske has operated coal mines on Svalbard continually, with the exception of a period during World War II. Store Norske Spitsbergen Kulkompani AS still has its head office in Longyearbyen. SNSK is the parent company of the Store Norske group and is 99.9 per cent owned by the Norwegian State. The group also includes the companies Store Norske Spitsbergen Grubekompani AS (SNSG), Store Norske Gull AS and Store Norske Boliger AS.

Most of the coal production in the past was carried on in Longyearbyen. The principal activities of Store Norske are now located at Svea, 60 kilometers south of Longyearbyen. Store Norske Spitsbergen Grubekompani AS produces approximately 1.8 million tonnes of coal annually from the Svea Nord mine. In the area around Longyearbyen, mining operations are now carried out only in the Gruve 7 mine, which is in Adventdalen, 15 kilometers east of Longyearbyen. The Gruve 7 mine produces about 75 000 tonnes of coal annually. Through the company Store Norske Gull AS, Store Norske operates mineral exploration activities on Svalbard and in the counties of Finnmark and Troms on the Norwegian mainland.

A break for coffee was followed by the second talk was given by Dr Richard Maslen of Fairport Engineering Ltd. Due to the absence of his colleague, Haydn Wren, Richard presented two papers. His first was entitled “Biomass Conversion of Coal-based Material handling Facilities”.

Richard began his talk on biomass by explaining the LCPD and the rationale behind the use of biomass in UK power plant. He then went on to explain the differences between coal and biomass stressing, in particular, the bulk density, calorific value, moisture and ash contents of both. The differences in properties between the two fuels made it obvious that any plant designed for coal would not be suitable for biomass. Biomass is not an easy material to handle. It appears in a myriad of species, forms and sizes; it knits together, doesn’t flow well, consolidates and packs easily. One particular difference that needs special attention was that of dust handling. Whereas dust suppression of coal using water is highly effective this is not the case for wood pellets and can actually cause more harm, swelling and causing mould growth.

Richard then described a case study of the equipment and methodology used in a power station burning biomass and coal. The delivery may be by road (30 tonnes per load), rail (2,000 tonnes per load) or sea (45,000 tonnes per load). It is unloaded by various methods of which vacuum suction is one. The biomass is moved by belt conveyors some of which may be air-supported and totally enclosed. As biomass must be kept dry new storage facilities are generally needed. These can be sheds, silos or dome silos Richard indicated that although coal day bins might be re-usable with biomass it was preferable to replace them with new. This is because of the very different nature of dry biomass which represents a higher explosion risk. The inevitable degradation of wood pellets in transit produces a quantity of fine wood dust. Richard suggested that the separation of pellets from dust was well worth while from the point of view of dust minimisation and reduction in milling energy. The fine dust is passed straight to the burners and the pellets go for milling prior to combustion. Milling is a potential bottleneck, is energy intensive and can cause explosions. Richard finished his first talk by concluding that biomass power generation increases are set to continue in the short to medium term. The forms of biomass used will diversify. New industry Best Practices are still to be determined and that the handling of dust safely and economically is the key issue with biomass handling.

Richard's second paper was entitled “SRF (Solid Recovered Fuel) as a Fuel for the Cement Industry: A UK Case Study”. The first question that Richard posed was why would anyone wish to remove energy components from municipal waste? To which the answers were:- to prevent excessive amounts from being sent to landfill which is getting more expensive and can be hazardous due to methane generation; to reduce the dependence on fossil energy, to reduce emissions of pollutants and finally to make money!

Richard explained that the work he was about to present had been sponsored by DEFRA. DEFRA has initiated waste strategies and initiatives such as the Waste Implementation Programme, under which The New Technologies Demonstration Programme was introduced to support the development of new technologies for waste management in the UK. Several pilot plants were established including a mechanical heat treatment (MHT) plant at Huyton, Liverpool, led by the Merseyside Waste Disposal Authority and supplied and operated by Fairport Engineering Ltd.

The MHT plant was designed to process up to 50,000 tonnes MSW, produce recyclables and a range of high calorific value fuel products. The plant comprises: a reception area, into which refuse collection vehicles discharge their load, a pair of rotating thermal processor drums where the waste is broken down and dried, a materials classification area to separate recyclables, and a fuels refining area. Mixed, shredded waste is turned and lifted in the thermal processor drums, and dried and sanitised by hot air. Drying is controlled to optimise the moisture content of the final processed fuel products. The treated waste is then sorted by size and density. Ferrous and non-ferrous metals are separated by over band magnets and eddy current separators. Plastics are separated using an infrared detector and a compressed air deflector and can be baled for sale or added to the fuel product. After separation of metals and plastics, the remaining lightweight material is separated from the heavier fraction comprising glass and rubble. The lightweight material (including biomass and plastics) can be blended to a range of end-user specifications.

Over the operational period the plant received 20,500 tonnes of waste. The incoming waste had a high proportion of textiles and plastic film. These materials caused blockages in the plant during the early period of operation resulting in lost working hours. Modifications to the plant including the introduction of a larger shredder solved this problem. Over the operational period, a total of 575 tonnes of ferrous metal, 120 tonnes of non-ferrous metal, 400 tonnes of mixed plastics and 680 tonnes of glass and rubble was recovered. The results from manual sorting tests on the recyclable materials demonstrated that a high degree of purity was achieved by the process.

The Huyton MHT plant was required to demonstrate that it could produce renewable fuels for the cement, gasification and combined heat and power industries. The material recovered at the plant for use as a fuel is referred to as a “fuel product", but specific fuels have been identified e.g. the fuel which was produced to a specification which would be suitable for the cement industry is referred to a Mixed Fuel (MF), the fuel for the gasification industry is referred to as a Medium Light Fuel (ML) and that for the combined heat and power industry is referred to as a Fine Floc Fuel (FF).BFP) and Refined Renewable Biomass Fuel (RRBF).

In total, 6,000 tonnes of fuel products were produced. The production rate over the operational period increased from 70 tonnes up to a maximum of 325 tonnes as modifications to the plant were made. The percentage of incoming waste which was diverted to produce fuel products rose from c.10% to a maximum of 76%. The plant achieved the design target of 30-40% recovery of fuel products for some 40% of the operational period. A range of fuel products were produced over the Demonstrator project, including a Mixed Fuel to a specification for the cement industry, and fuels trialled for gasification and a combined heat and power plant. Chemical analysis of the fuel products showed that mercury, chlorine and sulphur concentrations were below levels set by the end users. The average concentration of potentially toxic metals in the fuel products was significantly lower than the limits specified.

The median gross calorific value (15MJ/kg) of the Mixed Fuel samples was greater than the calorific value estimated for the incoming MSW (GCV = 11.8 MJ/kg) and for average UK household waste (GCV = 9 MJ/kg). The biomass content (by calorific value) of three different types of fuel ranged from 76 to 87%. While these fuel products were not produced with the aim of achieving ROC accreditation as biomass, the results suggest that this could be attained. To do so, the biomass density separation system could be adjusted to remove more plastics from the fuel products; this would, however, reduce the calorific value of the fuel.

Over the operational period, 8,000 tonnes of residual waste were sent to landfill; improvements in the plant reduced the amount of waste going to landfill from 65% (of the incoming waste) in the early phase of operation down to a minimum of 8.6%, thus achieving the target for the facility of diverting 80-85% of the input from landfill. The amount of biodegradable material in the residual waste going to landfill over the operating period was approximately 2,900 tonnes (assuming the biodegradability of this waste is 36%). Thus, the MHT process diverted around 9,500 tonnes of biodegradable material from landfill.

Overall, the operation of the plant demonstrated that it was capable of processing mixed MSW and producing clean recyclables and fuel products. The design of the plant was flexible enough to allow changes to be made to accommodate the variable nature of MSW, and the process and equipment were adapted to deal with difficult materials such as textiles and plastics. A significant reduction in the proportion of material sent to landfill was made, and the recovery of recyclables and fuel products was increased over the operating period. The process could be tuned to produce fuels to different customer specifications, although some criteria (such as high biomass content to achieve ROCs accreditation, high plastics content to achieve high calorific value, and low chloride content to reduce corrosion problems) might be mutually exclusive. After initial problems were resolved, significant improvements in energy efficiency were achieved. In conclusion, the operation of the Huyton facility demonstrated that MHT is an effective, viable process for dealing with mixed MSW and reducing the amount of waste going to landfill while recovering recyclables and an energy rich fuel product.

The last paper before lunch was given by Graham Davey of Metso Minerals and was entitled "Metso Stirred Milling Technology". Graham began by explaining that the stirred milling technologies currently supplied by Metso can be divided into two sub-categories: gravity-induced and fluidised. Gravity-induced stirred mills initiate a ball charge motion via rotational movement of a screw to provide a size reduction mechanism. In contrast, fluidised stirred mills use a rotational movement to fluidize a media-slurry mixture, resulting in a size reduction mechanism. The type of mill and the circuit configuration are intrinsic to maximizing the grade and recovery profile of an ore. Metso has both stirred milling technologies in the Vertimill and the Stirred Media Detritor (SMD), allowing Metso to offer the optimum equipment solution for the circuit.

The Vertimill is a unique product offered exclusively by Metso that has a long history in the metallic mining industry. The technology was originally developed in the 1950's for industrial applications. Metso successfully developed and implemented the technology in the first large scale metallic operations in 1980. In the thirty years since, the Vertimill has built the largest installed base of any stirred milling technology. Mechanically, the Vertimill is a very simple machine with an agitating screw suspended into the grinding chamber, supported by spherical roller bearings and driven by a fixed speed motor through a planetary gearbox. The figure above shows the Vertimill in its standard arrangement with all of its major components. The capacity of each unit size is relative to the required power input for the intended grind; however mills have been operated with throughputs exceeding 500 mtph. A total of 382 Vertimill units have been supplied by Metso, the standard unit sizes varying from 15 to 3,000 HP. It is a gravity induced stirred mill which operates with a feed size from 6 mm and product Sizes to sub 15 microns.

Graham then spent some time explaining the features and advantages of the Stirred Media Detritor (SMD). This device is a fluidised, vertical stirred mill designed for optimum grinding efficiency for fine and ultrafine grinding products. The SMD utilizes the rotational energy of the impeller arms to impart a high-energy motion to the media/slurry mixture inside the mill. This results in particle-to-particle shear and compressive forces which produce the desired grinding mechanism for fine grinding. The vertical arrangement allows the drive train to be entirely supported by the mill body which leads to a small foot print and simple foundation. Also, the vertical arrangement does not require any slurry seals or inlet feed pressure. The SMD is a fluidised media mill which means, the stirrer speed is high enough to distribute the media throughout the slurry regardless of media density, forcing particle and media contact. The SMD power intensity is optimised to achieve efficient grinding, limit wear, and allow for heat dissipation in the case of a high energy grind. The power intensity (kW/m3) is relatively high compared with other mill types, but is required to generate a vortex of the media and slurry during operation and to bring the particles in contact with one another for efficient grinding. However, the power intensity is not so high that a cooling system would be required to dissipate the heat generated during a high energy grind. Also, limiting power intensity limits the sheer force of the media/slurry on the liners, impellers and improves wear life. Metso have installed 170 units of their SMD which have a range of standard Units Sizes from 7.5 to 1,100 kW. It is a fluidising media mill with feed sizes from 250 microns which can produce Product to sub 5 microns.

Graham identified a number of plants throughout the world that are using Metso milling plant and highlighted some of the many materials handled by this equipment. Such materials included aluminium oxide, coal/water mixtures, copper and gold ore, limestone, petroleum coke, silica zinc ore and uranium. Graham concluded by describing Metso's newest mill the SMD E. The challenge in fine and ultra fine grinding applications, however, is the increasing energy requirements and the diminishing returns that occur as operations approach smaller product sizes. Metso believe that the solution is an energy-efficient, stirred, milling machine that maximises wear life and availability while achieving the desired product size and maintaining profitability. This is now available as the Stirred Media Detritor (SMD) E-Series, Metso's largest-scale SMD.

After a very pleasant lunch break the proceedings continued with the remaining session being chaired by Professor John Patrick representing the Coal Research Forum. The first talk in the afternoon was given by David Hyde of MEP Ltd. entitled "Coal Preparation Modification to Arcelor Mittal Coal Preparation Plants in Kazakhstan". David was standing in at short notice for his co-author Steve Frankland. David began by explaining that Arcelor Mittal's steel plant in Kazakhstan is supplied by coking coal from its eight coal mines in the nearby Karaganda Basin. The Karaganda Coal Basin is one of the major hard coal basins of the USSR, the third most important source of coal after the Donets and Kuznetsk basins. Coal is cleaned at three preparation plants, two located at the steel works in Temirtau and one at Vostochnaya. The oldest plant is Temirtau No. 1, which was built in the late 1960's, Temirtau No. 2 was built in the early 1970's and Vostochnaya followed in the late 1970's.

The coals are very difficult to clean and historical losses of coking coal and middlings needed to be reduced and the throughput of the existing three coal preparation plants increased to permit rationalisation of all the coal preparation facilities. A strategic review of the plant revealed opportunities to improve the plant performance and throughput.

Temirau No. 2 like its older predecessor, No. 1, uses large coal jigs for upgrading the 75mm to 25mm sized material, small coal jigs for material in the range of 25mm to 1mm and froth flotation for less than 1mm fines. Vostochnaya has a dense bath for plus 20mm, jigs for treating the 20mm to 0.5mm size fraction and froth flotation for fines less than 1mm. Unusually to Western eyes is the fact that there are very few vibrating screens. The raw coal screens are static sieves and the de-sliming and de-watering screens are all conical wedge wire screens. Small coal de-watering is by basket centrifuge and the fine coal is de-watered on disc filters. The fine coal in thermally dried at Temirtau but all the coal is dried at Vostochnaya.

Having carried out an initial review of the operations and condition of the plants, some preliminary views were formed on what could be done to improve coal recovery and operating costs. After some confirmatory tests to validate the proposed upgrades to the plant the global economic crisis began and a lower cost option had to be chosen which involved improvements to the fine coal treatment while closing the water circuit. The Temirtau plant had no tailings circuit and the rejects were pumped 15km by pipeline for disposal at a power consumption of 2,000kW. Arcelor Mittal had already decided to close the water circuit at Vostochnaya to eliminate the use of the tailings pond. As a result, six belt filter presses with ancillary equipment had already been purchased but not installed. This equipment was included in the final plans.

It was decided to install additional fine coal treatment in the two newest plants (Temirtau No. 2 and Vostochnaya) to achieve an increase in yield of concentrate and better environmental performance. The modifications comprised the introduction of a cyclone and Hydrosizer after the 2mm screen and before the froth flotation cells for both plants. The Hydrosizer would address the problems of loss of high quality coal in the 0.5mm to 2mm fraction. It would increase the capacity of each plant by about 150t/h and improve the efficiency of fine coal cleaning at the same time.

The project has been completed and David was able to present some early findings. The yield of concentrate exceeded the target figure of 4% and was 5% in both of the upgraded plants/ The Hydrosizer has been set up to produce coal with an ash of 11% to optimise plant yield. The quality of the discard is a produce of 80% ash. The water circuits to the upgraded plants were closed by the addition of the thickening and belt press filtration leading to improved environmental performance by the elimination of the use of tailing ponds.

The theme of last minute substitutions continued with the next paper given by Lucy England instead of Dr Liam McNamara of FL Smidth Minerals. Given that Lucy had, at one days notice, been given just the title "Continuous Improvements in Mineral Processing" she had full rein to interpret that as she saw fit. In the event she adopted what the editor felt was a very important approach which fitted in very well with the proceedings and with the audience. As is obligatory in such presentations an introduction of the presenter's employer and Lucy told us some thing about the history to and the activities of F.L.Smidth.

FLSmidth's R&D activities take place globally in various centres of excellence. They have recently made advances in key areas, such as alternative fuel systems and developing the world's largest flotation cells. Their Dania test centre in Denmark is the cement industry's largest with laboratories and pilot testing facilities for global projects, including a broad range of emissions and environmental solutions for new and existing plants. In September 2010, the new technology centre for Minerals Processing was inaugurated in Salt Lake City, USA. The technology centre brings the resources of the R&D organisation and pilot testing facility, together with the process testing laboratory into a single facility.

However, Lucy then moved into areas which she felt were of particular importance to the future of industries such as Smidth. She noted that the audience was, to put it politely, of advancing years in many cases. Notwithstanding the amount of knowledge and experience held by such attendees the future supply of suitable graduate to enable the industries like Smidth to prosper are in increasingly short supply. Lucy talked about Smidth initiatives to attract suitable staff and the importance of what she termed automated operation. Remote problem solving and safety and training were two other key factors to success. Her vision of the future was having the ability as a corporate entity to design, build, operate train and de-commission plant for its customers. The more specific aim was to increase activity in customer services with a goal of 10% to 15% per annum with a focus on long term Operations & Maintenance contracts.

Afternoon tea was followed by the last presentation by Australian expert Jamiel Muhor of BASF SE Germany. Jamiel gave a talk entitled “Technology Development in Flocculant Preparation & Performance”.

BASF is a global company with many interests. Jamiel is from the sector that deals with tailings processing and began by providing the audience with a brief overview of flocculation, hydration and dissolution, their similarities and their differences. He then went on to highlight technology developments and important applications of the products that are produced by BASF. BASF SE supplies a broad range of speciality chemicals (flocculants and coagulants) for use in a wide spectrum of mineral processing applications and potable, waste water and industrial effluent treatment plants throughout the world. Chemical flocculants and coagulants are supplied as powder or liquid grade concentrates, and dilute solutions must be prepared before they can be utilised. The key task is to achieve complete dissolution, constantly maintaining optimum mixtures to avoid wastage, backed by efficient dosage on a constant and ongoing basis. An integral part of achieving this aim includes programmed monitoring to ensure optimum levels of efficiency are maintained. This applies particularly in applications where the process variables require constant ‘fine-tuning’ of the chemicals being used, with the consequent need for dosage and application adjustment – quickly and easily for continued economy.

The challenge is to ensure efficient dilute chemical mixing, correct and accurate dosage within a system that offers full monitoring capability with minimum servicing requirements. BASF SE products include bulk storage facilities for powder and liquid grades of flocculants and coagulant chemicals; powder grade batch mixing systems, liquid grade semi-continuous mixing systems; Continuous Polymer System (CPS) powder grade mixing units; dosing pumps and dilution systems suitable for local manual or remote control operation; Alcotech TC automatic flocculant and coagulant dose control to thickeners/clarifiers; specialist dose control systems for all thickening and dewatering applications; telemetry and inventory management.

The final closing address was given by Greg Kelley and he was pleased with the outcome of the symposium and thanked all involved.

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The following information is about a new biofuels consortium
Welcome to **BRISK NEWS**, a brand new publication produced on behalf of the BRISK biofuels research consortium. We hope you find it useful, and would encourage you to participate in BRISK activities you find of interest. Inside you will find:

- How to apply for funding to carry out thermochemical biomass conversion research at any of the BRISK partners’ European facilities
- Features on various BRISK partners and their laboratories
- BRISK Open Workshops
- International Bioenergy Events Diary

- Useful Training Courses and Publications
- BRISK Project Overview – including Work Package updates

BRISK is a new research infrastructure. Its main activity is to fund researchers from any European country to carry out thermochemical biomass conversion research at any of the 26 partners' facilities. **The project will pay for the costs associated with accessing and supporting the facilities, along with a grant to contribute to travel, accommodation and subsistence.**

Please forward this email to other people who may be interested in this research initiative. Further details can be found at **www.briskeu.com**.

If you would like to contribute news items for future editions, please do not hesitate to contact me.

Best regards,
Irene Watkinson
BRISK NEWS editor

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The following article, which is self-explanatory, has been submitted by a Spanish government sponsored organisation and highly relevant to the present interest in carbon capture and storage.

CIUDEN es.CO2 – TECHNOLOGY DEVELOPMENT CENTRE FOR CO_2 CAPTURE AND TRANSPORT

By José Antonio Gutiérrez Bravo, Sandra Ramos Vigo, and Ruth Diego García, CIUDEN.

The Fundación Ciudad de la Energía (CIUDEN) is a state owned, public R&D institution created by the Spanish Government in 2006. It was conceived to foster economic and social development in Spain through activities related to the energy and environmental sectors. Currently, it depends on the Ministry of Industry, Energy and Tourism.

By carrying out collaborative research in Carbon Capture and Storage (CCS), CIUDEN contributes to strengthening the industrial and technological base in Spain and Europe, participating at the moment in seven FP7 projects. In addition, the project of CIUDEN is involved in one of the six projects funded by the European Energy Programme of Recovery (EEPR). However, this is not the only way to cooperate with CIUDEN; there are different ways of collaboration such as technological association or specific collaboration agreements, service contracts or project consortium agreements. In this sense, CIUDEN is opened to any proposal to develop R&D projects or services with international partners.

The Technology Development Centre For CO_2 Capture and Transport (es.CO_2)

The Centre es.CO_2 is located in Cubillos del Sil (León, Spain) in El Bierzo region, whose history is closely related to energy production, especially through mining and the use of coal. Its aim is to develop oxy-combustion capture and transport technologies feasibility to reach the industrial scale and it is open for international cooperation and research.

The main characteristics that make the Centre es.CO_2 a facility unique in Europe are:

- **Oxy-combustion technology**. The installation incorporates two different oxyfiring technologies: pulverized coal and circulating fluidized bed. Its two boilers are able to operate in both, air and oxy-modes.
- **Size**. Semi-industrial size, so that the research results could be more easily replicated at a commercial site.
- **Modularity** for simultaneous or separate operation and **flexibility and complete control** of the operation process.

- **Fuels**. Different types of fuels and their mixtures can be prepared for the combustion system and tested.
- **Equipment**. The most advanced and specialized equipments available in the market, and auxiliary facilities such as training centre, videoconference rooms, meeting rooms, etc.
- **Personnel**. Highly qualified personnel and experimented in international workbench.
- Integration of all CCS chain for a complete development of a project.

Technical description of the Centre

The Centre has been designed to optimize the integration of units and systems and incorporates full monitoring capabilities. Its flexibility allows operation under a wide range of conditions and has been conceived for later extensions to accommodate technological progress. Currently, the system capacities are the following:

The **fuel preparation system** can handle different types of coals: anthracites, bituminous and sub-bituminous coals and pet coke. Biomass can be stored and fed to the boiler. Coal is crushed and stored in two different silos of 120 m^3 each. The fuel preparation system has a ball mill and an indirect system with an 80 m^3 silo storage to feed the pulverized coal to the pulverized coal boiler.

The **Pulverized Coal boiler (PC)** has a power up to 20MW_{th} that is reached with 4 horizontal low NO_x burners. Vertical or tangential burners can be installed in the PC boiler too and it is designed to be able to carry out biomass co-combustion up to 25%.

The **Circulating Fluidized Bed boiler (CFB)** is 30MW_{th}, largest oxy-CFB boiler in the world. It has some advantages over PC boiler, firstly SO_x and NO_x removal is done inside the boiler. Secondly, the coal does not need to be milled, so it reduces the number of associated equipment to the boiler.

Both boilers can work from air combustion, partial oxy-combustion to complete oxy-combustion. Oxidant preparation system is very versatile. Several oxidants are adapted to the combustion in flow, oxygen concentration, temperature and pressure.

The flue gas treatment is achieved in the **flue gas cleaning system**. Fly ashes are removed in a first stage with a cyclone and in a second stage with a bag filter. NO_x treatment can be done by Selective Catalytic Reduction and a Flue Gas Desulfurization system reduces SO_x levels.

Flue gases are fully treated and CO_2 is captured on a **Compression and Purification Unit (CPU)**. CO_2 purification is done by cryogenics with 4,500 Nm^3/h and CO_2 capture purity over 99%.

CO_2 transport can be tested at the **CO_2 Transport Experimental Rig**. This facility can operate with CO_2 captured from the CPU or operate with commercial CO_2, which can be doped to simulate CO_2 captured from pre-, post- or oxy-combustion, or NG combustion. The transport rig also offers 6 experimental areas for testing depressurization, leakage, fracture, corrosion, instrumentation and pressure drop.

The **biomass gasifier** is a 3 MW_{th} bubbling bed gasifier and it has been designed to gasify pellets of wood chips with an efficiency up to 98%. It will enhance biomass conversion to develop sustainable biomass utilization.

The Centre also incorporates its own **laboratories** with specialized equipment and personnel. These facilities has been conceived to support the experimental work of the plant in matters of coal characterization and control of the process parameters, but also for tests related with the storage of CO_2 (petrophysical and petrographic characterization of reservoir and seal rocks, water and gas analysis or research on durability and reactivity of materials).

Furthermore the Centre incorporates **PISCO2**, an experimental facility for the investigation of the influence of CO2 injection in soils on different biotypes. Its main objective is to develop economical and ecological biomonitoring tools for safety control of CO2 geological storage.

The Technology Development Centre for CO_2 Capture and Transport (es.CO_2), conceived for collaborative research, is prepared for advanced innovation activities in the field of CCS technologies.
For further information, please contact us at sm.ramos@ciuden.es

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Next an article which tells us all……………………………………

About the Carbon Capture & Storage Association

The Carbon Capture and Storage Association (CCSA) was launched in 2006 with 11 founding members and has now grown to represent over 60 members across the CCS supply chain.

The CCSA is a business association formed in the UK to represent the interests of its members in promoting the business of Carbon Capture and Storage (CCS). From its base in London, the CCSA brings together a diverse range of companies from sectors including:

- Academic
- Air separation
- Carbon storage
- Coal
- Consultancy
- Development agencies
- Engineering & contracting
- Finance
- Law
- Manufacturing & processing
- Oil & gas
- Project management
- Power generation
- Transportation

The CCSA works to raise awareness, both in the UK and internationally, of the benefits of CCS as a viable climate change mitigation option, and the role of CCS in moving the UK towards a low-carbon economy.

The CCSA operates in a vertical slice of policy influence – working in the UK, EU and internationally - to assist policy developments towards a long-term regulatory and financial framework for CCS, as a cost-effective means of abating carbon dioxide emissions. (The CCSA is *not* a technical forum, professional institute or an environmental or climate campaign group and is not involved in policy developments in other jurisdictions).

The CCSA has become the trusted voice of the CCS industry in the UK and is the main point of contact for Government on issues facing the industry. The UK has come a long way on CCS regulation and with the help of the CCSA, we have moved to the position of when CCS will happen, not if.

The CCSA will play an important role in informing developments from the CCS Roadmap published by the Department of Energy & Climate Change in April 2012. Furthermore Dr Jeff Chapman, Chief Executive of CCSA, has accepted the position of Chair of the new Carbon Capture and Storage Cost Reduction Task Force recently announced by Government.

The aims of the CCSA are:

- To encourage development of CCS in the UK and internationally and to support business interests in global developments.
- To inform the public, professions and policy makers about the environmental, technical, socio-economic and commercial benefits of carbon capture and storage.
- To provide advice to policy makers on regulatory issues and potential incentive mechanisms associated with CCS.
- To promote industry priorities on financial, technical, research and policy issues related to CCS.
- To liaise with other industry and professional groupings with interests in energy conservation and CCS.
- To provide a forum to encourage information exchange, networking and enhanced capability in relation to CCS.

The CCSA is renowned for providing the CCS community, in the UK and internationally, with free, quality weekly newsletters that provide a roundup of the latest headlines.

A Strategy for CCS in the UK and Beyond

In September 2011, the CCSA released its comprehensive report, "A Strategy for CCS in the UK and Beyond", aimed at policy and decision makers. The report set out the current CCS landscape in the UK and Europe, the need for Carbon Capture and Storage and costs. Importantly, it set out the industry vision for CCS in the UK to 2030, the targets we need to deliver CCS and what is needed to deliver these targets.

Key highlights and recommendations of the report include:

- A clear framework for maintaining the momentum of the CCS Demonstration Programme and enabling a 'Progressive Roll-Out', of CCS with a steadily increasing build rate from 1GW in 2018 to 3GW per year in 2030 and beyond;
- 20-30GW of power station capacity equipped with CCS by 2030, which would save 100Mt of CO_2 per year with a total of 500Mt sequestered by 2030;
- The need to urgently launch CCS demonstration in the industrial sector – emphasising the role of CCS in decarbonising, and avoiding the risk of rendering uncompetitive, many UK energy intensive industries key to our economic growth;

- Proposals for the early planning, development and deployment of CCS transport and storage infrastructure, optimized for the long-term CCS industry, which could create dramatic cost and operational efficiencies going forward;
- Thorough, insightful analysis of further important factors to facilitate roll out, including: regulatory barriers, R&D, and political and public perception.

This report is available as a free download from the CCSA website.

Our key messages

To assist with communication of our views, we have developed some high-level messages on the key issues currently facing the CCS industry in the UK. The leaflet, available from the CCSA website, provides a brief summary of these messages, which we are happy to make available for use by the wider CCS Community. If you would like further information about these messages, please contact us.

To find out more about the CCSA, visit www.ccsassociation.org

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ARTICLES FROM THE TECHNICAL PRESS

Solar Solutions

February 2012, unattributed, RSC News

The RSC has released a new report to explain the concept of solar fuels and their potential to transform our renewable energy options. Solar Fuels and Artificial Photosynthesis is aimed at an audience of policy makers with interests in the UK's future energy strategies, and in UK and EU research and innovation policy. For the full article visit……
http://www.rsc.org/images/February%202012_tcm18-213834.pdf

UK co-ordinates research on carbon capture and storage

May 2012, Kulvinder Singh Chadha, Physics Today,

A new £13m centre to co-ordinate the UK's research into carbon capture and storage (CCS) is to be set up at the University of Edinburgh. The Engineering and Physical Sciences Research Council has pledged £10m over a five-year period for the UK Carbon Capture and Storage Research Centre, with a further £3m from the Department of Energy and Climate Change. The project involves eight different universities – Cambridge, Cranfield, Durham, Edinburgh, Imperial College London, Leeds, Newcastle and Nottingham – as well as the British Geological Survey and the Plymouth Marine Laboratory. CCS involves capturing the carbon dioxide (CO_2) emitted from the burning of fossil fuels and then transporting it to secure geological storage sites underground. CCS technologies are predicted to become a major element in the reduction of CO_2 emissions, which are thought to be a main cause of climate change. The centre will aim to bring together academics, industry, regulators and others in the sector to collaborate. "Around 70 academics from a multidisciplinary background will be involved," says Jon Gibbins, the centre's managing director. The centre forms part of plans by the UK government to make CCS commercially viable by the 2020s, which includes a further investment of £125m in CCS research and development between 2011 and 2015. The centre is also involved in the Pilot-Scale Advanced Capture Technology (PACT) facility, which is being built in Beighton, Yorkshire. "The centre is funding PACT for the next five years, costing £810 000," says Gibbins. "It is also offering support worth up to £630 000 for those undertaking new research using this facility."
http://mag.digitalpc.co.uk/Olive/ODE/physicsworld/LandingPage/LandingPage.aspx?href=UEhZU1dvZGUvMjAxMi8wNS8wMQ..&pageno=MTQ.&entity=QXIwMTQwMQ..&view=ZW50aXR
http://mag.digitalpc.co.uk/Olive/ODE/physicsworld/LandingPage/LandingPage.aspx?href=UEhZU1dvZGUvMjAxMi8wNS8wMQ..&pageno=MTQ.&entity=QXIwMTQwMQ..&view=ZW50aXR5

Fixing the climate

June 2012, Colin Baglin, Physics World

Global warming is perhaps the most important problem facing the world. If unchecked, it will threaten food and water supplies, and eventually cause a rise in sea levels that will threaten coastal cities. At present the only solutions being implemented to counteract this trend are those aimed at reducing greenhouse-gas emissions, predominantly carbon dioxide (CO_2). However, these solutions are slow and are currently not effective. For example, from 2006 to 2010, world CO_2 emissions increased by around 10% per year, yet governments seem apparently happy with this situation, believing that we have many decades in which to decarbonize our energy supply. For more visit.....
http://mag.digitalpc.co.uk/Olive/ODE/physicsworld/LandingPage/LandingPage.aspx?href=UEhZU1dvZGUvMjAxMi8wNi8wMQ..&pageno=MTg.&entity=QXIwMTgwMA..&view=ZW50aXR5

Norway takes the lead in carbon-capture technology

June 2012, Simon Perks, Physics World

The world's largest centre for testing and developing carbon capture and storage (CCS) technologies opened last month at Mongstad on Norway's west coast. A joint venture between the Norwegian government and the energy firms Statoil, Shell and Sasol, the Technology Centre Mongstad aims to act as a test bed for the capture of carbon dioxide (CO_2) and to demonstrate that the approach is commercially viable. For more visit.....
http://mag.digitalpc.co.uk/Olive/ODE/physicsworld/LandingPage/LandingPage.aspx?href=UEhZU1dvZGUvMjAxMi8wNi8wMQ..&pageno=MTI.&entity=QXIwMTIwMQ..&view=ZW50aXR5

Growth of Carbon Capture and Storage Stalled in 2011

Contact: Supriya Kumar, skumar@worldwatch.org,

8th May 2012

A New Worldwatch Institute report discusses the future of CCS technology - Global funding for carbon capture and storage technology, a tool for the reduction of greenhouse gas emissions, remained unchanged at US$23.5 billion in 2011 in comparison to the previous year, according to a new report from the Worldwatch Institute. Although there are currently 75 large-scale, fully integrated carbon capture and storage projects in 17 countries at various stages of development, only eight are operational—a figure that has not changed since 2009.

Carbon capture and storage, more commonly known as CCS, refers to the technology that attempts to capture carbon dioxide from a human-created source—often industry and power generation systems—and then store it in permanent geologic reservoirs so that it never enters the atmosphere. The United States is the leading funder of large-scale CCS projects, followed by the European Union and Canada. The new Worldwatch report, part of the Institute's Vital Signs Online series analyzing key global trends, discusses a variety of new CCS projects and facilities throughout the world. Among these is the Century Plant in the United States, which began operating in 2010.

"Although CCS technology has the potential to significantly reduce carbon dioxide emissions—particularly when used in greenhouse gas-intensive coal plants—developing the CCS sector to the point that it can make a serious contribution to emissions reduction will require large-scale investment," said report author and Worldwatch Sustainable Energy Fellow, Matthew Lucky. "Capacity will have to be increased several times over before CCS can begin to make a dent in global emissions." Currently, the storage capacity of all active and planned large-scale CCS projects is equivalent to only about 0.5 percent of the emissions from energy production in 2010.

The prospects for future development and application of CCS technology will be influenced by a variety of factors, according to the report. This March, the U.S. Environmental Protection Agency proposed regulations on carbon dioxide emissions from power plants. As a result, U.S. power producers would soon be unable to build traditional coal plants without carbon-control capabilities (including CCS). The technology will likely become increasingly important as power producers adjust to the new regulations.

Globally, an international regulatory framework for CCS is developing slowly, and the technology has been factored into international climate negotiations. Its classification as a

Clean Development Mechanism—a measure created through the United Nations Framework Convention on Climate Change that allows industrialized countries to gain credit for emissions reductions they achieve through funding development projects in developing countries—has raised objections, however, from those who argue that it risks prolonging the use of carbon-intensive industries.

"CCS technology is worth exploring as one of a large array of potential strategies for slowing the buildup of carbon dioxide in the atmosphere," said Worldwatch President Robert Engelman. "But as this report demonstrates, right now there's little progress in realizing this potential. A technology capable of permanently sequestering large amounts of carbon will be expensive, and so far the world's markets and governments haven't assigned much value to carbon or to the prevention of human-caused climate change. Ultimately, that will be needed for real progress in CCS development and implementation."

Further highlights:

- There are now seven large-scale CCS plants under construction worldwide, bringing the total annual storage capacity of plants either operating or under construction to nearly 35 million tons of carbon dioxide a year.
- According to the International Energy Agency, an additional $2.5-3 trillion will need to be invested in CCS between 2010 and 2050 in order to halve global greenhouse gas emissions by mid-century.
- On average, $5-6.5 billion a year will need to be invested in CCS globally until 2020 for the development of this technology.
- About 76 percent of global government funding for large-scale CCS has been allocated to power generation projects.

News alerts in coal and energy research

Carbon capture and storage: a risk worth taking?
20th April 2012, Stephen Harris, The Engineer (blog).
But the launch coincided with a report from the UK **Energy Research** Centre (UKERC) that reminds us just how many challenges still remain if we hope to use this technology to cut emissions while still burning fossil fuels. Though we are some way from **...**

UKERC report highlights challenges for UK CCS strategy
21st April 2012, unattributed, Carbon Capture Journal.
Is the culmination of a two-year project funded by the UK **Energy Research** Centre (UKERC). The report assesses the technical, economic, financial and social uncertainties facing CCS technologies, and analyses the role they could play in achieving UK **...**

Wind farms may have warming effect: **research**
29th April 2012, Nina Chesney, Reuters UK.
In a move to cut such emissions, many nations are moving towards cleaner **energy** sources such as wind power. The world's wind farms last year had the capacity to produce 238 gigawatt of electricity at any one time. That was a 21 percent rise on 2010 and **...**

Japanese **energy** policy stands at a crossroads
3rd may 2012, Catharine Mitchell, The Guardian.
Today's **energy** crisis offers new challenges and new solutions. On the one hand technology must play a fundamental role and once again Japan can be on the forefront of **research**, development and deployment. However, the new **energy** future will also **...**

Research reveals geothermal potential of abandoned mines
3rd May, unattributed, The Engineer.

New **research** could help predict how much **energy** could be harnessed from the heat collecting in abandoned mines. Researchers from McGill University in Montreal said using this kind of geothermal **energy** could benefit up to one million people in Canada **...**

European slump leads utilities to burn more **coal**
8th may 2012, Henning Gloystein & Jeff Coelho, Reuters.
Between January and May, German midday hard-**coal** and lignite power generation rose from 53 percent to 68 percent of the nuclear and fossil power generation share, according to data from Leipzig-based European **Energy** Exchange (EEX).

Taking a ride on a **coal**-fuelled plane
8th May 2012, Tony May, Brisbane Times.
Mr Bond is the man behind Linc **Energy**, a Queensland underground **coal** gasification company, that has a test plant at Chinchilla and operates projects in South Australia, the United States, Vietnam and Uzbekistan. "There were three companies on the panel **...**

UK leads Europe on **coal**-to-biomass conversion
8th May 2012, David Thorpe, Energy and Environmental Management (EAEM) Magazine.
The UK is by far the biggest driver in Europe of the conversion of **coal**-fired power stations to the combustion of biomass in the UK, according to a new report from IHS Emerging **Energy Research**, Europe Biopower Markets and Strategies: 2012-2035.

Whatever happened to carbon capture?
12th may 2012, Richard Black, BBC News.
A recent report from the UK **Energy Research** Council showed that the UK especially has abundant potential for storing CO2 under the seabed - potentially building a new business taking waste gas from more landlocked parts of Europe.

Should a tidal barrage be built across the Severn estuary?
17th may 2012, Leo Hickman, The Guardian (blog).
Pulse Tidal based in Sheffield is one company currently trying to **research** and develop the latter. Earlier this month, it was given permission to establish a tidal **energy** test facility off the coast at Lynmouth, north Devon.

Fracking's Methane Trail: A Detective Story
17th May 2012, Elizabeth Shogren, NPR.
"We need to know a lot about methane itself, which is natural gas, if we're worried about climate change," says **energy** consultant Sue Tierney, "so that we don't automatically think that gas is so much cleaner than **coal**." Explore key components of the **...**

Research Focused on Underground Solution to Greenhouse Gas Challenges
17th May 2012, Li Li, Gant Daily.
Li's **research**, with partial funding from the Department of **Energy's** National **Energy** and Technology Lab (NETL), is focused on the possibility for and potential impact of the leakage of carbon dioxide from underground sequestration sites.

Edinburgh set for new wave test facility
21st May 2012, unattributed, BBC News.
A £9.5m wave and current test facility is being built in Scotland to help **research** and development of marine **energy** devices. The facility in Edinburgh will be able to mimic the normal and extreme conditions of coastlines around Europe.

Report: China's actions are crucial on climate change
24th May 2012, Vicki Ekstrom, MIT News.
Research shows China's impact on climate change, as well as its potential to shape the path forward. Can you tell which of these smiles is showing happiness? Or which one is the result of frustration? A computer system developed at MIT can.

Energy minister supports Cornwall's plans for solar centre
24th May 2012, unattributed, BBC News.
Plans for a national solar centre in Cornwall have been welcomed by **Energy** Minister Greg Barker. Cornwall Council and Building **Research** Establishment believe a **research** and development centre would put the county at the cutting edge of the UK's solar **...**

Analysis: UK bets on biomass in move away from **coal**
25th May 2012, Karolin Schaps, Reuters.
Britain's biomass plans are Europe's biggest, with 3 gigawatts in planning representing 20 percent of Europe's growth through 2035, according to IHR Emerging **Energy Research**. It is part of the UK's aim to get 15 percent of its energy from green sources **...**

Research helps reduce **energy** costs of carbon capture by nearly a third
27th may 2012, unattributed, Click Green.
Current technologies would use about one-third of the **energy** generated by the plants – what's called "parasitic **energy**" – and, as a result, substantially drive up the price of electricity. But a new computer model developed by University of California, **...**

Poland has great 'fracking' potential with shale gas reserves
29th May 2012, Jim Boulden, CNN.
The Polish government is funding exploratory **research** into whether or not it should drill for shale gas -- a fossil fuel that some experts believe the country has an abundance of. Currently **coal** provides 90% of Poland's **energy** making it one of Europe's **...**

Research shows solid materials could assist carbon capture
28th May 2012, unattributed, The Engineer.
A team from the University of California, Berkeley, has developed a computer model showing that absorbent 'zeolite' materials similar to those used in water purification could reduce the amount of **energy** used in the carbon-capture process by 30 per **...**

Final funding secured for £95.7m renewable **energy research** centre
11th June 2012, unattributed, stv.tv.
The final funding pledge for an £95.7m centre for renewable **energy research** has been secured. Strathclyde University will host the facility that aims to help develop a world leading centre for the development of renewable energy technologies.

Universities ally with Germans for **energy research**
11th June 2012, unattributed, Scotsman.
Heriot-Watt University and Edinburgh University have signed an alliance for up to a decade of joint **research** with the institutions. The Memorandum of Understanding will include shared teaching on geological reservoirs and renewable **energy** production **...**

Carbon Polluters, **Coal** Miners Paying in Australian Tax Overhaul
1st July 2012, Ben Sharples, Bloomberg.
Australia is charging its largest polluters for carbon emissions and taxing profits of iron ore and **coal** producers starting today in the biggest change since 2000 in how the government collects and spends money. **...** "Around A$100 billion of investment **...**

Predicting waves could double ocean **energy** capture
1st July 2012, Paul Willis, TG Daily.
We already mentioned this development here at EarthTechling. Now the same team, which is being led by the University of Exeter, in western England, has published **research** claiming new methods for predicting waves could double current **energy** capture.

Spray-on Rechargeable Batteries Could Store **Energy** Anywhere
2nd July 2012, unattributed, Wired News.

A team of mechanical engineers has published a paper demonstrating its latest invention -- spray-on rechargeable batteries that could be combined with solar cells to create self-sufficient, **energy** conversion-storage devices. **...** The paper suggests **...**

UK tops **Energy** Efficiency Scorecard New **research** shows UK out-greens **...**
13th July 2012, unattributed, eGov monitor.
WASHINGTON, 12 July 2012 – The UK leads the world in **energy** efficiency according to The American Council for an **Energy**-Efficient Economy (ACEEE). The American non-profit organisation has ranked the UK No. 1 in its first International **Energy** Efficiency **...**

UK to benefit from new £5 million SUPERSOLAR Hub
16th July 2012, Paul Bennett, Solar Power Portal.
A consortium of UK universities led by Loughborough University, have announced the formation of a SUPERSOLAR Hub to drive **research**, training and industry partnerships in the burgeoning UK solar **energy** sector. The £5 million pound SUPERSOLAR **...**

Research centre set to tackle bioenergy generation problems
17th July 2012, Stephen Harris, The Engineer.
A new UK **research** centre is hoping to tackle some of the problems preventing bioenergy generation becoming more widespread.

Research shows feasibility for capturing carbon dioxide directly from air
24th July 2012, unattributed, R & D Magazine.
The Georgia Tech **research** into air capture techniques was funded by the U.S. Department of **Energy**. Papers describing the economic analysis and new adsorbent materials were published in the journals ChemSusChem, Industrial and Engineering **...**

What is green **energy**?
25th July 2012, Stephanie Rogers, Mother Nature Network.
In the past three decades, **research** and development in green **energy** has exploded, yielding hundreds of promising new technologies that can reduce our dependence on **coal**, oil, and natural gas. But what is green **energy**, and what makes it a better option **...**

UK sea **energy** cost could halve by 2025 - Carbon Trust
27th July 2012, Nina Chestney, Reuters UK.
LONDON (Reuters) - The cost of wave and tidal **energy** in Britain could fall by over half to current offshore wind levels by 2020-2025 and by 80 percent by 2050 if much more **research** and development is done, a marine **energy** expert at the Carbon Trust said **...**

UK projects accelerate 'green' hydrogen **energy**
27th July 2012, unattributed, Renewable Energy Focus.
In the UK, five new government-backed **research** and development projects will speed up the adoption of **energy** systems using hydrogen and fuel cell technologies. Funded by the Technology Strategy Board and the Department of **Energy** and Climate **...**

$90m fund for Vic brown **coal** technology
3rd August 2012, unattributed, Sky News Australia.
A $90 million joint government **research** fund will be used to promote low-emission brown **coal** technology in Victoria's Latrobe Valley. The federal and Victorian governments will each pledge $45 million to the project, which they hope will entice companies to **...** Technologies being encouraged in the 'advanced lignite demonstration program' include the drying of **coal** and conversion to higher-value **energy** products. Possible end products could include transport fuels, hydrogen, liquefied natural gas and fertiliser, the **...**

CALENDAR OF COAL RESEARCH MEETINGS AND EVENTS

Date	Title	Location	Contact
Monday 10th to Wednesday 12th September 2012	**9th European Conference on Coal Research and its Applications, (9th ECCRIA)**	**University of Nottingham, Nottinghamshire**	**For more information visit http://9.eccria.org/ibis/eccria9/home or contact Mr. David Couling, E.ON New Build & Technologies Ltd. Tel : 02476-192724 E mail : david.couling@eon.com**
25th to 27th September 2012	EUROCOALASH 2012	Thessaloniki, Greece	For more information visit: http://www.eurocoalash.org/index.php?start&lng=2
Monday 8th October 2012	**The 2012 Coal Science Lecture organised by the Biomass and Fossil Fuel Research Alliance, (BF2RA), with sponsorship from BF2RA, the Coal Research Forum, (CRF), the British Coal Utilisation Research Association, (BCURA), and the Energy Generation & Supply Knowledge Transfer Network, (EGS-KTN), to be given by Dr. Andrew J. Minchener, OBE.**	**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**
17th and 18th October 2012	Carbon capture and storage - ready, steady, go!	I.MechE 1 Birdcage Walk London SW1H 9JJ	For information visit: http://events.imeche.org/EventView.aspx?EventID=1442
15th to 18th October 2012	2012 Pittsburgh Coal Conference	David L. Lawrence Convention Center 1000 Fort Duquesne Blvd Pittsburgh, PA 15222	For more information visit http://www.engineering.pitt.edu/pcc/
10th or 17th April 2013	**Coal Research Forum Annual Meeting and CRF Environment Divisional seminar, "The Emissions Control of NOx, SOx and Particulates"**	**Cranfield University, Cranfield, Bedfordshire.**	**Dr. David J.A.McCaffrey Tel : 01242-236973 E mail : mail@coalresearchforum.org And Dr. Trevor Drage Tel : 0115-951-4099 E-mail : trevor.drage@nottingham.ac.uk**