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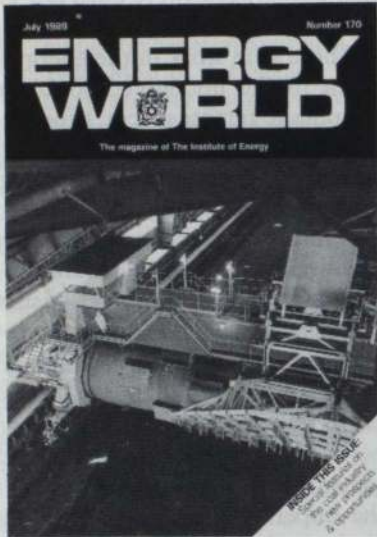
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COVER STORY

An overhead view of one of the two barrel reclaimer machines located inside the massive covered stockyard at the Gascoigne Wood drift mine; the central receiving and despatching point for all the coal produced in north Yorkshire's Selby coalfield. The barrel reclaimers transfer the coal from the stockpile onto conveyors which pass the coal to bunkers alongside and over the mine's railway lines, ready for onward despatch to power stations. Each reclaimer is capable of moving coal at a rate of 2000 tonnes an hour.



The Gascoigne Wood drift mine is the largest of the Selby coalfield locations, covering some 164 acres. It has two parallel tunnels which bring the entire output of the five Selby shaft mines to the surface. At peak output, coal will be delivered from either tunnel at a rate of 1800 tonnes an hour. This rate of production will bring the output of the Selby coalfield to 10 million tonnes a year in the 1990s.

Photograph by courtesy of British Coal.

* A series of feature articles dealing with various topical issues affecting the coal industry begins on page 7.

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TERMS OF CONTROL

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Distorted energy prices

With all this privatisation of energy enterprises, first gas, now electricity, and coal apparently to follow later, perhaps we may hope for less of the standardisation of prices that only distorts economic realities.

Consider for instance how a single electricity tariff independent of location neutralises differences in transmission costs. It has long been the policy of the electricity supply industry in England and Wales to price power at the grid/area board interchange according to a common Bulk Supply Tariff (BST), from which area boards derive consumer tariffs that reflect the relatively small (and differing) costs of local distribution; the BST remains the dominating ingredient.

Yet the reality is that generation is mainly in the north, where the coal lies; and consumption mainly in the south, necessitating substantial flows of power from north to south down the 400kV system (at certain times as much as 20GW, nearly 40 per cent of total generating capacity). Because the BST is the same everywhere their cost is not passed on to southern customers.

We should not make the mistake of thinking it negligibly small, just because the ohmic losses are. It is the cost of providing the cables and pylons that matters, as a couple of examples will show: in successive Severn Tidal Power reports (Bondi 1981, STPG 1986, & STPG to the Hinkley C enquiry 1988), sums of the order of £500m (ie, over £60/MW installed) for the "transmission reinforcement" were debited to the project; similarly, the CEGB's own evidence claims significant transmission savings for Hinkley C by virtue of its location. Taken together, those examples may seem to contain some paradox, but the point here is that transmission costs are far from negligible.

The mystification does not end there. Generating stations are sited near coal mines in order to save coal transport costs, on the argument that transmitting electrical power is cheaper. Unfortunately this is not reflected in the price of coal supplied through merry-go-rounds at the pithead, which is made the same as for coal anywhere else to this particular customer, by means of an averaging formula applied to the total transaction between British Coal and the CEGB. We may ask ourselves how the benefits of pithead siting are passed through to the customer. We may also wonder whether the preference for power stations on southern coasts burning imported coal is

strengthened by the neglect of differential transmission costs, either of coal or of electricity, or of both.

The gas experience should have important lessons as it was the first energy industry to be privatised (albeit into a monopoly), but their tariffs are not easy to interpret: there is a degree of standardisation between places a long way apart, and such variations as do occur are not readily explained by relative distance from the landing points on the east coast. The change to private ownership does not seem to have been a factor.

Another oddity is to base prices on the thermal content of the coal. This seems to undermine the achievements of the researchers at Stoke Orchard who have led British developments in fluidised bed combustion, one of whose particular virtues is coping with low grade coals. But pricing it all on thermal content ignores the ash and other impurities and the toil of washing, and would seem to remove the incentive to burn dirty coal instead of clean. Admittedly, some 90 per cent of the market is power station coal, which is not particularly clean, and is covered by separate price negotiations. Still it is a pity that encouragement to burn low-grade fuel cannot be built into the other 10 per cent.

Those who work in the energy supply industries may often point to the undoubted social benefits of uniform pricing: supplies to remote places, support of difficult pits, etc. But it is difficult to see social merit in subsidising electricity to the prosperous south (by not charging for getting it there), and in artificially enhancing its relative attractiveness as a location for new industry and commerce. In any case, social needs should be identified and funded separately to eliminate confused thinking (and to have some prospect of surviving privatisation).

The new plans for electricity do not automatically rule out a distorting treatment of transmission costs, but it may be that the associated rethinking will cause them to be assigned more fairly among customers. If and when they move on to coal, perhaps there will also be a beneficial effect; but we should remember that it is the removal of the monopoly that provides the impetus, not privatisation as such. In fact, it is not too obvious why all this could not have been straightened out even in a nationalised monopoly.

Philip Warner

Hon. treasurer

The author

Philip Warner has been a member and Fellow of the Institute of Energy since 1979 and was elected to the Institute's Council in 1982. He has also served the Institute as a former president, and as its treasurer for the past two years.

A Chartered Engineer with some 40 years' experience in a number of power engineering sectors including prime mover engines, nuclear power plant and conventional power plant, Mr Warner retired in March this year as director of corporate engineering,

NEI, Newcastle upon Tyne.

His career began in the north east after he had gained an engineering degree at Cambridge and had served his National Service with the Royal Engineers. His early practical experience in this period was gained at the turbine works of C A Parsons & Co Ltd of Newcastle upon Tyne.

He returned to his native south east of England in 1952 to work for a period on free-piston engines and aero gas turbines before joining the newly formed Atomic Power Construction Group in early 1957. In the next 12

years he worked on the engineering of nuclear reactors, principally on the Trawsfynydd magnox reactor and on the advanced gas reactor.

On the reconstruction of the nuclear consortia in 1968, he joined Clarke Chapman & Co Ltd of Gateshead as deputy chief engineer for the group. Following the merger with John Thompson Ltd, he was appointed to the board of Clarke Chapman-John Thompson in 1971 with special responsibility for activities in the power market.

The formation of the

Northern Engineering Industries Group in 1977, which brought together the Clarke Chapman and Reyrolle-Parsons interests, led to his appointment in September 1978 as director of corporate engineering for NEI, with the responsibility for formulating the group's corporate engineering strategy.

In addition to his activities with the Institute, he has also served on such bodies as the Engineering Materials Requirements Board and the Welding Institute Council, and he has written a number of papers on energy topics.



World energy consumption continues to rise

WORLD energy consumption continued to climb at an increased rate in 1988, according to the *BP Statistical Review of World Energy* published in June. Total primary energy demand grew by 3.7 per cent to 8.1 billion tonnes of oil equivalent.

The most rapid growth in energy demand occurred in the industrialising countries of South East Asia, where consumption rose by 11.4 per cent to 241.8 million tonnes of oil equivalent. For the first time in many years, OECD primary energy consumption grew in step with GDP, increasing by 3.4 per cent to 4

billion tonnes of oil equivalent.

The USA remained the world's largest consumer at 1,940.8 million tonnes of oil equivalent, an increase of 4.1 per cent — an energy consumption per-capita of more than 8 tonnes of oil equivalent. This was more than double the per-capita consumption of Japan, where energy consumption rose by 6.2 per cent to 399.9 million tonnes of oil equivalent.

Western Europe's consumption only grew by 1 per cent to 1,302 million tonnes of oil equivalent, with Greece (9.1 per cent to 22.8), Spain (6.0 per cent to 85.2) and Turkey (8.8 per cent to 51.7) showing the greatest growth rates.

In the UK, primary energy consumption rose by 0.7 per cent, from 206.8 million tonnes of oil equivalent in 1987 to 208.3 million tonnes of oil equivalent in 1988. Most of this increase was due to a 6.5 per cent growth in oil demand to 80 million tonnes.

Both gas and coal consumption in the UK diminished, by 5.3 per cent (to 47.8 million tonnes of oil equivalent) and 3.8 per cent (to 65.6 million tonnes of oil equivalent) respectively.

Nuclear energy consumption increased to 13.5 million tonnes of oil equivalent and now accounts for 6.5 per cent of UK energy requirements.

Single copies of the Review may be obtained free of charge from Briefing Services, Government and Public Affairs Department, British Petroleum Company plc, Britannic House, Moor Lane, London EC2Y 9BU. Bulk requests for three or more copies may be made through BP Educational Service, PO Box 5, Wetherby, West Yorkshire LS23 7EH. Price: £7 a copy. For bulk orders placed by bona fide educational institutions, a 50 per cent discount on the cover price is allowed.

Feasibility study on converting wood to electricity

THE National Engineering Laboratory in East Kilbride is to investigate the possibility of converting wood to generate electricity for the National Grid.

In a paper submitted to the EEC, Doug Jackson, manager of control engineering at NEL, has outlined proposals to study the feasibility of converting energy crops to generate electricity for supply to area electricity boards via the existing distribution network.

Until three years ago it was assumed there would be no quality land on which fuel crops could be grown to compete economically with food crops. However, with one million hectares likely to be taken out of food production because of surplus stocks, the prospects for biofuels are looking increasingly good, particularly where redundant farming communities may be looking for effective utilisation of their resources.

Research has established that a triennial cropping cycle is required to grow wood for energy. When harvested, however, it is not in a saleable form due to its low density and high water content but is readily converted to produce gas which, via standard three-phase engine generators, produces electricity. This conversion process uses the heat, normally wasted in large-scale production, to dry the crop and increase the overall efficiency of the process.

New efficient 'green' technology can win business for coal

THE world's coal industries have to take the initiative to get the new high-efficiency clean coal burning technologies up and running, otherwise they face stagnation, warned British Coal commercial director, Malcolm Edwards, speaking to the Pacific Rim Coal Conference in Cartagena, Colombia, in June. "Coal has won the economic argument; it is the cheapest fuel," he said. "The problem is," he continued, "that it is under unprecedented attack from those who try to label it as the chief polluter of the universe. It is patently not true but the fuel which now produces 40 per cent of the world's electricity, and produces it cheaply, will pay dearly if it allows this damaging and false argument to gain ground. How our customers and the public at large perceive the industry is of crucial importance."

He declared that the world's coal industries must get stuck in quickly, robustly and publicly if they were to secure the stable, healthy and expanding future that their product justified. They had to get small, clean, high-efficiency coal generation plant up and running to meet the growing market for electricity.

He suggested that combined cycle coal-fired generation, offering efficiency increases of 20 per cent or more, was the most important single issue for the immediate future of the world steam coal business. Besides cutting out the risk of acid rain, it would further reduce the contribution made by coal-fired stations to the greenhouse effect which is only 7 per cent now.

They had to get the ultimate consumer, the general public, to realise that electricity generation from coal was at least as good environmentally as from gas, but that coal would be about a third cheaper to run; that reserves of coal would last at least six times as long; and coal was far more easily available from a range of sources. It was better value now and in the future and in every way was more secure, he claimed.

"Burnt in the modern way, coal is infinitely more benign than nuclear," he said. "Nobody has solved the problem of nuclear fuel reprocessing and decommissioning without major hazards, and to add to this mega-problem, nuclear is now clearly identified as more expensive to build and operate as well."

Harwell ends cold fusion research programme

FOLLOWING a comprehensive programme of electrochemical experiments, Harwell Laboratory has decided to end research into cold fusion by this technique.

Dr Ron Bullough FRS, chief scientist of the AEA, who initiated Harwell's work in March 1989 said: "The potential benefit and scientific interest in cold fusion, together with Government's need for information and advice meant that the subject had to be investigated. However, results to date have been disappointing and we can no longer justify devoting further resources in this area."

In the absence of new information, Harwell do not intend to reopen work on cold fusion.

Dr Bullough went on to say that the work demonstrated their capacity to mount a thorough programme in basic science at short notice and the ability to put together a sophisticated cocktail of scientific expertise and equipment was the unique attribute of the AEA.

A brief paper will be published in an appropriate scientific journal and a full assessment and report of Harwell's work will be available through HMSO in due course.

Contract for new FGD unit at Drax

BABCOCK CONTRACTORS, the Crawley-based process plant contracting arm within the FKI Babcock Energy Group, is to participate in an important contract awarded to Babcock Energy and will undertake process design, engineering and procurement services for the world's largest flue gas desulphurisation plant. This is to be installed progressively by Babcock Energy for the Central Electricity Generating Board at Drax power station over the next five years.

The new flue gas desulphurisation (FGD) unit will be the first to handle coals having a combination of high sulphur and chlorine levels.



The new President takes office



Professor Brinkworth presents the retiring Institute President, Ted Pugh, with his past President's badge shortly after his installation as the new President.

PROFESSOR Brian Brinkworth, who is professor of Energy Studies and Dean of the Faculty of Engineering at the University of Wales, Cardiff, was installed on 25 May as the new President of the Institute. He was installed, as is customary, by the retiring President, Ted Pugh, at the end of the annual general meeting and the special general meeting held on that day.

In his opening address, Professor Brinkworth drew attention to the need for consistency and continuity of policy from one president to the next and the benefits that are beginning to emerge through following through on a long term review of the Institute's affairs.

He referred to the long time-scale over which changes occur. "If anything meritorious happens during my year it will almost certainly be traceable to my predecessor as President and not to me. If anything good happens in successive years, I shall be happy to claim credit for that," he continued.

Professor Brinkworth added that the arrangements that are in place for the presidential succession mean that one President very often carries into effect measures that have been devised by his predecessor.

He recalled that two years ago, on the same occasion, the then new President, Guy Masdin, launched a long term look at the Institute's affairs, and this has continued, sometimes behind the scenes and sometimes more obviously with great vigour. "I

have been impressed with the breadth of coverage and its penetration. I shall want to see that continue and to maintain the momentum," he said.

"We are already seeing, although perhaps not too obviously, the effects of that review with minor changes over time, a few rather more major ones, all adding up to a substantial change in starts in the Institute. I believe that we shall be able to look back to that initiation by Guy two years ago as being a very significant factor in the affairs of the Institute, and I shall want to carry that on," he added.

"Gradually we are moving away from what were initially fire brigade activities through to improving the management structure of the Institute, and I hope to begin addressing some of the mid-term and long-term factors that face us, which are of great significance," he concluded.

ENERGY WORLD has a new editor — Ken Harrison, who has carried through the design changes to the magazine seen in the latest three editions.

Ken, who has been a professional journalist for more than 20 years, commenced his duties with the Institute at the end of February. He has spent the past 14 years specialising in publishing and public affairs work in the energy industries.

A native of Manchester, he is the former editor of *International Power Generation*, an independent technical magazine which

AGM Report

1988-89 — a year of creativity and progress

The outgoing President C E (Ted) Pugh recalled a presidential year of fresh thinking, creativity, and further progress in laying the foundations for an era of greater influence for the Institute.

In his final address as President at the annual general meeting on 25 May, Mr Pugh observed that the year had passed incredibly fast for him, and that he was very impressed by the enthusiasm and creative attitudes of many people whom he had met.

He said that one thing that stands out in the accounts is how close the income and expenditure came, but that the Institute has done better in 1988 because of the realisation of some of its investments. However, it seemed to him that the Institute needed more revenue. Obvious sources would be from new subscriptions, from advertising placed in the Institute's publications, and from conference activities.

He commented that *Energy World* is now being published in a new format, and he believed that everyone would appreciate the change. With the new format he hoped there would be more advertising in the magazine, and in the Institute's publications generally.

On the membership side, he thought a recruitment campaign was needed, which might be started through *Energy World*, and by approaching some companies and providing them with appropriate information.

Also with a view to future development, he believed that the Institute should further

pursue the idea of creating a library information service, and it might be beneficial if the Institute could start thinking in terms of a technical committee to consider such matters as the Greenhouse Effect, industrial efficiency, and energy conservation.

With regard to federation, the President stated that there had been talks with other groups, and that such discussions would continue with a view to determining what is possible without making any commitments.

Later, in the financial report, Philip Warner, the Hon. Treasurer, drew attention to improvements made to the presentation of the accounts which included, for the first time, a statement on the sources and applications of funds. However, he added that it was worth underlining the weakness of the Institute on its operational account, although the 1988 deficit was smaller than in previous years and, if the budget was adhered to it should be smaller or extinguished in 1989. However, the deficit was counteracted by a "windfall" arising out of investments, which the Institute cannot expect to receive every year.

He added that while the Institute is weak on the operational side, it is strong in cash and reserves, and the Council is able to use intelligently those reserves to build up for the future.

At a special general meeting which followed the AGM, a number of bye-law changes were introduced including the removal of age restrictions on the qualification for the student and graduate membership grades.

Energy World — the new editor

covered the development of technologies for the production of electrical energy and served a readership mainly in the developing countries (1984-87). He has also spent seven years with the Central Electricity Generating Board on the production of a number of the board's publications, including two years spent as the assistant editor of *Power News*, the board's former national house journal (1980-82).

He has recently enjoyed a period in the public affairs

department of The Engineering Council in London.

Earlier in his career he spent several years as a reporter, sub-editor and editor in the newspaper industry, including editorial experience on the award-winning *Oxford Mail* (1973-75) and on a number of national daily newspapers.

He became a professional associate member of the Institute in 1988 and he is also a member of the Institution of Diesel and Gas Turbine Engineers.



The internal market — 1992 and energy policy

LAN TOZER, FInstE, reports on a lecture presented to the London and Home Counties branch by Clive Jones, EEC Deputy Director-General for Energy.

Mr Jones said that 1992 would be a watershed in Europe's political destiny and he emphasised that the UK was one of the original promoters of the 1985 White Paper, or "Livre Blanc", which set it in motion. Energy was excluded from the White Paper, not because it had not been thought of but because of the daunting problems associated with it. The Commission made a conscious decision to deal with energy separately and on a different time scale.

Following publication in May 1988 of the Commission's paper *The internal energy market*, the course was set to achieve a fully integrated energy market in Europe. The paper identified priorities and set out to eliminate national policies which might hinder or interfere with free trade and competition in respect of different forms of energy. One aim was to bring about the removal of national differences which might distort competition, such as the imposition of differing levels of excise duty.

As regards standardisation, Mr Jones said that the aim was not to achieve uniformity but to ensure that distortions of trade did not occur from the use of differing standards, for example, by a mutual recognition approach. For instance, energy efficiency standards for refrigerators, being tighter in one country than in another, might be used as a trade barrier by denying the entry of less efficient models.

Environmental standards were particularly important for the energy industries and for competition between industries. Some progress in the direction of common standards at the energy/environment interface had been made with the passage of the Acid Rain Directive introducing common rules for sulphur dioxide and nitrogen oxide emissions for large combustion installations — power plants and the like.

The Commission had published proposals for introducing transparency in energy prices. The level of transparency for oil

products and for coal was considered to be relatively good but for gas and electricity, particularly as far as industrial consumers and larger consumers were concerned, the situation was far from satisfactory. A Directive was to be published in July to enforce a system of reporting and publication of energy prices. Monopoly pricing practices could produce major price distortions between one country and another not because of differences in costs but because of differences in the system of pricing.

In order to bring about an integrated European energy market, an interconnected energy infrastructure was required. This was particularly necessary for gas and electricity. The Commission was in any case, for instance through the regional fund, financing the installation of gas and electricity lines and should endeavour to inject, through this expenditure, some energy policy considerations. There was also the vexed question of the use of state subsidies in coal mining, and misgivings about monopoly practices (for example, in electricity and gas transmission) and the way in which national governments used energy monopolies to support national policies outside the energy field.

CIBSE hosts CFC summit

FOLLOWING the recent publication of a policy statement giving guidelines on the use of chlorofluorocarbons The Chartered Institution of Building Services Engineers held a CFC summit at its conference centre in Balham on 26 June.

The session was designed to review the problems of CFCs as they relate to the building services industry and the engineers who specify air conditioning and refrigeration systems and insulation. The meeting was chaired by Dr David Fisk, Chief Scientist at the Department of the Environment, who praised the CIBSE for its constructive advice

Desulphurisation in coal combustion systems

THIS international conference, organised by The Institution of Chemical Engineers in association with The Institute of Energy, was held in Sheffield from 19-21 April 1989. The conference attracted 225 delegates, 45 of whom came from overseas.

In the first of the keynote addresses, Nigel Haigh, Director of The Institute of European Environmental Policy, spoke about the historical development of atmospheric pollution policy in Europe culminating in the recently agreed Directive issued by the EEC.

Bill Kyle of the CEGB presented the second keynote paper and reviewed the current status of SO₂ abatement technology. In this review of possible methods he emphasised energy conservation and process efficiency. Later, Ted Pugh, President of the Institute of Energy, also highlighted modern man's extravagant use of energy. As most were derived from fossil fuels, we were creating larger than necessary atmospheric problems with acid rain and the greenhouse effects (CO₂).

Peter Cammack, British Coal, chaired the session on desulphurisation before combustion. He made it quite clear that desulphurisation of the coal feed was difficult and expensive to achieve. Papers concerned with novel methods of coal cleaning, chemical and magnetic separation reported laboratory scale results only.

to members. Speakers represented Friends of the Earth, the Building Research Establishment, the chemical industry, designers, contractors and manufacturers.

Denis Mason of Stanley Refrigeration described the advantages of increasing the frequency of maintenance checks from once every six months to once a week. This minimised the risk of CFC leaks — savings of 37-38 per cent could be expected.

Emphasis was laid on simple design solutions such as isolating valves which enabled equipment to be removed for repair without affecting the whole system.

The session on desulphurisation during combustion was chaired by Klaus Hein of West Germany and the papers were from Germany, Finland and Sweden. Subjects covered included fluidised bed technology; furnace injection of lime/limestone; the Lifac process developed in Finland; and methods of limestone injection into chain grate stoker furnaces.

The main thrust of the conference was in the area of flue gas desulphurisation (FGD) where twelve papers were presented. The chairman and technology reviewer was B Forck of VEB West Germany, one of Europe's leading experts in the subject. Speakers reviewed the forward planning in response to new regulations in the UK, in Mainland Europe and in the USA. FGD for industrial boilers was also covered in this session.

At the end of two days of technical presentations, the President of The Institute of Energy made his summing up to a nearly full complement of delegates. Mr Pugh spoke of the need for energy conservation referred to earlier. A conclusion from the conference, he felt, could be that the technology for FGD and other desulphurisation methods was now well established and the next concern would be to establish reliability. Current coal-fired power generating plants had exceptional reliability that was a credit to electrical and mechanical engineers. To retain that performance the desulphurisation process plant must have similar integrity and that presented a real challenge to process engineers and manufacturers.

The CIBSE recommendation not to use CFC-foamed insulation was strongly supported. Despite unease expressed by insulation manufacturers, the consensus was that alternative insulation was adequate for most purposes.

All manufacturers wanted reassurance concerning future alternatives to CFCs and the extent to which they should depend on R22 while further development was continuing.

(continued on page 6)



New members

Fellow

Brian Patrick Coll, Dinardo & Partners, Paisley (*transfer*)

Richard William Stonebridge, Foster Wheeler Power Products, Middx

John Street, CEGB, Operational Engineering Division, Solihull

John Sykes, Atomic Energy Research Estab, Harwell Lab, Oxford

Member

David Blakeborough, CEGB, Hartlepool Power Station, Cleveland

Richard Keith Clark, British Coal, Grimethorpe PFBC Estab, South Yorkshire

Christopher Richard Cook, Charing Cross Hospital, London

Martin James Jameson, NW Regional Health Auth, Manchester (*transfer*)

Ian James Kemp, Glasgow College, School of Engineering

Chi Keung Patrick Lui, GEC, Hong Kong (*transfer*)

Jacob Wole Olateru, NEPA, Lagos Thermal Station (*transfer*)

Joanna Nerys Rowson, Airoil Flaregas, Middlesex

Associate Member

David John Dodd, University College of Swansea

Roger Anthony Sparkes, Hereford & Worcester County Council

Associate

Andrew Harper

Stephen Robert Whatling, Troup Bywaters & Anders (*transfer*)

Graduate

Mark Cameron Anderson, Gloucestershire County Council, Glos

Philip Victor Aspinall, Hampstead Health Authority (*transfer*)

Alan Rupert Clarke, Ove Arup & Partners, London

Geoffrey Michael Willis, Max Fordham & Partners, London

Johnson Wu, Aero & Industrial Technology, Burnley, Lancs

Correction

Parisima Khajehhosseini, SLC Energy Group, London (*Member*)

We regret that there were two errors in our published list of New Members in *Energy World*, May/June 1989, p 6.

Honours list

WE congratulate the following whose names appeared in the list of the Queen's birthday honours:

MBE

W Wright (Fellow), station manager, Fawley Power Station, CEGB.

BEM

E A Higgins (Fellow), for services to the community and to charity.

Members who receive awards in honours lists are reminded that they should let staff at The Institute know as soon as possible so that records can be altered.

Appointments

N E Charlesworth (Member), chief executive of the fuel and energy consultants, NIFES Ltd, is leaving the company. NIFES have recently been acquired by Phoenix Power Holdings Ltd. The incoming executive chairman is **A W Tweedale** (Member), a former managing director of Associated Heat Services plc.

REJ Roberts CBE FEng, chairman of Simon Engineering plc and deputy chairman of Dowty Group plc, has been elected 1989/90 President of The Institution of Mechanical Engineers and took up office on Wednesday 24 May 1989.

Dr O Ta'eed (Graduate) is now Engineering and R & D manager, Molynx Ltd, Newport, South Wales.

Obituary

Dr D T Davies (Senior Fellow) died on 21 May 1989. He joined The Institute as a Member in 1930.

W C Hankins (Fellow) died on 20 February 1989.

CIBSE hosts CFC summit

(continued from previous page)

The Institution was urged to publicise its guidelines more widely, especially throughout the international community, and to liaise with government officials in order to advise on appropriate legislation.

The afternoon debate by specialists aimed to pose questions and focus on the associated dilemmas. As a result of this there

will be a one-day conference to offer clear guidance to building services engineers in general. This will be a joint CIBSE/Institute of Refrigeration event and will take place on 27 November at the Cavendish Conference Centre in central London. For further information contact Jennifer Hand on 01-675 5211.

J Sainsbury Student Prize — University of Surrey



Colin Rigg (right), Secretary of The Institute of Energy, presents Tom Barlow (a principal Engineer with Watford Council) with the J Sainsbury Institute of Energy Student Prize for 1988. This is awarded annually to a student nominated by the University of Surrey and selected as achieving the best all round performance in the MSc Energy Engineering degree course. Mr Barlow was a part-time student at the University of Surrey.

J Sainsbury Student Prize — South Bank Polytechnic



Peter Ibbotson (left), Director of Construction and Chief Engineer, J Sainsbury plc, presents the J Sainsbury Institute of Energy Student Prize for 1988 to John Duffin MSc, student in the Institute of Environmental Engineering. The prize is awarded annually to a student nominated by the Polytechnic of the South Bank who achieves the best all-round performance based on course work, examinations and project in the MSc Environmental Engineering degree course.'



Electricity privatisation: a new opportunity for coal

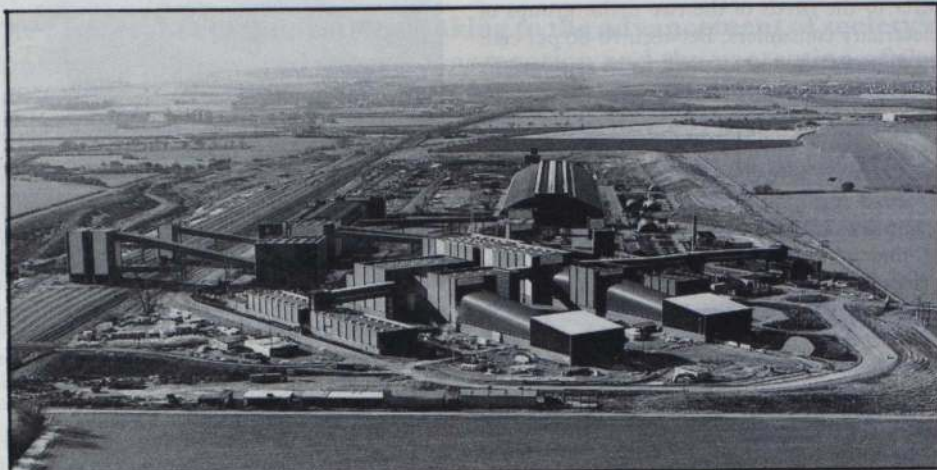
by Martin Cruttenden BA*

THE privatisation of the electricity supply industry and the prospect of British Coal's own privatisation make this a period of great uncertainty.

British Coal's interest in the current debate about contractual arrangements between generators, suppliers, distributors and end user, is on two levels — as suppliers and as a major customer.

The electricity industry uses 77 per cent of our coal with a sales value of £3.3 million, but the understanding which covers most of these sales comes to an end on 31 December 1989. Beyond that we have no commercial contracts, with the exception of Scotland. That is a measure of the intense artificiality of the situation, and would have been quite inconceivable if electricity had developed in private ownership to which they and, later, British Coal are to be transferred. Had we both been in the private sector major investment by either party would only have been made against the security of firm commercial contracts.

The popular misconception of the coal industry dogged by industrial trouble, disruption and high prices still lingers. The reality is very different. More than half the collieries working at the start of 1985/86 will



An aerial view of the coal-handling and despatch facility at Gascoigne Wood, Yorkshire, which processes up to 10 million tonnes a year of coal produced by the five mines of the Selby coalfield. All five mines are linked underground and their output is collected, assessed to quality, and despatched from the centralised facility shown above.

have closed by September and manpower will have declined by a similar proportion. Productivity, however, will have risen by 90%. While it may not be possible to maintain this unprecedented rate of increase we see a steady growth in productivity continuing as a result of better equipment, more retreat working and better utilisation of existing machinery. The produc-

tivity boost enabled British Coal to meet the challenge of falling fuel prices in 1986 and again in 1988 by actually reducing prices to the electricity industry. British Coal's revenue in real terms is now some £650 million less than in March 1988 — a drop equal to 20 per cent of our present revenue.

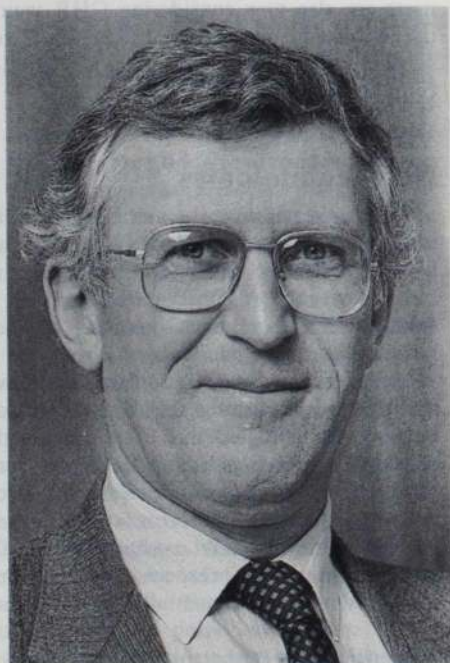
Trends in pricing

Given the industry's remarkable performance, the likely upward trend of world coal prices in the early '90s towards a higher but sustainable level — a view shared by almost every energy expert — British Coal can make a considerable and stabilising contribution to the UK energy business, and in particular to the generators.

British Coal can be certain about its production capacity, costs and prices. Traded coal or heavy fuel oil cannot, given the uncertainty of exchange rates to which they are subject. It is equally important to remember that coal competes where it is burnt and not where it is mined. The cost of transporting our coal to the major power stations is about 8 per cent of the delivered price. Transport costs for Australian coal would be 60 per cent or more. While there will always be some tonnage available from somewhere in the world at lower prices, British Coal claim to have a total package which is unique.

This is why: first, British Coal has always been prepared to match the competition's

The author



Martin Cruttenden was educated at King Edward VI Grammar School, Bath. Later he studied geography and geology at St. John College, Cambridge.

He joined the then National Coal Board as an administrative assistant in the West Midlands Division before working for a time in the office of the then Chairman, Lord Robens.

Since joining the Marketing Department as an industrial sales representative, Mr Cruttenden has been head of industrial sales and head of domestic and industrial sales at Hobart House; deputy regional marketing director for Yorkshire and regional marketing director, Midlands, before being appointed to his present post in 1987.

He is the Chairman of National Fuel Distributors and of Domestic Solid Fuels Approval Scheme Ltd, a director of the Solid Fuel Advisory Service, of the Coal Trades Benevolent Association and Hon Treasurer of the National Home Improvement Council.

*Director of Sales, British Coal Corporation



prices in real terms where that competition is real and sustainable. Over the rest of the tonnage for electricity generation British Coal's delivered prices and the sustainable prices of world coal and heavy fuel oil should come into balance during the early 1990s if recent trends in price continue at the current rate.

Consumers' needs

In a bid to retain its massive stake in the generation business British Coal will relate its offer to the needs of the two major groups of electricity consumers. Between 70-80 per cent of all power is sold to small users — domestic customers and other small tariff consumers. These currently enjoy tariffs among the lowest in Europe — only Portugal, Greece and the Netherlands have cheaper domestic electricity!

Small consumers are right to show concern that prices will increase unpredictably and out of line with the general movement in UK prices. They are likely to judge what is fair in relation to general UK price movements. BCC has therefore offered a combination of modest reductions in real prices coupled with firm guarantees that prices for generating coal will stay within the UK retail price index for as long as they wish. Since coal represents half the cost of generating electricity and a third of the final price this offer has real benefits for small consumers.

The second group are the large electricity consumers, including British Coal, second largest user of electricity, and our interest like those of other large users is to see that electricity prices are broadly in line with those of our overseas competitors.

The rule for what was regarded as fair pricing to large users is unique to the UK. At its most extreme, the cost of a unit of electricity has generally been regarded as identical whether supplied to ICI or BSC at one extreme or to run your own home computer. Account is taken of time of use to fit into the complexities of lead management but electricity prices for the large user are very much higher relative to the small user than elsewhere.

The 1973 and 1979 energy crises resulted in efforts to protect the European large user from the full effect of oil price rises, but in Britain the burden of increased fuel prices was shared equally between small and large users. The large users found themselves in an even worse competitive position in relation to their overseas competitors.

British Coal saw this with alarm because CEBG sales were, and remain, essentially coal's sales. Coal was first offered at special prices in 1980 to help meet the need of large users but the concept was not finally accepted until 1986 when the Qualifying Industrial Consumers Scheme (QUICS) was introduced. It ran successfully until early 1988. The advantage it offered was eliminated by the QUICS tariff being increased by more than twice the rate of inflation even though coal prices for the QUICS has been kept within the RPI.

Large users still want a predictable price which enables them to remain competitive with overseas rivals. But there are clear indications that after privatisation electricity



The computerised control centre at the Gascoigne Wood coal handling and despatch plant. The centre controls all the movements of the output of the five mines of the Selby coalfield along a complex series of underground conveyors, through weighing and screening facilities, and manages the movements of the rail wagons which transport the coal off the site to nearby power stations.

will be subject to very tight regulation. Terms for large users which are required to make UK industry competitive could still be regarded as unfair discrimination. Large users prices could therefore still rise, particularly because the QUICS scheme would finally disappear.

Electricity market — large generators

It is against this background that the electricity industry is contemplating three or five year contracts rather than longer periods originally thought likely. This introduces serious unpredictability to the sale portfolios of the electricity companies. It is likely that some other area of predictability will be seen as necessary, and British Coal has indicated willingness to continue providing specially low priced tonnage to help hold down electricity prices to the large users. In return for three to five year contracts for electricity signed by the consumer with either generator or distributor, the discount would vary according to the size of the order, starting at 1 MW. Detail must still be worked out but this could represent the best way forward to cheaper electricity for large users.

British Coal has to meet stiffer competition to hold business with the generators but would prefer to concentrate price reductions on coal to be processed into electricity for the large user because that is what the market clearly shows as being desirable and necessary.

Small generators

While British Coal's main interest must be in reaching satisfactory agreements with the large generators, in the next few years smaller generating plants than that traditionally installed by the CEBG is likely to meet much of the projected increase in electricity demand.

Gas combined cycle is clearly a major competitor but coal, probably using circulating

fluid bed technology, is likely to secure some part of this new market. Bilsthorpe in the East Midlands is the first project where plans are well advanced but several others are likely to follow closely behind. British Coal's determination to offer long term supply contracts insulated from exchange rate fluctuation will be an important asset especially if such stations are on colliery sites where services are available and the use of lower priced coals such as washery middlings and fines is possible.

Small private power stations are likely to be based on individual modules of 100/150 MW capacity, but British Coal as a major electricity user is also considering smaller scale generation plant at the pits to burn colliery methane, which is likely to be released in increasing quantities as mining production rates are increased underground. Other major energy users are also now considering CHP against the background of electricity privatisation with surplus power being sold to the distribution companies.

New technologies

Slough Estates with their recent order for a major (circulating fluid bed) CHP plant are hopefully setting a trend, and increasing concern over the greenhouse effect is likely to stimulate CHP schemes because of their higher overall efficiencies.

Meanwhile, as Jim Harrison's article shows, British Coal is pushing ahead with new coal burning technologies and in particular the development of pressurised fluid bed combustion. The aim is to add a coal topping cycle to boost efficiency and bring an entire new package into commercial use by the early '90s.

There are exciting prospects for a whole new generation of environmentally friendly small power stations operating on coal at fuel efficiencies 20 per cent higher than has ever been achieved before. □



AS IT has become appreciated that energy resources are limited and competition for the use of energy has increased, the necessity to improve efficiency has become more and more urgent.

In recent times, the need for the conservation of energy resources and the need to protect the environment have increased the pressure for improvement. The results of these pressures are shown in the reduced energy requirements of modern manufacturing processes as reflected in the relationship between energy consumption and the gross domestic product in advanced countries.

In particular industries the improvement has been very dramatic. For example, in the electricity industry the efficiency of utilisation of fuel has doubled in the last 50 years. Similarly in the metallurgical industry the amount of energy required per ton of iron has halved in the last 50 years.

These improvements do not happen automatically; they represent considerable effort by scientists and engineers collaborating together to improve existing industrial processes and to introduce new technology. Successful innovation is the product of fruitful interaction between fundamental research — probably best carried out in universities, development or applied research — probably best carried out by industry, and strategic research which is long term in nature and which usually requires a combination of industrial forces on a national or international scale.

The improvement of established processes comes about by a progressively improved understanding of the basic science and technology and by applying the results of fundamental research to the particular industrial

Innovation for the clean use of coal

by James S Harrison*

The importance of innovative thinking to the advancement of society's dual need for improved energy conservation and the protection of the environment was considered by J S Harrison, the Director of Britain's Coal Research Establishment in the 1988 Robens Coal Science Lecture, presented to an audience of energy and fuel specialists at the Royal Institution, London last October. The following article is based on the address given by Mr Harrison at this leading event in the energy industries calendar.

process. By contrast to this step-by-step improvement, the step change represented by the introduction of new technology often requires a leap of imagination in advance of scientific understanding and sometimes even in the face of established opinion. Examples of this might include the steam engine, the pf furnace and the Bessemer converter for steel making.

Technical merit does not automatically lead to industrial success. Improvements usually require resources for their implementation and have to compete for finance with other opportunities for investment. A proposed innovation has, therefore, to demonstrate prospects for a good financial return on the investment required for its introduction — and this means

increasingly that the favoured projects are those with high returns in the short term.

Other less quantifiable obstacles to innovation are, on the one hand, the risk attached to anything new, and on the other, suspicion that something Even Better is just over the horizon. Innovation on the scale required for the energy industries is costly and hardwon; it is not surprising that there can be a reluctance to imperil established reliable production technology by introducing new, risky technology which itself may be superseded in a short time.

The progress of coal technology in which British Coal have had a major part in recent years provides good examples of the success of innovation based on strategic research and on developmental research and by close collaboration with manufacturers and users. British Coal have encouraged the direct participation of manufacturers at the early stage of research and in the development and demonstration stages. This has proved to be a particularly successful means of ensuring the transfer of technology from the laboratory to the market place.

Coal characterisation

Some of the special expertise which is needed to be developed to bring about the advances in the technology of coal utilisation arises because coal is a solid. Chemical engineering has largely been developed on systems handling gases and liquids; solids handling is at a comparatively early stage. The other reason for special expertise arises from the nature of coal itself. It is extremely variable in composition and contains mineral matter which is sometimes intimately mixed with the coal substance, but may also be present as discrete minerals. In European coals most of the mineral matter is in the latter form, ie, it is

The author

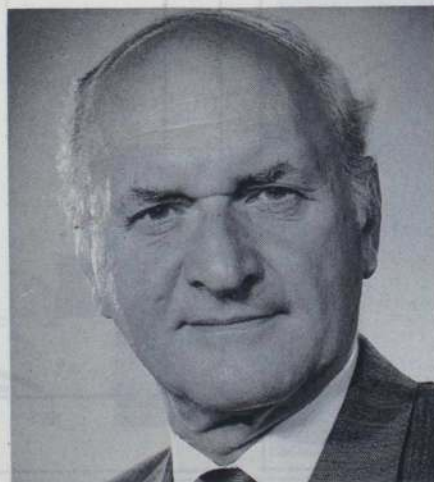
James S Harrison is a native of Lancashire. He went to school in Guildford, and to college in Loughborough where he studied chemistry and chemical technology. He has worked in the coal industry for all his professional career and is now the Director of the Coal Research Establishment responsible for British Coal's work over the whole range of technology relating to the clean use of coal.

He is also Chairman of IEA Coal Research, the international project established in London under the auspices of the International Energy Agency.

He has always appreciated the role which the professional institutions place in the development of science and technology. As a member of the Royal Society of Chemistry he has chaired the Process Technology Committee.

In the Institute of Energy he has

served as a member of Council and was Chairman of Publications and Conferences Committee for a number of years. He was responsible last year for the organisation of the Institute's conference on Fluidised Combustion, and was given the Special Award of the Institute of Energy at last year's annual luncheon.



*Director, Coal Research Establishment, British Coal Corporation

discrete from the coal substance. In some southern hemisphere coals much of the mineral matter and the coal can be extricably mixed.

Coals are commonly characterised in terms of their volatile matter, swelling properties and ash content. These characteristics define coal type but are not absolute quantities. The conditions under which they are measured need to be carefully controlled in order to produce consistent and meaningful results. The standard conditions, which are the basis of international classification, are those for which the results are most readily interpreted in the context of making coke, and in particular to the behaviour of coals when heating in coke ovens.

Petrographic expertise has similarly concentrated on the characterisation of coal and coke-making. However, most of the coal used in the UK and in the world is not used for coking; it is used for burning, in the most part for electricity generation. Of the world production of coal in 1987 (4.6 billion tonnes) about half was used for electricity generation. The parameters used for characterising this coal remain, however, those derived from the coke industry. In the conditions obtaining in a power station boiler, coal behaves quite differently from the predictions of the standard tests. At the high temperatures and heating rates encountered in modern pulverised fuel burners, and with small particles in dispersed systems, the volatile matter may be significantly greater than that predicted (Figure 1).

At high temperatures and in high pressure systems, the swelling properties of the coal may also be considerably different from the predictions of the standard tests. In the UK a considerable body of expertise has been built up which relates the results under these conditions reasonably well with the standard tests. This means that the standard tests have not needed to be replaced by tests more specific to the end use. This correlation does not, however, hold for the new sources of coal which are being considered internationally. Petrology

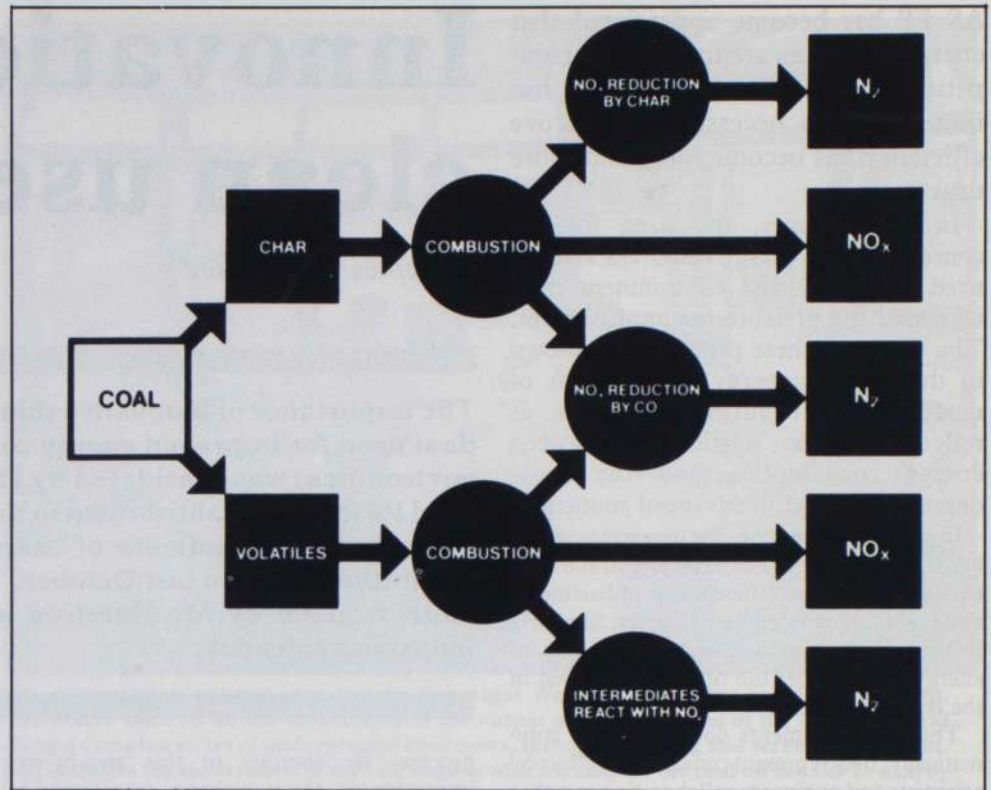


Fig. 2: chemical behaviour of fuel nitrogen in fluidised combustion

may eventually be able to assist in characterising these newer sources of coal, but there is no general agreement as yet in sight of an international system of classification.

Pollutant elements

In response to the increased sensitivity to the environment, more attention has been paid in recent years to the way in which potential pollutant elements occur in coal and in the products of coal utilisation. The major elements of concern are sulphur, nitrogen and chlorine. About half the sulphur in British coal occurs in the mineral matter and as such is in principle amenable to physical separation but subject to the limitations imposed by the size of

coal which can be satisfactorily handled in practical preparation systems. The remainder of the sulphur occurs organically bound to the coal substance, as an integral part of the coal molecules. This sulphur is not amenable to physical separation. Its removal from coal could be achieved only by severe chemical methods, which would be prohibitively expensive and would result in the complete breakdown of the coal itself as in a total liquefaction process. Whatever its form, virtually all of the sulphur in a combustion process is converted to sulphur dioxide and therefore has to be dealt with as a pollutant gas.

Nitrogen occurs in British coals mostly in two organic forms in quantities related to the

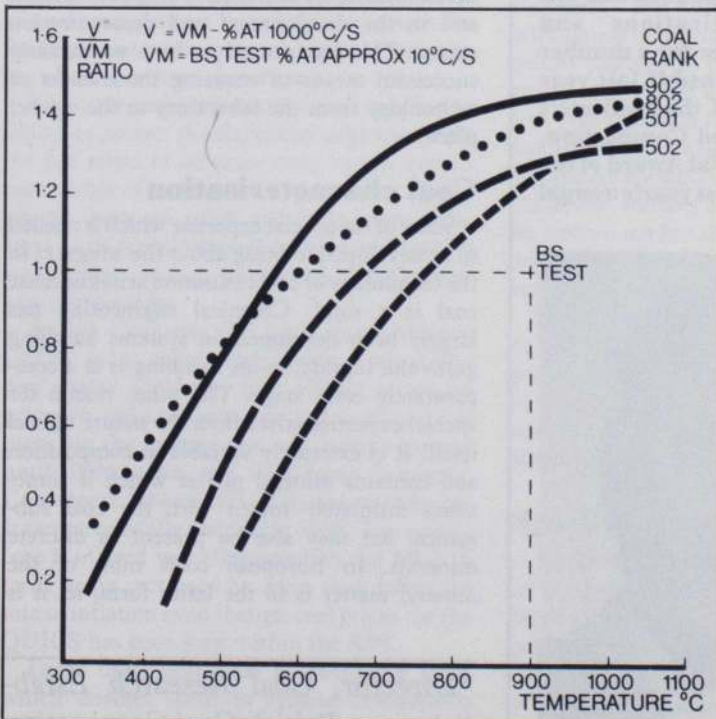


Fig. 1: volatile matter yield at 1000°C/S heating rate

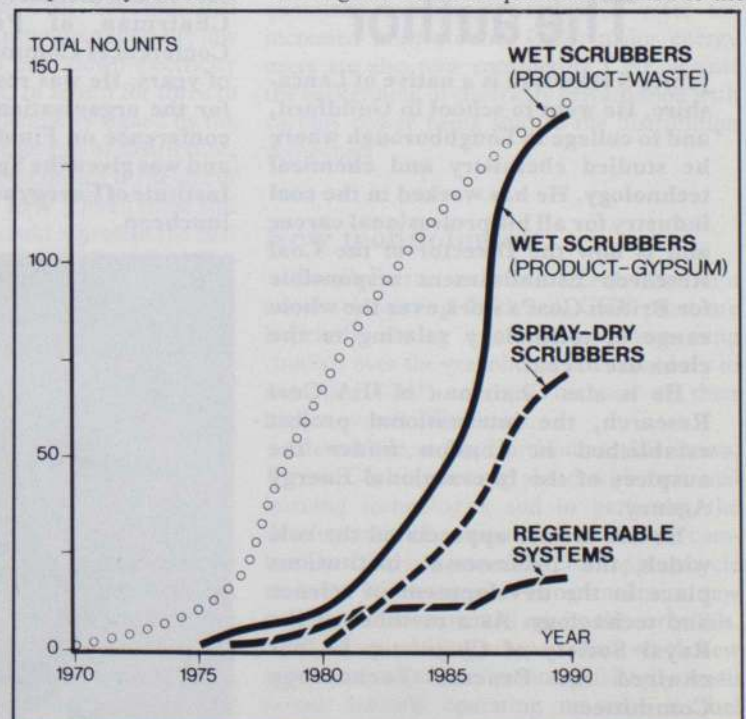


Fig. 3: world markets for FGD technologies



rank of the coal, and like organic sulphur would be prohibitively expensive to remove from the coal by chemical means (Figure 2).

When coal is burned it breaks down under the effect of heat into volatiles and a solid residue. The nitrogen in the coal passes into these components which then burn in the combustion air. Some of the nitrogen is converted into gaseous oxides in the flue gas, but some leaves as nitrogen gas. In typical industrial combustion systems, 15-20 per cent of the nitrogen in the coal leaves the plant as gaseous oxides. High temperatures and high oxygen concentrations favour oxide production. High carbon and low oxygen concentrations favour the formation of nitrogen gas. At very high temperatures the nitrogen in the combustion air can also react with the oxygen to become oxides, but unless the temperature is in excess of about 1200°C the proportion converted is a small component of the total nitrogen oxides produced in the combustor.

Once the mechanism of the formation of oxides of nitrogen had been elucidated and the importance of reduced air supply and low temperatures was understood, these features could be used for the design of improved equipment:

- for pf boilers, low-NO_x staged burners have been successfully introduced by the burner manufacturer. Designs are now being adapted to suit the different kinds of power stations.
- in bubbling fluidised beds, staging can be introduced by minimising the primary air used for fluidisation and introducing secondary air above the bed.
- in circulating fluidised beds, operating at low temperatures and with long residence times, conditions favour low-NO_x operation.

By contrast, the only way that oxides of sulphur can be removed is to convert them first into a solid form. The most common way of doing this is to react the sulphurous gas with lime or limestone which is then converted into a solid product and can then be removed from the gas.

The conditions for the reaction have to be chosen with care particularly in respect of temperature. If the temperatures are too high the sulphur product is unstable. For this reason adding lime or limestone to the combustion temperature of a pulverised fuel system is not effective; better results are obtained at the lower temperatures of a chain grate stoker, but the best results are obtained in fluidised beds which operate at the temperatures favouring the capture of sulphur dioxide.

As an alternative to the direct injection of limestone, sulphur dioxide can be washed out of the flue gases. This is the basis of the systems now to be installed by the CEBG as their contribution to the national reduction in SO₂ emissions which was agreed earlier this year (Figure 3). The processes are expensive, adding some 10 per cent to the capital and operating costs of large boiler plant. On a smaller scale such plant becomes proportionately more expensive in terms of costs per tonne of sulphur removed, even when meeting the lower percentage reduction standards for the smaller plant.

Chlorine is not bound to the coal organically. In British coals it is present in ionised form on the coal surface. In principle therefore it is amenable to removal by washing but again in practice removal is limited by size considerations because some of the chlorine is contained in very small pores in the coal. The chlorine leaves combustion equipment as gaseous hydrochloric acid.

For the most part other elements of concern do not become gaseous pollutants; they appear in the solid residues. However the proportions in which they appear in the different solid residues differ from one appliance to another depending largely on the temperature regime and on the prevailing oxidation/reduction conditions.

MARKETS FOR COAL

Iron and Steel

Although combustion represents the biggest use of coal in this country and abroad, considerable quantities are still used in the manufacture of iron and steel. Innovation in the methods used for iron making are impressive. The halving in energy requirements of conventional iron making has been brought about by considerable advances in blast furnace technology.

Part of the improvement in blast furnaces is attributed to the improvement in quality of the coke which has been brought about by a better understanding of the carbonisation processes and the properties of the coals used. Close control over the properties of the coal can be achieved on the basis of blend criteria relating to the fundamental properties of the coal. Nevertheless coke making remains an expensive process both from the point of view of the capital cost of the plant and the low yield of coke. These factors have led to a revival of interest in the direct use of coal in the blast furnaces by injection into the hearth.

The technology was first investigated in the 1960's in the UK and elsewhere, but recently the merits of coal injection have become more widely recognised. By next year over 60 blast furnaces will use coal injection. Experience so far confirms that coal can be used to replace its thermal equivalent of coke, that the blast furnace is tolerant to a wide range of coal properties and that some 20 per cent of the coke can be replaced. In the UK it has been demonstrated that excellent performance can be obtained by a coal preparation and feeding system much simpler and cheaper than that required for the pulverised coal which has hitherto been favoured. It has recently been estimated that by the year 2005 more than 30 million tonnes a year of coal will be internationally traded for injection.

In the longer term there is considerable activity in the development of steel making processes based entirely on coal not requiring coke at all. One such process being developed by British Steel gasifies the coal in an iron bath to produce a reducing gas which effects the reduction of iron ore. The iron passes through the gasifier and can be refined to steel in an adjacent melting unit.

Domestic market

On the domestic scale innovations in the use of coal have been based on two different approaches, one to improve the fuel, the other to improve the appliance, both aimed at improving convenience and amenity and at the same time improving efficiency and eliminating the production of smoke. In the 1950's the urgent need to clean up the atmosphere led to a need to reform the burning of coal in domestic and small scale appliances. Early attempts at developing appliances which would burn coal cleanly were unsuccessful and the supply of natural occurring smokeless fuel was insufficient. There was a need for a process

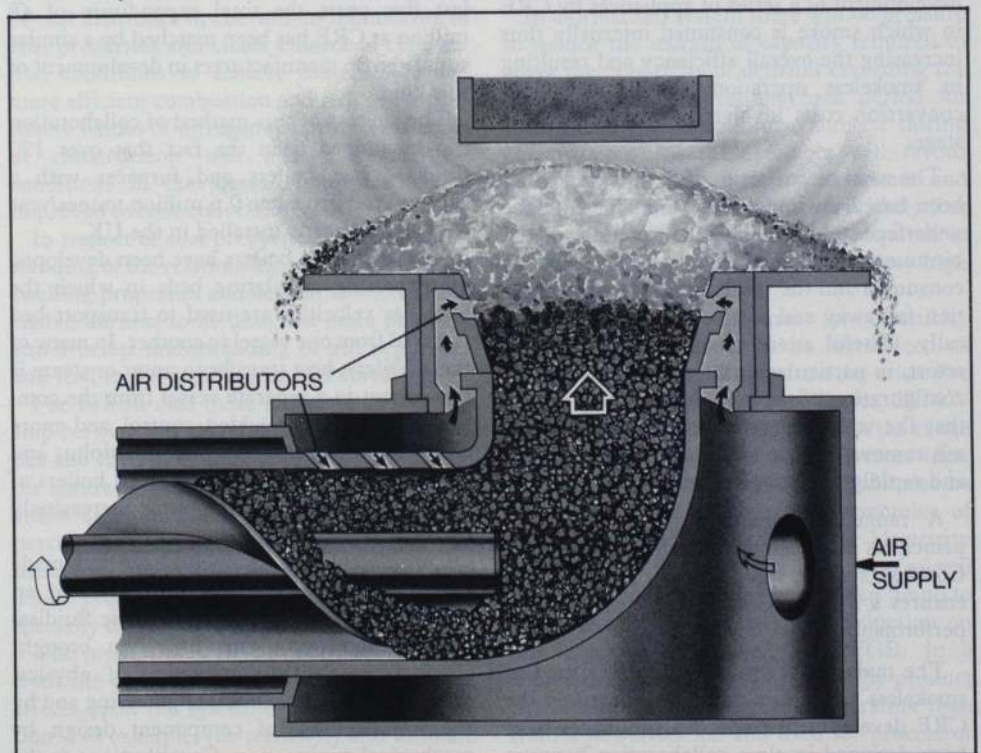


Fig. 4: self cleaning underfeed stoker retort



to be developed which would use bituminous coals and would produce a smokeless free-burning domestic fuel.

CRE developed a method of producing smokeless briquettes by treating the coal by low temperature carbonisation in a fluid bed, producing a char which had sufficient plastic properties for it to be briquetted without a binder. This is the basis of the Homefire process which is still in operation and produces a fuel with the attractive properties of burning with a flame on the open fire, but without producing smoke. It is clean to handle and attractive in operation, and therefore maintains a popular market.

A fluidised bed was chosen for the carbonisation stage because it provides a means of closely controlling temperature. Very close control of operating conditions was necessary, both in the carboniser and in the briquetting presses to achieve a successful engineering scale-up, and it was necessary to develop an understanding of processes taking place during briquetting. An example of this was the work done at the Coal Research Establishment on the effect of the composition of coal on briquetting performance.

Basic techniques developed primarily for coal petrography were used to examine the way in which the macerals of the parent coal contribute towards briquette quality. The different macerals undergo a series of swellings and contractions when heated and eventually decompose completely. It is the plasticity created during these changes which was responsible for the strength of the briquettes. Much detailed work of this kind was carried out to underpin the successful scale-up of the technique from the laboratory to full commercial production.

The alternative approach to the clean use of coal in the small scale was the successful development of a series of appliances by CRE in which smoke is consumed internally thus increasing the overall efficiency and resulting in smokeless operation without the high conversion costs involved in the briquetting stage.

The most recent series of developments has been based on improvements at CRE to the underfeed stoker, which will burn high volatile bituminous coal in such a way that smoke is consumed and the solids products of combustion fall away and can be removed automatically. Careful attention to the design of the retort, in particular to the air inlet and to the configuration of the combustion zone, ensure that the whole operation of coal feeding and ash removal can be made to respond flexibly and rapidly to demand (Figure 4).

A range of appliances based on these principles has been developed in the generic Coalflow system, and a specially prepared coal ensures a system with reliable and sustained performance.

The majority of coal now being burned in smokeless zones is in appliances based on the CRE developments; specific appliances have been designed in close collaboration between CRE and the manufacturers.

The industrial market

One major innovation in the utilisation of coal has been the introduction of the fluidised bed as an improved means of burning coal.

Fluidised bed technology grew from coal gasification technology and later developments in the chemical engineering industry. The particular advantages of fluidised operation arise from the uniformity of temperature brought about by the intimate mixing of the gas and the particles through which it flows, and the good heat transfer which is obtained to surfaces immersed in the fluidised bed. It was soon appreciated that an additional benefit for coal combustion comes about because of the retention of sulphur oxides by limestone at the operating temperatures in fluidised beds.

Many types of plant have been developed from the initial success obtained by burning coal in bubbling fluidised beds. Deep bed technology has been developed in some countries to suit the locally available coals and where a premium has been justified on environmental grounds. In the UK the emphasis has been on shallow bed technology which has the particular virtue for the smaller industrial application of being relatively cheap and suitable for use with the types of coal normally used in British industry.

One of the reasons for the successful introduction of the technology has been the collaboration of plant manufacturers with the British Coal development programmes. Typically CRE has provided technical input and financial support matched by contributions on a smaller scale from the manufacturer. In this way the developments are linked with specific manufacturers and can be introduced into the market place directly. CRE continues to support the development during the market proving period, often working on customer's premises to ensure that teething problems are dealt with promptly and effectively. Over the last five years the total expenditure of £8 million at CRE has been matched by a similar sum from 36 manufacturers in development of this kind.

The success of this method of collaboration can be judged from the fact that over 120 fluidised bed boilers and furnaces with a capacity to burn some 0.6 million tonnes/year of coal are already installed in the UK.

More recently, boilers have been developed incorporating circulating beds in which the high gas velocities are used to transport bed material from one vessel to another. In many of these boilers, heat transfer to water or steam is carried out in a separate vessel from the combustor. This gives added control and more efficient suppression of oxides of sulphur and nitrogen. Worldwide, fluidised bed boilers of different designs are becoming increasingly used.

Considerable improvements have been made to the design of fluidised bed boilers by an improved understanding of the basic fluidisation phenomenon. This has been brought about by a fruitful interaction of physics, mathematics and chemical engineering and by the improvement of component design by mechanical engineering. Contributions to the better understanding of fluidisation as applied

to coal utilisation have been made by universities, equipment manufacturers and the coal industry as well as being the objective of national and international collaboration.

In fluidised beds, gas is introduced through a perforated distributor plate and passes through the bed of particles and forms an emulsion phase with the particles. As the gas flow is increased, bubbles are formed in the bed which expand until they reach the surface. In this stage the particles and the gas are well mixed, new bed material is rapidly dispersed, temperature differences are minimised and there is good heat transfer to surfaces immersed in the bed. At higher fluidising velocities still the character of the bed can change and in extreme conditions material is removed so rapidly that the bed is destroyed.

The transition from one form of behaviour to another is affected not only by the composition of the gas and its velocity but by the size, shape and density of the particles. Much work has been done on obtaining a better understanding of the relationship between these various factors, for example Geldart has classified the fluidisation behaviour of different kinds of bed material. These basic studies need to be applied to commercial plant and of particular interest is the ability to predict the behaviour of the large fluidised beds which are required in industry. Fluidised beds with dimensions of several metres can behave differently from the smaller beds on which most of the experimental work has so far been done.

One technique which has been successfully used is to simulate the complex industrial application in a cold model designed in such a way that the main behaviour is reproduced, but under conditions more amenable to study. Cold models allow different operating conditions and different materials to be explored more quickly and more cheaply than would be feasible on the industrial plant itself.

In order to simulate large scale behaviour it is necessary to choose characteristics of the cold model in such a way that plant phenomena are correctly reproduced. Compromises have to be made between competing criteria. At CRE and at Grimethorpe fluidisation conditions in industrial and pressurised boilers have successfully been modelled, using criteria developed by Glicksman for fluidised beds, for which complete similarity is not possible in respect of geometry and dynamics (friction, gravity and inertia), at the same time as chemistry and heat flow characteristics.

In practice, successful modelling has been obtained using compromises based on the use of sand as the bed material and plastic tubes to represent immersed heat exchanger surfaces. In order to monitor transitions between fluidisation regimes, as well as quantifying important fluidisation parameters such as particle velocities, flow paths and bubble size, special diagnostic instrumentation and procedures have been developed at CRE and in co-operation with universities. The main procedures are those based on:

- **Painted Plastic Tubes** — tubes are coated with several layers of paint of dissimilar colours; each layer is approximately 25 μm thick. In regions of high particle mobility the paint tends to be completely removed.



In static regions only the outer layers of paint are disturbed. The technique has been used to assess the mobility of the fluidised bed material and also to evaluate particle flow around heat exchangers that are immersed in fluidised beds.

- High Speed Video Tape Recording** — by employing high speed video equipment it is possible to replay the motion of cold model fluidised beds in slow motion. Such an approach yields information on bubble coalescence and particle flow and to calculate particle and bubble velocities and bubble frequency.
- Differential Pressure Probes** — the measurement of hydrostatic pressure within a fluidised bed using a differential pressure probe can be employed to monitor changes in fluidisation regimes as well as facilitating the calculation of minimum fluidising velocity, bubble size, frequency and bed voidage (Figure 5). A successful probe has been developed for CRE by the University of Surrey.
- Heat Transfer Probe** — a means of mapping the mobility of particles in a fluidised bed is achieved by measuring the localised heat transfer rates between a heat transfer probe and the fluidised bed.
- Optical Probe** — a further method for measuring bubble properties, viz velocity, frequency and size involves the use of an optical probe. The probe consists of a light emitter and a light sensor. When a unit is located in a fluidised bed, light is detected only when reflected on to the sensor by bed particles within about 4 mm of the probe window. Processing of the data provides bubble velocity and frequency distributions in addition to their mean values.
- Force Probe Sensor** — for certain purposes, eg. design of heat exchangers, it is necessary to establish the forces acting on the tube bank when it is immersed in the fluidised bed. A method for achieving this has been developed at CRE, using a strain gauge probe.
- Acoustic Probe** — acoustic probes can be used both in hot and cold conditions and the outputs of these probes can provide information on fluidisation behaviour and wear potential.

Marked differences can be seen between Geldart Group 'B' conditions, where most bubbles rise faster than the interstitial gas and Geldart Group 'D' conditions, where most bubbles rise more slowly than the interstitial gas. Hence, the fluidising conditions can be established broadly, and wear potential estimated in the light of other important considerations such as bed depth, and heat exchanger design.

Many commercial designs of coal combustion plant already incorporate the results of studies on cold models carried out using these diagnostic techniques.

Cold models have been particularly successful in aiding the design of the fluidised bed for the pressurised combustor of the experimental unit at Grimethorpe. Cold models have been used up to the same size as the distributor and bed height of the fluidised bed in the

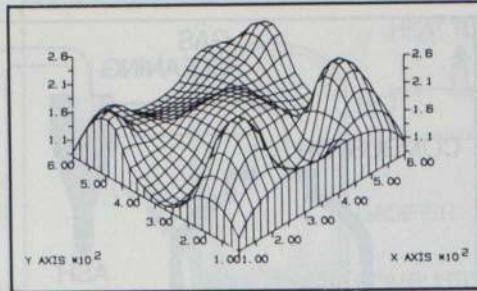


Fig. 5: profile of bubble v bed position

pressurised combustor. By exploring a range of operating conditions, chiefly fluidising velocity, bed height and mean particle size, a specification was established for the operation of the full-scale plant. Good fluidisation, combustion and sorbent performance was obtained with this specification and at the same time long lifetimes of the tube banks. By these techniques, therefore, the overall confidence of the engineering performance of the combustor regimes of fluidised bed boiler systems has been greatly increased. Larger plant can be designed with a high degree of reliability.

Electricity generation

The established technology for the combustion of coal for electricity generation is based on the pulverised fuel burner. In a typical large power station each boiler will have 60 pf burners which together can have a capacity for burning nearly 2 m tonnes of coal per year. The pf power station is an example of a technology which was first introduced in a step change, but has benefitted from innovation by continuous evolution. The increased understanding of the processes involved in the preparation, feeding and combustion of coal have allowed larger stations to be built and efficiencies to be progressively increased.

The evolution of the existing technology continues with emphasis on improved control of coal distribution, continuous monitoring of coal properties and closer control of combustion conditions to achieve more stable and more efficient combustion and reduced formation of oxides of nitrogen. Improved materials of construction will allow supercritical conditions in the steam circuit leading to improved overall conversion efficiency.

In respect of coal properties a better understanding of the relationship between coal type, swelling properties and devolatilisation would enable burners to be designed more precisely and a better understanding of ash properties will lead to reduced fouling and corrosion.

For British coal there is a general relationship between the slagging and fouling properties and the ash content. For a particular coal the nature of the ash changes in such a way that at low ash contents there is an increase in the percentage of iron, associated with an increased propensity for deposits to form. These properties are being studied at CRE in specially designed equipment.

The properties of the ash particles resulting from the combustion of coal may have other effects upon the system design and optimisation. For example, the resistivity and ultimate size analysis of pf ash may affect the efficiency

of electrostatic precipitators and the erosivity of the ash may influence the design of mills. Improved correlations between coal composition and plant behaviour are being developed for British coals. This will enable burners and boilers to be designed and operated more efficiently and with increased reliability of performance.

The privatisation of the electricity supply industry creates new opportunities for electricity generation. The CEBG was set up as a monopoly, generating and distributing electricity throughout England and Wales. As a nationalised industry they are protected against normal commercial risks and their economic criteria are appropriate to an industry in public ownership. Against these criteria the national system was built up based largely on the addition of capacity in units of 2000 MW. Such large units would not be favoured to the exclusion of others by a privatised system consisting of competing generating companies without monopoly powers, without the obligation to supply of the CEBG, and subject to more stringent financial criteria which will be appropriate both in respect of the return on investment and on the acceptance of risk.

One result of building large power stations was that decisions on new capacity were made for anything up to seven years ahead. In a period when electricity demand has been particularly difficult to forecast these long planning horizons have resulted in considerable errors in the provision of capacity.

In the last 17 years, demand has been substantially below the forecast level. The average over-estimate was 10.4 GW, which represents an extra 12.6 GW of net capacity after including the planning margin. Spare capacity never reached these levels because of delays in construction of new power stations and early retirement of older plant. However, in broad terms something like £10,000 million at today's prices was spent on surplus capacity.

In a privatised system there will be pressure to reduce the margin of capacity required to cover the possibility of demand exceeding the forecast, to reduce the payback period for investment and to minimise interest during construction. All these factors will favour plants with shorter construction times and with lower capital costs. Hence it is likely that at least some of the new capacity required in future will be in the form of smaller, high performance plants.

A variety of plant sizes for electricity generation is expected to be introduced as individual commercial opportunities arise. For example 5–10 MW units at collieries, 30 MW units on industrial sites and units in the range 100 to 500 MW power plant to meet local needs or to serve the Grid. There will also be opportunities to improve the economics of power generation by associating electricity production with the supply of that on a local basis — an option which has not been found to be practicable with electricity production on the large scale favoured by CEBG. In a combined heat and power station, by-product heat is extracted at a higher temperature than from a power station and used for process or space heating. Although this reduces the



electrical output from a given fuel input, the overall thermal efficiency can be raised from about 37% to 80%. The potential for CHP plants is considerable in the UK and could be as much as 20 GWe.

New small power stations will need to conform to increased environmental standards, and will need to be able to respond flexibly to the growth in demand and to the instantaneous needs of electricity consumers. PF technology is not ideally suited to the smaller scale to these new objectives.

For this reason there have been many technical innovations directed towards the development of coal based plant more suited to electricity generation on the smaller scale.

One successful innovation is based on the circulating bed. There are several variants which have been commercially established up to the 100 MW(e) scale. The technology has been found to have good performance in respect of thermal efficiency and environmental control. Some plants are dedicated to power generation, others are combined heat and power units. Circulating bed technology lends itself to shop-fabrication and hence has the potential for reduced capital cost and for short construction times. Plant is flexible in fuel properties and also has good response characteristics so that it can readily follow demand. At the 100–200 MW scale, circulating bed plant produces cheaper electricity than a pf station.

Plans are being drawn up by a number of commercial companies for larger plant based on this technology. Because of its flexibility to fuel properties it would have particular merit in Britain at sites where coals of a wide range of properties are available.

Conventional power plant

Conventional power stations based on the steam cycle operate with efficiencies of less than 40 per cent and technological constraints limit the possibility of worthwhile improvements. However the steam cycle can be combined with a gas turbine, operating at higher temperatures, to generate electricity at a substantially higher efficiency. In this way the efficiency can be increased in principle up to some 50 per cent. Further efficiency increases can be foreseen as gas turbine technology is developed.

One way in which the advantages of combined cycle operation may be obtained is by using a fluidised combustor under pressure to drive a gas turbine, which can be combined in various ways with a conventional steam cycle.

PFBC has been developed in the UK at the facility of Grimethorpe which was supported in its early days by the UK, US and German Governments, and later in collaboration between British Coal and the CEBG.

In a commercial plant based on the combustion system investigated at Grimethorpe, the gas turbine is driven by the off-gas from the combustor and the gas turbine cycle is integrated with the steam cycle for which the main heat input is the fluidised bed itself (Figure 6). The temperature of the gas supplied to the turbine depends on the operating temperature of the fluidised bed

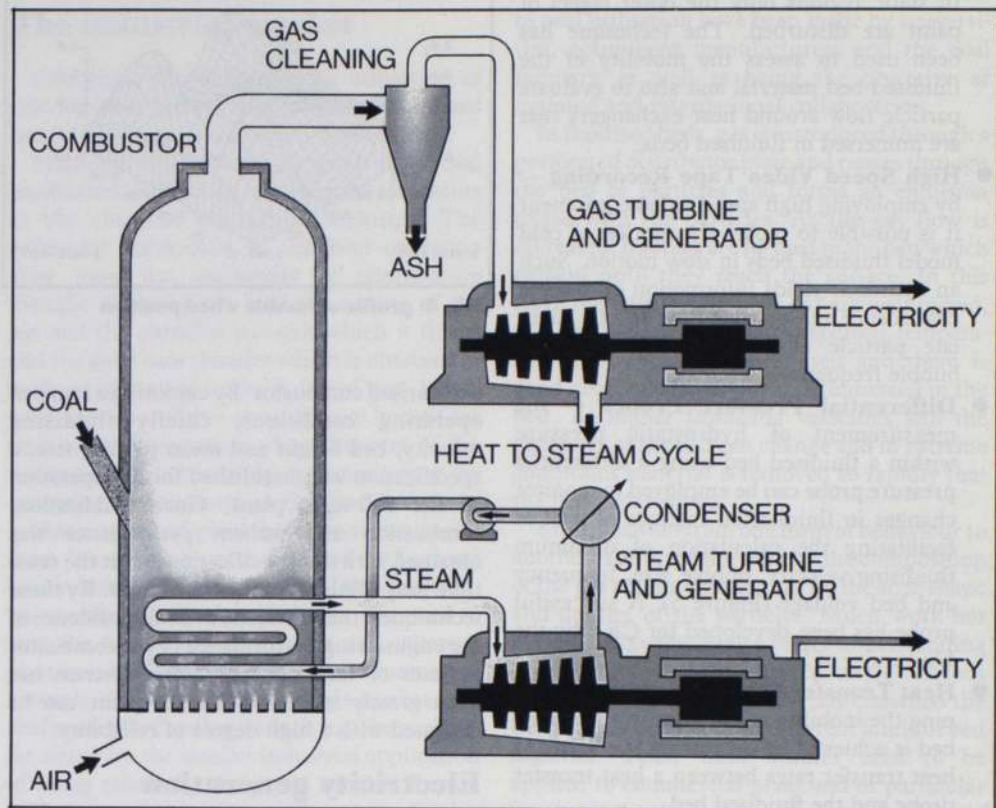


Fig. 6: PFBC system for power generation using a combined cycle

rather than on the system conditions. With typical bed temperatures in a PFBC system the overall efficiency of the system is increased. For small-scale plant of about 400 MW(e) PFBC has an advantage over conventional pf in terms of efficiency — 40.3 per cent for PFBC, 37.5 per cent for conventional plant — it is cheaper by some 10–15 per cent and electricity generation is therefore some 10 per cent cheaper. In addition to the success in demonstrating the long life of components (referred to above), Grimethorpe has had considerable success in demonstrating the merits of feeding the coal in the form of coal water slurry, and in the successful cleaning of hot gases with ceramic filters in collaboration with the US/DOE and EPRI. The operation of the Grimethorpe plant has confirmed the expected merits of the combustion system. It has also demonstrated that oxides of sulphur can be suppressed by the addition of limestone and that the system by its nature produces low levels of nitrogen oxides.

Pressurised fluidised combustion is well suited to fulfil the needs for power generating plant on the intermediate scale. It has economic advantages over alternative systems whilst completely satisfying environmental requirements.

The efficiency advantages of pressurised fluidised combustion can be further improved by increasing the operating temperature of the gas turbine by burning gas in the combustor outlet. In such a topping cycle the fuel gas can be produced from coal in a separate gasification stage. The gasification process can be combined with a combustion process in such a way that the gas turbine inlet temperature can be raised and overall efficiencies increased.

In the most promising of the cycles studied by British Coal the topping gas is produced in

a pressurised fluidised bed, blown by air. Part of the coal is gasified and the remainder is fed to a suitable combustor — either a pressurised fluid bed, or a circulating steam-raising bed. The design of the fluidised gasifier is based upon operation of the CRE spouting bed, which has been demonstrated to be flexible in respect of coal type (Figure 7). It operates at a temperature high enough to avoid excessive tar production, but not high enough to promote objectionable levels of alkali in the turbine input. Hot gas clean-up systems can therefore be used, to the advantage of the overall conversion efficiency. In-bed sulphur retention can be incorporated to the gasifier and combustor, thus saving the cost of a separate gas washing stage.

In this arrangement of gasifier and combustor, 60–80 per cent of the coal is gasified with air (thus avoiding the high cost of oxygen plant) and the char is passed to the combustor. The fuel gas at 1000°C is cleaned and then burned in the combustor gases to raise their temperature to a turbine inlet of 1260°C. Steam raising, superheating and reheating are achieved from the combustor and from the turbine exhaust.

This topping cycle is based on British Coal expertise in fluidised bed combustion, at atmospheric pressure and at high pressure, and on the CRE industrial fuel gas process. A programme is actively under way to take the concept further in perfecting fully integrated operation to prove the advantages of the process for small-scale electricity production.

In the context of the present concern about the production of carbon dioxide from the combustion of coal, advanced cycles, with their increased efficiency are of particular relevance. An increase of efficiency from 37.5 per cent of conventional plan to 45 per cent for a topping



cycle would reduce CO₂ emission by 17 per cent and with no cost penalty.

Further advantages arise when advanced cycles are used for the combined production of heat and power, because they can be operated to produce higher proportions of power than conventional cycles. For a given heat requirement, an advanced cycle produces more electricity, which has a high value, and thereby improves the overall economics.

Financing innovation

The use of coal is important in the economies of many countries. Indeed, the future development of the economies of some countries is almost entirely dependent on the use of coal. This widespread dependence on coal is reflected in the international interest in the promotion of innovation in its various forms. Improvements in technology rapidly spread throughout the world sometimes by licensing arrangements and sometimes by parallel or co-operative developments. Interchange of technology is promoted between coal producing countries by means of bilateral agreements which promote the rapid dissemination of information. Innovation is funded in very different ways in different countries, and as a result different roles are played by coal producers, consumers, manufacturers of equipment and the governments themselves. All these collaborate with each other to an extent which depends on national policy and the corporate policies of the different industries involved.

The objectives of governments are usually concerned with factors such as the strategic supply of energy, support for indigenous fuels, support for national industries, safeguarding the environment and maintaining safety standards. The relative importance assigned to these goals in different countries results in very different levels of government expenditure.

In Britain the position has been complicated by the peculiar status of the nationalised coal industry. It has not been considered appropriate to include sizeable provision for coal research in government R&D budgets. Where research on national objectives has been undertaken it has been included in the expenditure by British Coal and not treated separately as is more usually the case elsewhere.

For this reason the expenditure in Britain on coal research has lagged behind that in other major developing countries, but because the national expenditure has largely been controlled by British Coal the expertise has been generated centrally, which results in British Coal being in a special position as a coal producer with expert knowledge on the utilisation of its coal. British Coal is therefore in the position of an informed seller, and its customers benefit from the expertise available to British Coal over the whole range of coal utilisation.

British Coal has always recognised the need to support an element of long term research. For coal producers it is important to establish confidence about the long-term future in the

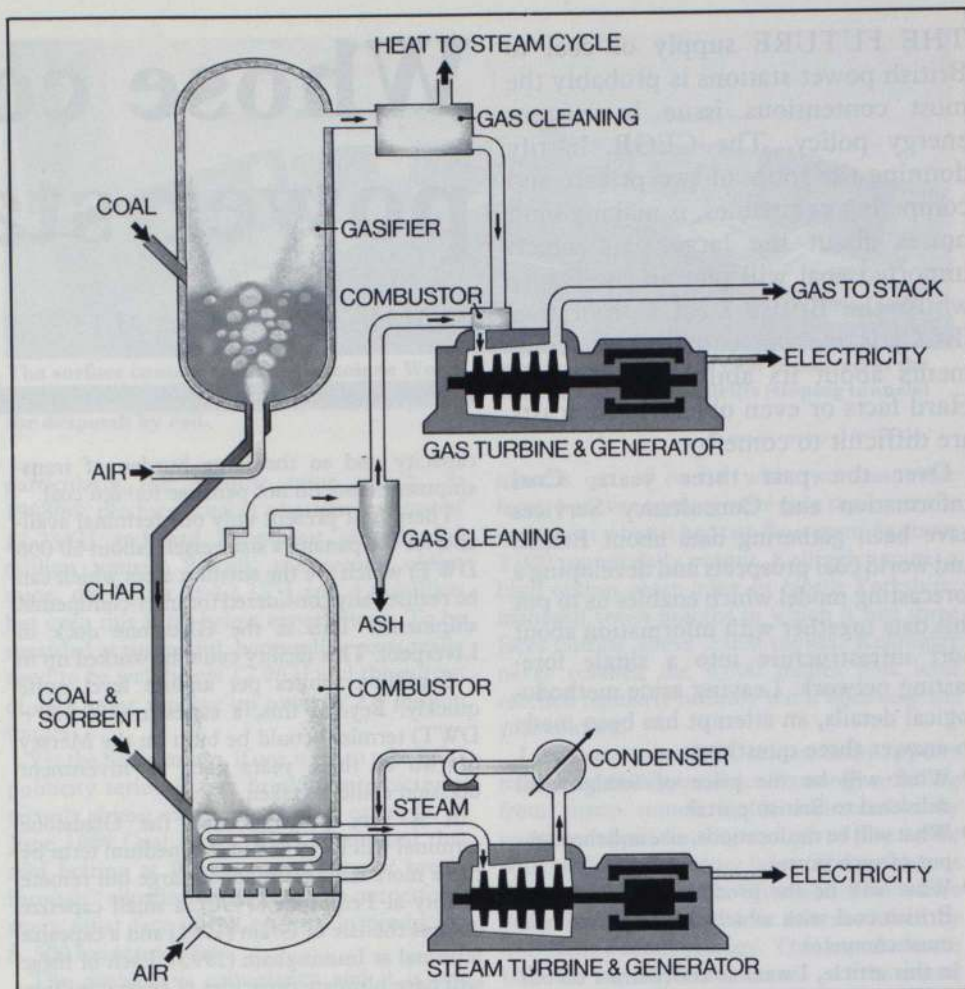


Fig. 7: topping cycle for electricity generation with the CRE-designed spouting bed type of fluidised gasifier

industry. In turn this increases the confidence of coal users in the long-term stability of coal supplies. However, in the present economic climate it is becoming increasingly difficult to fund such research, as benefits will not be seen by present customers. In other countries such work is sponsored by governments as part of the strategic programme and as an insurance policy as general support in order to create business opportunities in the future for manufacturing industry.

Sir George Porter, the President of the Royal Society, gave a lecture in the Institution in April last year in which he pleaded for increased resources for basic research of the type carried out in universities. In his view it was the job of universities to pursue knowledge for its own sake, but not their job to carry out the development of technology for industry.

While one might dispute with Sir George the nature of the relationship between universities and industry, his basic thesis is indisputable; that without basic science there would be no applied science to be used in the development of technology. But it is also true that adequate resources need to be made available for applied science or there would be no innovation and no new technology to develop. Resources, therefore, need to continue to be made available for what is becoming known as strategic research, by which is meant research directed to the market or to commercial opportunities, in addition to resources for the development of existing technologies.

As in the coal industry, the gas and electricity industries in the UK have benefitted from having strong central research organisations. In other countries, some of which spend far more government resources on energy research, expertise is not centralised, but is diffused among contractors and numerous non-specialist laboratories. The full benefits of the expertise are not so easily applied in such a diffuse and resource intensive system. It is unlikely that such a policy could ever be afforded in the UK. It would therefore not be appropriate in the UK for the privatisation of the energy industries to lead to the dispersal of their scientific and technical expertise; means should be sought to build on that expertise to resource it adequately, to ensure that technology continues to advance and the results are transferred effectively to industry.

As British Coal's primary objective is to operate on a break-even basis R&D resources have increasingly to be confined to short-term objectives. Alternative means will have to be found to support long-term, strategic research on the utilisation of coal. The Government has an immediate opportunity to develop advanced electricity systems based on the pioneering work of British Coal. BCURA was founded to promote the efficient use of coal on a national basis and was supported by independent coal producers, by manufacturers of equipment and by the Government. It may well be worth considering BCURA as a model of research collaboration in the future. □



THE FUTURE supply of coal to British power stations is probably the most contentious issue in current energy policy. The CEBG, hastily donning the robes of two private and competing companies, is making loud noises about the large part which imported coal will play in the future whilst the British Coal Corporation (BCC) is making equally bold comments about its ability to compete. Hard facts or even objective forecasts are difficult to come by.

Over the past three years, Coal Information and Consultancy Services have been gathering data about British and world coal prospects and developing a forecasting model which enables us to put this data together with information about port infrastructure into a single forecasting network. Leaving aside methodological details, an attempt has been made to answer three questions:

- What will be the price of foreign coal delivered to British ports?
- What will be the locations, size and throughput of such ports?
- What will be the production costs of the British coal with which this imported coal must compete?

In this article, I want to concentrate on our answers to the last question but, initially I will summarise our results to the first two.

Port capacity

We have studied both existing and possible coal import infrastructure throughout England and Wales. (Scottish ports are too remote to compete in England except at the biggest ship sizes and only the existing Hunterston port falls into this category.) Our conclusions are that whilst there is a large amount of capacity available for transshipment from ARA ports in vessels up to 25 000 DWT, this is unlikely to be competitive in British power stations apart from the Thames coastal plants. These plants are remote from any significant domestic

Whose coal in the power stations?

by Michael Prior, MSc, MA*

capacity and so the large burden of transshipment costs do not penalise foreign coal.

There is at present only one terminal available for the panamax size vessels (about 60 000 DWT) which are the smallest sizes which can be realistically considered for inter-continental shipments. This is the Gladstone dock in Liverpool. This facility could be worked up to a 5 million tonnes per annum level quite quickly. Beyond this, a capesize (120 000+ DWT) terminal could be built on the Mersey in two or three years once an investment decision could be taken.

It is very probable that the Gladstone terminal will be joined in the medium term by three more large terminals; a large but remote facility at Pembroke (1990), a small capesize dock at the Isle of Grain (1991) and a capesize terminal at Immingham (1993). Each of these will have ultimate capacities of several million tonnes.

In addition to these, it is possible that by 1992, there could be a capesize terminal on Teesside and a further Humberside facility of panamax size. Both these are in the balance with respect to investment decisions and planning approval.

Finally, a panamax facility at Bristol and Tilbury and a capesize terminal at Southampton could be set up quite quickly if an investment decision were to be taken. All three are under some level of scrutiny but have not come close, yet, to a decision stage.

So by 1993, there will almost certainly be 15–20 million tonnes of large import capacity in place, possibly, a further 10 million tonnes

and, if everything were put into action, another 10 million tonnes plus.

This is, in crude terms, a serious challenge to the domestic coal industry. But, and it is a large but, only part of this capacity will be well-placed to serve CEBG stations. The Humber and Mersey ports will be within a few tens of kilometres of large coal-fired units, distances comparable with the transport hauls from local mines. The Isle of Grain will be well-placed to serve as a transshipment point for the Thames stations but for little else. The other possible locations on the Avon and Tees and at Pembroke and Southampton are all more-or-less remote from large stations. Our work shows that they hover on the very edge of competitiveness with UK coal. The key threat comes from the Mersey and the Humber.

Import prices

Forecasting future prices of imported coal requires a large amount of detailed analysis which I will not even attempt to summarise here. Our final conclusions are that it will be possible up to 1995 to import coal at prices between £1.10 and £1.35/GJ on the dock.

One of the major complicating factors in making these estimates is exchange rate uncertainty and, with the recent drop in the sterling/dollar rate down to nearly 1.5, there have been almost audible sighs of relief from Hobart House. One cautionary note should be introduced however, apart from the obvious one that what goes down may also go up. The UK coal market is the most tempting prize up for grabs in the international market. Coal producers, particularly in South Africa, are aware that once UK domestic capacity is closed it has gone for ever given the high cost of new mines in Britain. It is likely that they will not let an exchange rate fluctuation or two rob them of an extra few million tonnes of long-term sales.

It is currently the common wisdom that steam coal is in short supply and international prices are rising rapidly. All true. And yet, it would still be a surprise, to me at least, if those nice men from Sydney and Johannesburg were unable to find an extra million or so tonnes at an attractive price for their old friends from the CEBG. Spiders know all about making attractive webs.

The author

Michael Prior is an economic consultant who has worked on various aspects for the coal industry since 1977. He is now a director of Coal Information and Consultancy Services of London, but will be moving to Ethiopia in the near future to undertake an overseas contract as an energy adviser.

He is the co-author, with Gerard McCloskey, of a recent FTBI report *Coal on the Market, can British Coal survive privatisation?* This has stimulated discussion and prompted the organisation of the one-day seminar, *British*

Coal privatisation — fission or fusion, organised jointly by the Institute of Energy and Financial Times Business Information, which will be held on 12 September this year at The Conference Forum, Aldgate, London.

He is also the author of a number of authoritative economic appraisals on aspects of the coal industry, including *The British Opencast Coal Industry* and *Whose Coal in the Power Stations?* (available from Coal Information and Consultancy Services, 17 Mountgrove Road, London N5 2LU).

*Director, Coal Information and Consultancy Services



British coal costs

The heart of the matter is summarised in Figure 1. This shows the production cost curve for UK deep mine production in 1988/89 superimposed upon the likely cost of imported coal in the early 90s. (Only mines still in production in March 1989 are included so total output is only 81 million tonnes.) Two cost curves are shown, with and without a capital charge included as well as the depreciation included in operating costs. Broadly speaking, BCC would like to sell at above the top curve but would be willing to sell down to the bottom curve.

The message of Figure 1 is stark for although domestic production could expect one or two pounds a tonne further protection against imports because of its shorter inland transport distances, such differences are not significant for the key Mersey and Humber ports. Basically, BCC must move down its production costs so that the bulk lies at least between the two lines of upper and lower import prices. There are two aspects to this; how much of a contribution will the new mines make and how much lower can the cost of existing mines move?

The new mines

BCC has two major projects which are now coming to completion; the huge Selby complex in Yorkshire and the Asfordby mine in NE Leicestershire.

The first mine in the Selby complex — Wistow — is in its fourth year of production and must be thought of as a mature mine whilst the final mine — North Selby — should start coaling in 1991.

Selby is a paradox. On the one hand, it is the most modern mine in Britain planned to utilise fully high-productivity equipment and with coal clearance and storage systems able to cope with very high outputs. On the other hand, its current performance is very disappointing,



The surface control room at Gascoigne Wood, Yorkshire, where all the coal produced at the £1,050 million Selby mining complex is conveyed to the surface up twin drifts (sloping tunnels) for despatch by rail.

Picture by courtesy of British Coal

particularly the Wistow mine which, in 1988/89, produced coal at a bottom line cost of £2.73/GJ and had an output of only 1.1 million tonnes. Riccall, the second oldest mine, did better at £2.3/GJ and 1.6 million but even this is far below expectations. To be regarded as successful, bottom line costs really need to be well below £2.0/GJ and the output of each mine moving up towards 2.5 million tonnes.

Yet the Selby mines, if one were to take BCC publicity seriously, are breaking productivity records almost every month. For example, in June 1989 Coal News, BBC announced that roof bolting at Wistow was a "major breakthrough" allowing the H37 face to outperform every other face in the country in producing 8 500 tonnes per day.

The problem is consistency and it is one which in essence applies to much of BCC's emphasis on the use of high-output high-cost face equipment as the main route to low costs. Wistow faces do indeed work well — when they work. But in 1988/89, there were only five months when the mine had two faces operating at above 1 000 tonnes daily output whilst there were five months when only one face was operational.

Riccall was more successful, managing eight

months out of twelve with two reasonable faces, but even so there were only three months in the year when it had two faces running above 3 000 tonnes daily output. Kellingley mine, a high output older mine in North Yorkshire, managed seven months in which it had three faces cutting above 2 000 tonnes. Kellingley never reached the 6 000 tonnes plus level reached regularly in Selby but it does keep the coal coming.

Like many other BCC mines, Selby appears to have a difficult small-scale geology suffering from many minor faults undetectable by seismic analysis but big enough to play havoc with modern heavy-duty faces. The problem is the greater at present in Wistow, but the whole Selby coalfield seems to be overshadowed by uncertainty about geology. The Area Assistant Director recently commented... "the minor faulting has been far worse than anyone could have anticipated and this has caused difficult conditions... That's why at North Selby we have got headings going in all directions to give us more information." It has also been announced that full production at Whitmoor has been delayed in order to prove the geology.

The implications for BCC of any large shortfall at Selby are extremely serious. We have assumed in our work that Selby will be working at least down to £1.0/GJ operating costs in the early 90s. This is less optimistic than previous estimates where it was hoped that costs might go well below £1/GJ. But at £1.0/GJ, Selby can protect the Yorkshire power stations from import penetration. But if its operating costs went above, say, £1.2/GJ — and this level has not yet been approached with any consistency — then the situation could shift rapidly with coal imports coming from as far away as Teesside.

The second new mine, Asfordby, is much less problematic. Data released by the Monopolies Commission in its recent report on BCC show it to be a total turkey which should never have been started. It will produce dreadful coal which may prove unsaleable except at a big discount and its operating costs will be, at best, little better than average. The politics of Asfordby are only partially revealed but clearly they play a much bigger role in its continuation than any economic or financial appraisal.

What both Selby and Asfordby show is that new deep mines in the UK are now too expensive to allow any reasonable financial return. At the Hawkhurst Moor Inquiry, in a desperate attempt to defend its economics, BCC claimed that its operating costs would be

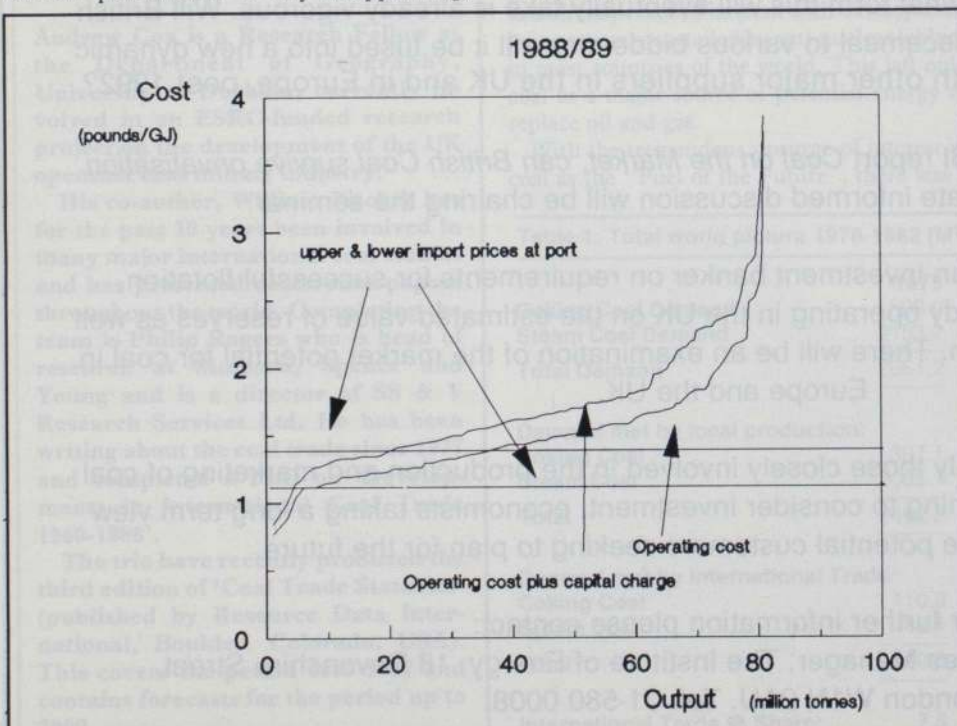


Fig. 1: Production costs curve for UK mines.



below £0.5/GJ and thus allow its large capital charges to be accommodated. In the light of Selby and Asfordby, such statements can be viewed either with stunned incredulity or hollow laughter depending on how one reacts to such massive potential waste of public money.

Existing mines

The defence of the UK coal industry thus rests squarely upon the ability of existing mines to reduce their costs. The magnitude of the task can be seen in Figure 1. Briefly summarised it reduces to this; the current average operating cost in the central coal fields is £1.52/GJ¹. This has to come down by at least £0.2 or about 13 per cent if any substantial resistance is to be made to imports. Even at this level, significant penetration would be possible in major stations in Lancashire and the Trent Valley.

Is such a reduction possible? The answer to this has to be "Yes, possibly". It has to be acknowledged that it is asking a lot of a mature extractive industry to achieve cost reductions even of 3-4 per cent pa over any extended period. Yet, in the past four years, BCC mines have, roughly, achieved such decreases. What remains unclear is the main driving force behind these decreases and whether it has the capacity to continue.

BCC management is strongly enamoured of the technical solution: triumph by heavy-duty

faces and retreat mining. The problem with this approach is that there is very little evidence that major cost reductions are being achieved by investment in heavy-duty equipment. Take an extreme case for illustration. Up to 1987/88, Bilston Glen and Longannet received £13.3 million investment in heavy duty equipment whilst the entire North East area received only £5.4 million. The North East produces coal at £1.42/GJ and the remnants of Scotland produces at 2.39/GJ². This is, of course, an extreme case but detailed pit-by-pit analysis fails to show any relation between pits with heavy duty equipment and lower operating costs. In 1988/89, Goldthorpe was by far the cheapest producer in the country at below 1.8/GJ. It operates two faces without heavy-duty equipment.

Cost reductions — the key

The key to the past reduction in costs by BCC mines has not been any particular technology but a systematic reduction in labour at all mines irrespective of their investment. Far from the lower-cost mines being the leaders in this process, the evidence is that they have not reduced their costs by the same amount as middle-rank producers. The result has been a general flattening of the production cost curve but no clear drop in costs at its cheaper end. The £1.0/GJ cost level remains a barrier which no mine appears able to cross with any consistency.

Labour reduction not based on any major technological shifts is a process which cannot be continued indefinitely. The worry for BCC mines is that they have gone nearly as far as they are likely to by simply squeezing employment and altering manning levels and that the technical fixes such as heavy-duty faces are not delivering the goods.

Basically, the problem is the same as at Selby — consistency. Whether further development will allow heavy-duty faces to show their full potential over long production periods or whether, as some believe, uncertain geology will always limit such consistency remains to be seen.

At the moment what can be said is that several million tonnes of imports will certainly come in. The infrastructure is there and the power companies have signalled their intentions so prominently that they will have to deliver something. Penetration of imports will become steadily more difficult above a level of about 15-20 million tonnes but it could move upward to top 30 million unless BCC costs move down quite fast. Above these levels, we begin to talk in terms of total collapse of BCC mines and that would be premature. But if the writing is not yet on the wall then certainly the chalk is poised. □

¹ Figures for April, 1989 excluding Scotland, Wales, Kent and the North East.

² April, 1989 figures.

THE INSTITUTE OF ENERGY

a seminar

'BRITISH COAL PRIVATISATION — FISSION OR FUSION'

12 September 1989, The Conference Forum, Aldgate, London

The Government have said that their plans to privatise British Coal will be reserved for their next term of office but debate as to what form this will eventually take is already vigorous. Will British Coal be fragmented and sold piecemeal to various bidders or will it be fused into a new dynamic plc, capable of competing with other major suppliers in the UK and in Europe, post 1992?

Gerard McCloskey, whose FTBI report *Coal on the Market*, can British Coal survive privatisation did much to stimulate informed discussion will be chairing the seminar.

Other speakers will include an investment banker on requirements for successful flotation, private mining companies already operating in the UK on the estimated value of reserves as well as views on worker participation. There will be an examination of the market potential for coal in Europe and the UK.

The seminar will interest not only those closely involved in the production and marketing of coal but to financial institutions wishing to consider investment, economists taking a long term view and of course those potential customers seeking to plan for the future.

For further information please contact:

Judith Higgins, Conferences Manager, The Institute of Energy, 18 Devonshire Street, London W1N 2AU. Tel: 01-580 0008.



The international coal trade — past, present and future

by Andrew W Cox BSc, MSc, PhD, William H Fischer BA, FInstE,
and Philip G Rogers BSc, PhD, MCIT, FICS

NOT LONG AGO it was widely forecast that the days of the coal industry, or "Old King Coal" as it was referred to, were numbered. By the 1950s it was being squeezed out of its biggest markets by its expanding competitor, oil. The new fuel was cheaper and was seen as being more convenient and cheaper to use. At that time oil also lacked the political problems associated with a notoriously militant labour force. Nuclear power also entered the electricity sector and natural gas began to invade the heating markets.

During the 1960s some of the world's major coal industries went into a rapid downward slide. Between 1961 and 1971, some 400 collieries were closed in Britain with 300,000 miners finding alternative employment. In the developed countries the decline of coal was regarded as irreversible.

The authors

Andrew Cox is a Research Fellow at the Department of Geography, University of Durham, currently involved in an ESRC-funded research project on the development of the UK opencast coal mining industry.

His co-author, William Fischer has for the past 10 years been involved in many major international coal studies and has presented conference papers throughout the world. Completing the team is Philip Rogers who is head of research at Simpson, Spence and Young and is a director of SS & Y Research Services Ltd. He has been writing about the coal trade since 1977 and completed a PhD on 'Developments in International Coal Trade 1960-1986'.

The trio have recently produced the third edition of 'Coal Trade Statistics' (published by Resource Data International, Boulder, Colorado, USA). This covers the period 1983-1987 and contains forecasts for the period up to 2000.

During recent years the world has seen the emergence of an international seaborne trade in steam coal, alongside that already established in the more specialised coking coals for the steel industry. This article examines the recent development of world coal demand and international coal trade and also presents a forecast for the period to 2000.

Then came the dramas and traumas of the 1970s and the oil-price explosions which rocked the world.

The oil crisis of 1973 and the subsequent actions of OPEC had three major effects on the world energy scene:

- Supplies of oil and gas were no longer allowed to follow the laws of supply and demand — quantities released to the world market were arbitrarily controlled by OPEC countries.
- The prices of oil and gas were suddenly increased by three- and four-fold — to impose great financial strains on the world economies.
- The continued flow of oil supplies could no longer be guaranteed — free of political or nationalistic interference.

This situation forced the industrialised nations of the world to turn to other major sources of energy. Interest in nuclear power had already reached its peak with development being severely curtailed by anti-nuclear lobbies in most countries of the world. This left only coal as a major source of potential energy to replace oil and gas.

With the tremendous upsurge of interest in coal as the "Fuel of the Future", there was a

proliferation of conferences, seminars, multi-client studies, long term forecasts, etc., during the past few years. Billions of pounds were poured into new mining ventures, often by international oil companies, dismayed by the sudden loss of their lucrative power station fuel oil sales.

Further major investment also took place in port facilities, railways and other infrastructure as a large expansion was expected in the volume of coal traded internationally, both overland and seaborne.

In the period since 1973 the coal industries have experienced some setbacks as well as successes. The forecasts used for many of the new mining investments often proved to be wildly optimistic. They failed to predict the depth and duration of the economic recession which followed the second oil shock of 1979 and its depressing effect on electricity and energy demand.

The major steam coal estimates published at the end of the 1970s forecast that total world steam coal demand would increase at 3.0 to 3.5 per cent per annum from the base year (1977) of 2.2 billion tonnes to 3.3 billion by 1990 and 4.4 billion by the year 2000.

Global steam coal demand actually increased

Table 1: Total world picture 1978-1982 (MTCE)

	1978	1979	1980	1981	1982
Coking Coal Demand	508.0	529.6	526.3	518.0	501.9
Steam Coal Demand	2153.2	2280.6	2342.3	2373.7	2440.2
Total Demand	2661.2	2810.2	2868.6	2891.7	2942.1
Demand met by local production:					
Coking Coal	397.1	403.3	391.8	379.4	360.0
Steam Coal	2065.1	2178.0	2222.5	2245.7	2309.7
Total	2462.2	2581.3	2614.3	2625.1	2669.7
Demand met by International Trade:					
Coking Coal	110.9	126.3	134.5	138.6	141.9
Steam Coal	88.1	102.6	119.8	128.0	130.5
Total	199.0	228.9	254.3	266.6	272.4
International Trade % Share:	7.5	8.1	8.9	9.2	9.2



to 2.9 million tonnes by 1987 and it is now thought unlikely that demand will exceed 3750 million tonnes by 2000.

A summary of world coal demand and trade for the period 1978 to 1982 is shown in Table 1(1).

During the period 1978 to 1982 total coal demand increased by some 280 million tonnes an increase of over 9.6 per cent or 1.93 per cent/annum. However, most of the increase took place in the first two years, namely 1979 and 1980. The figures also show that while steam coal demand increased, coking coal demand fell back.

In the second half of the 1980s coal producers were knocked by plummeting oil prices. Many new mines were unable to repay the cost of their capital charges and increasingly, coal producers have found themselves competing with each other.

More recently, the industry has been aware of growing public and political sensitivity about the effect of fossil-fuel burning on the planet and the atmosphere.

It was recently observed, however, that the momentum created in the 1970s is still strong (2). This is shown by the scale of new investments, their widespread distribution, the sharpening competition between producers (old and new), the drive for more efficient mining methods and technologies, as well as advances in ways of transporting and burning coal.

Coal trade — key issues

When considering international trade in coal, it is important to remember a number of salient facts:

- Internationally traded coal comprises only 10 per cent of total world demand.
- International trade in coking coal shows a quite different pattern to that of steam coal.
- International trade itself is split into two categories: overland and seaborne.

These points are demonstrated in Tables 2 and 3.

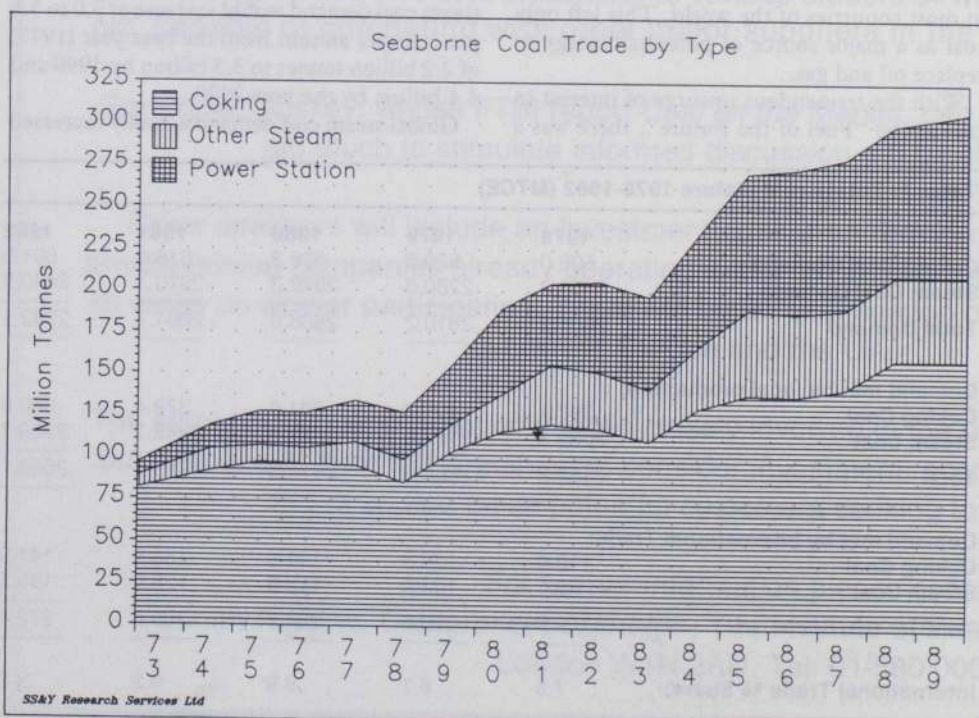
Table 2: Total world picture 1983-1987

	1983	1984	1985	1986	1987
Coking Coal Demand (tonnes)	484.8	516.8	529.9	523.5	537.2
Steam Coal Demand (tonnes)	2478.7	2626.7	2746.6	2813.9	2904.7
Total Demand	2973.5	3143.5	3276.5	3337.4	3441.9
Demand met by local production:					
Coking Coal (tonnes)	355.3	357.3	362.4	357.5	366.3
Steam Coal (tonnes)	2324.5	2435.3	2558.2	2625.5	2704.9
Total	2679.8	2792.6	2920.6	2983.0	3071.2
Demand met by international trade:					
Coking Coal (tonnes)	139.5	159.5	167.5	166.0	170.9
Steam Coal (tonnes)	127.2	147.9	171.9	173.5	172.2
Total	266.7	307.4	339.4	339.5	343.1
Demand met by withdrawal from stocks:					
Steam Coal	27.0	43.5	16.5	14.9	27.6
International Trade % Share:	9.0%	9.4%	10.3%	10.2%	10.0%

NOTE: All tonnes are metric — not short tons. All coal has been converted to a hard coal equivalent of 6000-7000 kcal/kg or 25.13 to 29.31 MJ/kg (on an dry ash free basis).

Table 3: Total world picture (MTCE)

	1983	1984	1985	1986	1987
Overland Movements:					
Coking Coal	23.7	24.2	23.6	22.2	22.0
Steam Coal	38.7	42.0	39.0	40.6	38.7
Total	62.4	66.2	62.6	62.8	60.7
Seaborne Trade:					
Coking Coal	115.8	135.3	143.9	143.8	148.9
Steam Coal	88.5	105.9	132.9	132.9	133.5
Total	204.3	241.2	276.8	276.7	282.4
Percentage of International Trade:					
Overland	23.4	21.5	18.4	18.5	17.7
Seaborne	76.6	78.5	81.6	81.5	82.3



Over the five year period total demand increased by some 470 million tonnes, an increase of 15.8 per cent overall or 3.6 per cent/annum. This overall increase was almost twice that of the rate of increase (1.85 per cent/annum) reflected for the period 1978 to 1983.

Within the total picture, coking coal rose from its 'low' of 495 million tonnes in 1983 — the first time it had fallen below 500 million tonnes annually since the mid 1960s — by 4 per cent in 1984 but then levelled out and rose only a further 4 per cent in the next three years.

It is interesting to note that of the total demand shown in Table 1 some 90-91 per cent was supplied by local (indigenous) production and that only 9-10 per cent was met by international trade. Furthermore within the 9-10 per cent share held by international trade, a fair proportion is concentrated by overland movements as shown in the following table showing the breakdown of international trade.

The overland trade percentage share continues to decline as West German exports of coking coal to European countries are

replaced by Australian and US coking coal and as the absolute tonnage of international trade increases, all in the shape of seaborne movements.

Seaborne trade now accounts for some 82 per cent of international trade and within that 82 per cent share there has been a marked swing between coking and steam coal in the last two decades. In the early 1970s coking coal movements constituted some 75 per cent of all seaborne movements but this share has fallen steadily until it is now 55.0 per cent.

Seaborne traded coal is transported in large bulk carriers, which are typically 40 000 dead weight tonnes (dwt). Larger carriers used in the trade are the Panamax-sized vessels 50-70 000 dwt and Cape-sized vessels 110-130 000 dwt. The largest ever coal cargo was 200 000 dwt.

International Trade Patterns

Coking coal

The international trade patterns for coking coal can be highlighted under a number of distinctive headings:

(1) In the period 1978 to 1982 only some 22-28 per cent of total coking coal demand was met by international trade. In the period now under review this percentage has increased to 31.8 as Table 4 demonstrates.

There are two factors which help to explain this development:

- The decline in production in the well established steel communities in the EC which has led to increased imports to meet demand.
- The main growth areas have been the Pacific Rim countries which have no significant local production.

The main exporting countries during the five-year period are shown in Table 5.

(2) Of the total volume of international movements, the proportion supplied by



The modern, automatic coal conveying and loading systems are reflected in this picture of loading operations at British Coal's Immingham Bulk Terminal at South Killingholme, Humberside.

Picture by courtesy of British Coal

overland trade has continued to decline over the years until it is now only some 13-14 per cent of the total. The reasons for this are threefold:

- The inability of West German production to compete with Australian and US coal in terms of cost in the European market.
- The static nature of the captive market, ie Comecon, supplied by Poland and USSR.
- The fact that the burgeoning markets for coking are those markets such as Japan, South Korea, Brazil and Turkey that rely on imports for their additional requirements.

(3) Seaborne trade during the period 1983 to 1987 was dominated by Australia and the USA. Between them they have supplied some two-thirds of the coking coal moved by sea with Canada contributing some 12 per cent and Poland a further 6 per cent.

(4) The import scene during this period was again dominated by Japan with approximately 40 per cent of the total seaborne movements. Brazil, Italy and South Korea took some 5 per cent.

Steam coal

The point has already been made what a small part of the total world coal demand is met by international trade. The applies to the steam coal market — shown in Table 6.

Moreover, overland trade accounts for a substantial part of the steam coal movement. The main overland movements are:

- USA supplies to Canada
- Poland supplies to USSR/other Comecon
- USSR supplies to other Comecon
- West Germany supplies to other EC

In 1983/84 these movements accounted for 30 per cent of the export trade but this share fell to 25 per cent thereafter. Seaborne trade is made up mainly of exports from Australia, Poland, South Africa and the USA to the main consuming areas of EC and Pacific Rim countries. A country by country breakdown of the EC imports is shown in Table 7.

Imports to the Pacific Rim countries are as shown in Table 8.

From Table 8 it can be seen how rapidly imports to the Pacific region have grown since 1983. The main suppliers to the Pacific Rim are as in Table 9.

With its great geographical advantage, Australia has held a very large share of the Pacific Rim steam coal market.

The future

What about the future? What are the likely forecasts for international trade?

Table 4: International trade in coking coal vs local production

	1983	1984	1985	1986	1987
Met by local production (MTCE)	355.3	357.3	362.4	357.5	366.3
Met by International Trade	139.5	159.5	167.5	166.0	170.9
Total Demand	494.8	516.8	529.9	523.5	537.2
International Trade (%)	28.1	30.8	31.6	31.7	31.8

Table 5: Tonnages exported by main exporting countries (1983-87)

	1983	1984	1985	1986	1987
Overland Trade					
Czechoslovakia	1.7	1.5	1.9	1.6	1.1
W. Germany	5.3	4.7	3.2	2.3	2.1
Poland	1.6	2.2	2.1	2.3	2.4
USSR	8.8	8.6	9.7	9.8	10.0
USA	6.3	7.0	6.4	5.8	5.8
Seaborne Trade					
Australia	42.1	47.0	49.8	48.9	54.8
Canada	21.1	22.2	21.1	21.7	
China	2.3	2.4	2.5	2.7	3.7
W. Germany	2.4	2.1	1.6	1.8	1.3
Poland	8.4	8.7	8.6	9.3	8.8
South Africa	3.3	4.9	5.3	6.2	5.3
USSR	2.3	2.7	4.1	6.4	7.3
USA	39.0	44.7	48.3	44.0	41.3



For hard coal in general many questions remain to be answered — the environment, pollution, oil and gas prices, changing technologies, even new fuels (orimulsion).

The authors believe that growth is assured for the next ten years but we do not support a continuation of the rate of expansion seen over the last decade. An intriguing question can be put: will the coal trade reach its peak in the late 1990s?

Looking ahead to 2000 a number of decisions have to be made:

(1) Is world economic growth going to continue, will it stagnate or will it go into decline? We have assumed that over the 10 year period, growth will increase at a rate of 1.5 to 2.0 per cent/annum, although within that modest progression there will be peaks and troughs.

(2) At what rate will the demand for energy grow? Allowing for energy efficiency improvements, energy conservation measures and general environmental concerns, it is assumed that energy demand will grow at the rate of 1.0 to 1.5 per cent per annum.

Working from the above assumptions, we have produced the forecasts shown in Table 10 for coking and steam coal:

International Trade Patterns

Coking Coal — it seems fairly certain that the international trade patterns will, for the next ten years, follow much the same lines as in recent years with overland trade remaining static in absolute terms but constituting a smaller percentage of total movements. Seaborne trade is likely to grow at a healthy rate, particularly to meet demand in the Pacific Rim and EC 12.

Australia, because of its geographical and special commercial links, will continue to supply the largest share of the Pacific Rim imports, hoping to increase its share of the spoils, but will probably have to battle to hold its own in Europe if the current hardening of freight rates continues in the long term.

Canada with its contractual links in the same area will aim to maintain its outlets, but will find it hard to increase its exports if prices become very competitive.

USA, being the marginal supplier, will no doubt fluctuate with market conditions, but always maintain a solid and substantial movement to all areas.

Poland and the USSR are likely to continue at much their present levels of export, acting as residual suppliers in the overall international supply pattern.

Steam coal — In recent years there has been a more realistic approach to forecasting

Table 6: International steam coal market

	1983	1984	1985	1986	1987
Total steam coal demand (MTCE)	2478.7	2626.7	2746.6	2813.9	2904.7
of which:					
International Trade (MTCE)	127.2	147.9	171.9	173.5	172.5
International Trade (%)	5.1	5.6	6.2	6.1	6.0

Table 7: Steam coal imports to EC countries (MTCE)

	1983	1984	1985	1986	1987
Belgium/Lux.	3.7	3.0	3.2	3.8	3.5
Denmark	8.6	9.6	12.5	12.1	12.0
Eire	1.4	1.3	1.6	2.6	2.9
France	11.8	13.3	11.0	9.5	7.3
Germany W.	8.7	8.6	9.7	9.8	8.1
Greece	1.0	1.3	2.0	1.5	1.7
Holland	4.0	5.2	5.0	5.0	5.5
Italy	8.1	9.8	11.6	10.3	9.5
Portugal	0.1	0.1	1.0	1.7	2.1
Spain	2.5	3.3	3.1	2.6	5.2
UK	2.1	3.1	5.8	4.0	3.3
	52.0	58.6	66.5	62.9	61.1

Table 8: Steam coal imports by countries of Pacific Rim (figures in MTCE)

	1983	1984	1985	1986	1987
Indonesia	—	—	0.8	1.4	1.2
Japan	15.8	19.0	24.0	21.6	25.9
Korea S	2.6	6.7	11.1	13.7	12.1
Philippines	0.3	0.6	1.7	1.5	1.2
Taiwan	3.7	5.2	7.3	8.3	10.0
	22.4	31.5	44.9	46.5	50.4

Table 9: Main steam coal suppliers to Pacific Rim countries (MTCE)

	1983	1984	1985	1986	1987
Australia	11.7	17.4	25.7	25.5	28.8
South Africa	6.4	6.1	8.9	11.5	11.6
United States	3.4	3.2	4.9	5.4	6.2

future levels of steam coal demand. In particular it is now accepted that in the commercial light industry and domestic heating sector, coal will make no significant inroads into this market, of which oil and gas now have a significant share. It is also accepted that coal-to-oil conversion projects on which so much hope was pinned, and money spent, in the early 1980s, are not an economically viable alternative in the near future.

It is our view that the forecasting of future coal demand should be based on the potential growth of electricity (power stations) and heavy industry (cement) and within these terms the likely share that coal will obtain of that energy growth.

In the steam coal sector a number of basic assumptions can be put forward:

- There will be two major importing areas: Pacific Rim and Western Europe.

- There will be three major and established supply sources: Australia, South Africa and USA.

- There will be three challenging and recent supply sources: China, Colombia and Venezuela.

- There will be three established but static or declining sources of supply: West Germany, Poland and USSR.

- The current economic and commercial concept governing consumer buying and producer selling will continue to prevail, namely:

- (1) No one area will wish to depend too heavily on any other area, either as a supplier or for its supply.
- (2) Producers will seek to diversify their contracts for security reasons. Continuity of offtake is an essential constituent of their cash flow success.
- (3) For a variety of reasons the USA will continue to be regarded as the marginal supplier.

References

- (1) W.H. Fischer
Coal Trade Statistics — Volume II (1978-1983)
Financial Times Business Information Ltd (1984)
- (2) M. Samuelson
'The Old King Fights Back'
Financial Times — Monday, March 20th, 1989
(p 15)

Table 10: World forecasts for coking and steam coal (figures in MTCE)

	1980	1995	2000
Coking Coal			
Total Demand	542-547	560-570	585-605
International Trade	177-182	180-185	195-205
Seaborne Trade	157-162	165-170	180-185
Steam Coal			
Total Demand	3075	3400	3750
International Trade	185	205	225
Seaborne Trade	145	160	175



Recently published

Spatial energy analysis.

Edited by L Lundqvist, L-G Mattsson and E A Eriksson. 386 pp. Price: £35. Available from Gower Publishing Company Limited, Gower House, Croft Road, Aldershot, Hants GU11 3HR, England.

Guidance Notes on the Installation of Industrial Gas Turbines, Associated Gas Compressors and Supplementary Firing Burners (Reference IM/24).

Available from British Gas plc, Service Engineering Department, 326 High Holborn, London WC1V YPT or from Industrial and Commercial Sales Departments of British Gas regions.

A review of processes developed

'Synthetic Fuels from Coal' Edited by I Romey, P F M Paul and G Imarisco

The subject of the manufacture of liquid fuels from coal is now out of fashion and most people have lulled themselves into the belief that the supply of naturally occurring liquid fuels will last for ever — or at least long enough for consideration of what to do when it does run short to be of no immediate relevance. This is obviously unduly complacent. Most estimates of the length of time before rising oil prices signal a coming reality of oil shortages are still of the same order as the time that will be required to develop new industries for the manufacture of synthetic fuels.

It is therefore much to the credit of the Commission of the European Communities that they have sponsored this review of work already carried out to develop ways to make liquids from coal by the indirect route via gasification, or by direct synthesis using single or two-stage processes. Co-processing of coal with heavy fuel oil (which can ease some of the potential problems in the continuous operation of some direct processes using only coal) is considered as a separate option, while a final chapter reviews the role of catalysis in direct combustion. The authors of the various chapters are drawn from teams who have worked or are still working on coal liquefaction within the EEC and the book is edited by two respected experts with long experience in the area: Dr Romey from Bergban Forschung and Dr Paul, formerly at the Coal Research Establishment, Cheltenham. These two have been well supported by G Imarisco of the Commission.

The book reviews the bewildering number of coal conversion systems that have already been, to some degree at least, developed but, understandably enough, cannot make judgements as to which processes are the best for future development. This is still a subjective matter, confused by commercial considerations and uncertainties as to the interpretation of the experimental data. (I am still waiting for the true, inside story as to what was proved or not proved regarding the long-term continuous

operation of the 'H' coal and Exxon processes on their very large demonstration plants in the early 80's). However, as a review of the principal processes that have been developed, the effort that has been expended on them and a summary of the results reported, this book is most valuable, if only to suggest some of the common threads which may lead to a consensus on the forms of plant to be concentrated on in the future and to remind decision makers of the work ahead and the decisions — and money — that still need to spout before the world can be in a position to be independent of those holding the world's dwindling oil resources.

G G Thurlow

Published by Graham & Trotman for the Commission of the European Communities, London, 1987
387 pp. £58.50 £63.50 (airmail)

Passive solar building design

'Passive Solar Energy in Buildings' Watt Committee Report No 17 Edited by Patrick O'Sullivan

Prof Patrick O'Sullivan and his 32 colleagues have produced an important statement about the present applications and future possibilities of passive solar building design. The report is divided into four main sections with a brief introduction and a conclusions and recommendations chapter provided by Patrick O'Sullivan. The first main section examines the opportunities for the use of passive solar energy in educational buildings, with a working group chaired by David Curtis of the Essex County Council. Following a review of the present stock of school buildings, the group concluded that the greater potential for energy saving remains in the existing building stock although new school building provides the best opportunity to evaluate and monitor the various passive solar techniques that are available. A particular feature of this section is the use of photographs to illustrate the various different treatments, eg, south-facing glass, Trombe wall, lightweight solar wall and atria.

John Campbell, Ove Arup Partnership, chaired the group which studied the use of passive solar energy in offices. They concluded that careful design could mean that the need for air conditioning may be eliminated and, at worst, not only may the running cost of the air-conditioning plant be reduced but its capital cost may be minimised also. They also warn that current planning and building controls do not give either a right to sunshine (buildings may be constructed to shade your solar wall) or protection from the reflections and subsequent heat gain from other buildings.

Industrial, retail and service buildings were covered in the third section. Here the recommendations largely followed some of the conclusions reached in the other sections: for example, for existing buildings add conservatories and atria, optimise space utilisation to suit orientation and function, replace older glazing with more effective types of glass and insulated or blank panels.

Neil Milbank, Building Research Establishment, chaired the working group considering the passive solar approach to new and existing domestic buildings. Unlike some earlier studies, they included the effects of site density, site suitability and the reduced altitude in northern latitudes and concluded that annual savings of some 0.2 Mtce could be achieved over the next 20 years if a total of 616,000 solar houses and 56,000 solar flats were to be constructed.

In conclusion, Patrick O'Sullivan points out that the way forward is to encourage more climatically interactive buildings by the presentation of best-buy documented exemplars. The report also reminds the reader that one of the main characteristics of passive solar buildings is their high amenity value, which "... will reflect itself in low occupant stress response, that will in turn result in healthier people". It is interesting to reflect that if a healthy person is worth one tonne of coal equivalent per annum, the savings quoted above would be increased by a factor of four. But accountants (and governments) are not yet influenced by such arguments.

Dr Cleland McVeigh

Published by Elsevier Applied Science Publishers, Barking, England, 1988
67 pp. £34.00

Data on wind turbine shipments

'Wind Energy 1988' Prepared by Thomas F Jaras

This book is a sequel to the useful and comprehensive collation of data on wind turbine shipments for the years 1981 to 1986, which was published last year. This edition catalogues and analyses wind turbine shipments for the year 1987. Developments in the various sectors of the wind turbine market are analysed and data are presented on shipment values, number of units and power rating. Further analyses are made on regional and national bases and this enables a very detailed picture of movements in the market to be drawn. The presentation of information on a national basis enhances its value, although the limited number of sales to many countries necessitates, in the words of the author, "suppression of values" in order to protect sensitive information on individual manufacturers' prices.

In reviewing current developments the author also includes commentaries on the political and economic forces at work on both regional and national bases. Forecasts for the future development of the market, up to the year 2000, are included and the author paints an encouraging picture with a central projection of 1000 MW per year of wind turbines being manufactured by the turn of the century.

Overall the book is an indispensable source of reference for those wishing to monitor developments in the renewable energy field.

D J Milborrow

Published by the Wind Data Center, Stadia Inc, Great Falls, USA, 1988
121 pp.



Careers education and guidance

IF the provision of careers education and guidance is to be effective at local level it is essential to ensure full co-ordination at central level. This is the theme of *Careers education and guidance — key issues*, a joint statement issued in May by The Engineering Council and the Society of Education Officers.

The two organisations call for effective communication and full co-operation between all those with legitimate interests in the provision of careers education and guidance:

- Teachers and careers officers must work closely together to ensure that pupils are aware of the vocational implications of curriculum choice and of the range of educational, training and employment options open to them.
- Parents should be aware of these implications and options, through the availability of careers information and through knowledge of the various decision points faced by their daughters and sons.
- Employers should be more active in their partnership with the education service, with the careers service providing a channel of communication for the gathering, interpreting and disseminating of information appropriate to the needs of individuals, educational establishments and employers.
- Employers and training organisations should be encouraged to contribute to the development and education of pupils and students through the provision of work experience, representation on school and college governing bodies, the provision of information about employment and training opportunities and their employment requirements, and by generally supporting and encouraging the life and work of the school and college in its community.

This document, together with the first document in the series entitled *Careers education and guidance within the national curriculum*, is available free from The Engineering Council, 10 Maltravers Street, London WC2R 3ER.

Prince of Wales Award winner for 1989

AN IDEA based on the humble horseradish to help doctors make accurate diagnoses is this year's winner of The Prince of Wales Award for Innovation and Production organised by The Engineering Council. The invention, Amerlite, by Dr John Holian and Dr John Edwards of Amersham International plc, is now being sold into the billion-pound immunoassay market.

For many years hospital laboratories have been using the technique called immunoassay to help diagnose a range of diseases such as cancer, thyroid disorders and abnormalities of pregnancy. It measures blood levels of substances such as hormones by "labelling" them with radioactive molecules and is so sensitive it can measure amounts as small as a millionth of a millionth of a gramme.

A problem with the technique is that it involves using radioactive material with a short shelf life, is relatively slow and can only be carried out in licensed laboratories. The award-winning Amerlite uses light-stimulating enzymes derived from horseradish instead of radioactive materials. It is faster, easier to do and just as sensitive as radioimmunoassay.

Dr Holian is product development manager of Amersham International plc; and John Edwards is technical development manager at Amersham.

The best new ideas for future wealth creation become the finalists in the first year, and the outright winner is selected two years later on the basis of progress made with actual production.

New ways of teaching engineering

MORE than 150 academics, industrialists and others concerned with the education of future Chartered Engineers attended a conference held in London on 27 June 1989 and heard about exciting new developments in engineering teaching. The conference was organised by The Engineering Council to publicise the results of 18 months of development work in nine higher educational institutions.

The aim of the project, which was funded by the higher education branch of the Department of Employment Training Agency, was to develop and demonstrate good practice in the

integration of Engineering Applications into engineering degree courses. Engineering Applications is the means of helping engineering students to take an active role in their own learning by attempting to solve practical engineering problems, working co-operatively in teams, and often in an enterprise or business environment. It makes learning relevant to the needs of industry and of integrating theory and practice.

In summing up the conference, Dr Jack Earls, a member of The Engineering Council and chairman of its Initial Education and Training Committee, commented on the rich and diverse range of approaches to Engineering Applications which had been demonstrated.

He said that the outstanding message communicated to the conference from speakers and other contributors was the excitement, commitment and motivation engendered in the students by these new approaches. Because of the need to attract engineering students from a declining number of young people, they must now secure the educational environment in which those developments could flourish.

To follow up the conference, The Engineering Council plans to produce further guidelines on what should be considered in implementing engineering applications, although the final approach will always be in the hands of the course designers and teachers concerned.

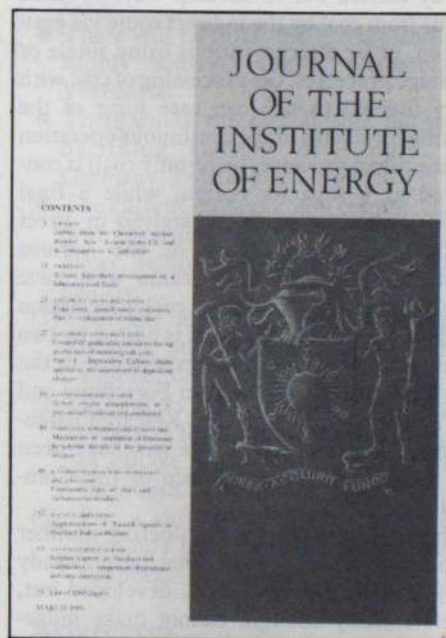
Further information from Peter Swindlehurst, Initial Education and Training Executive, The Engineering Council, 10 Maltravers Street, London WC2R 3ER.

Are you missing out on the Journal?

The *Journal of the Institute of Energy* is the technical journal of record for the Institute. Published quarterly, it carries refereed technical papers on a wide range of subjects and it is available to members of the Institute who register their wish to receive it. To put yourself on the mailing list, simply write to the Membership Secretary at The Institute of Energy, 18 Devonshire Street, London W1N 2AU, stating your preference to receive the Journal (please include your membership number in all correspondence).

To those outside of membership, it is available on subscription jointly with *Energy World* — price £110 (UK), £115/\$US185 (overseas subscribers).

Examples of papers recently published include: *Debris from the Chernobyl nuclear disaster — how it came to the UK and its consequences to agriculture* (FB Smith); *A laser light-sheet investigation of a laboratory coal flame* (PR Ereat); and *Sulphur capture in fluidised-bed combustors — temperature dependence and lime conversion* (A Lyngfelt and B Leckner).





Swiss boiler-burner design reduces pollutant emissions

Using an improved gasifying combustion technique, Swiss engineer Jorg Fülleemann has developed a new type of oil burner which reduces pollutant emissions to well below current European limits.

The burner — which is quiet in operation — produces negligible amounts of carbon monoxide, hydrocarbons and solids, and cuts NO_x emission to half the value required under Switzerland's stringent new regulations to be introduced in 1991.

The burner will be produced in a range of outputs from 6 kW up to 300 kW, making it suitable for both domestic and medium-size commercial and other buildings. Herr Fülleemann was presented with the 1988 European Community Environmental Award in recognition of the importance of this development.

The world marketing rights for the burner were won by the Swiss firm of Stramax (Zürich), who intend appointing agents in the various countries later this year.

For further information contact Stramax AG, Ankerstrasse 53, CH8004 Zürich, Switzerland.

Kent offer new fibre optic range

The P940 Series fibre optic temperature transmitter, manufactured by Kent Industrial Measurements, is the first in a range of equipment like this based on optical transmission principles.

Operating via a single optical fibre, which can be up to 2 km in length, and is lighter than an equivalent copper conductor, the transmitter covers a temperature range of -70°C to 515°C with a single design, giving complete rejection of common and series mode noise with immunity to interference through electrical or electromechanical influences. The use of non-metallic cable gives true galvanic isolation between the sensor and the control room. The cost of a system is comparable to a conventional isolated electrical sensor.

Dewpointmeter to monitor furnace humidity

In the production of microwave tubes the cathode and electron gun are manufactured in a high-performance hydrogen brazing furnace. It is important that the furnace humidity is continuously monitored and maintained at precise levels. The Michell 2000-series dewpointmeter has been selected for this operation by the microwave tube manufacturer, Thorn Microwave Devices.

In cathode and electron gun production, the hydrogen brazing furnace operates over the range 1000 to 2000°C, with the dewpoint maintained at between -50 and -70°C. This is monitored at two points: at the furnace exhaust, to provide a final system check; and immediately following the gas drying process, before its entry into the furnace, this being the most critical point. The series 2000 dewpointmeter, with its -80°C range, 3 per cent accuracy, fast response and linear output, is well suited to this application.

For further information contact Michell Instruments Limited, Unit 9, Nuffield Close, Nuffield Road, Cambridge CB4 1SS.

The transmitter comprises three parts: the fibre optic resistance thermometer (FORT), which measures the temperature of the process liquid or gas; the high speed optical receiver (SHOR), which is mounted in the control room and converts optical signals to electrical pulses; and the optical pulse time interval converter (OPTIC), which computes the RT resistance, linearises the information and provides a proportional 4-20 mA output signal.

Switch selection determines the actual range over which the temperature transmitter operates with 130 different choices available.

For further information contact Kent Industrial Measurements Ltd, Howard Road, Eaton Socon, Huntingdon, Cambridgeshire PE19 3EU.

Combined air heater and emission control system

A combined air heater and pollution emission control system is now available from Aerogen. Called Aerocin, the new system is based on the company's gas-fired air heaters and heat recovery units. It has been designed for installation on all types of printing and converting machines for drying inks and coatings.

Recognising the growing concern about the danger to the environment as solvents become more sophisticated and noxious, the system has been designed to destroy organic solvent fumes present in printing and coating processes as well as to supply large quantities of heated process air.

Air, that has been used to dry inks and coatings, is drawn into the heat recovery unit at temperatures of ±60°C. Here, the temperature of the solvent-laden air is raised to ±400°C before it passes into the incineration chamber. Increasing the temperature at this stage of the process, instead of in the later incineration

stages, is more effective and less costly.

When the required temperature has been reached, the air is transferred to the incineration chamber where heat from combustion of the solvents is liberated, reducing the energy input required from the specially designed, support burner system. This produces an efficient combustion temperature of ±750°C, the optimum temperature needed to destroy completely organic solvents. The system also allows for adequate residence time in the chamber, this time being adjustable for more resistant solvents.

Once the solvents have been destroyed the clean air, still at ±750°C returns to the heat recovery unit, where it gives up heat to incoming solvent-laden air. It can then complete the cycle by returning to the drying stations where once again it is used to dry the inks and coatings.

For further information contact Aerogen Co Ltd, Newman Lane, Alton, Hants GU34 2QW.

Ventilation without air conditioning

It is now recognised that CFCs (chlorofluorocarbons) released from air conditioning equipment are damaging the ozone layer in the stratosphere. In the UK's temperate climate it is possible to relieve building heat gains through using simple mechanical ventilation without resorting to air conditioning. Mechanical ventilation will be adequate for many buildings which do not have extreme conditions.

Thermal Technology's range of Recupovent ventilation/heat recovery units are designed to ventilate efficiently buildings by controlling both the supply and exhaust airstreams. The Recupo-

vent extracts vitiated air and replaces it with clean air directly from the atmosphere.

The standard STG range of packaged Recupovents is designed to handle air volumes up to 1.80 m³/s. They handle both supply and exhaust air streams and incorporate aluminium plate heat exchangers. The heat exchanger extracts energy (hot and cold) from the outgoing exhaust air and transfers it to the incoming supply air stream.

For further information contact Thermal Technology Limited, Thermal House, 46 Hilperston Road, Trowbridge, Wiltshire BA14 7JH.

Seeking out gas leaks

The makers of Digiflam 2000, Neotronics, claim that it is a new concept of gas leak instrumentation. The equipment has applications in many organisations including gas utilities, gas servicing contractors, bulk gas users and landfill site operators, where service engineers have to track and identify gas leaks.

The Digiflam 2000 incorporates: automatic autorange from percent LEL to percent by volume of gas with clear range indication; automatic zero cali-

bration; optional percent by volume oxygen measurement and ATE (automatic test equipment) instrument recalibration and performance check systems for the large user.

Safety has been built in; a built-in pump with automatic cut-off if liquid is drawn into the sampling system.

For further information contact Neotronics Ltd, Parsonage Road, Takeley, Nr Bishops Stortford, Herts CM22 6PU.



- Title:** **Control of electroheat processes.**
Location: EITB, Leeds.
Duration: 5 days.
Starting: 4 September 1989.
Content: Measurement and control in electroheat. Quality and reliability through electroheat. Modern electroheat systems.
Contact: BNCE on 01-834 2333×6339.
- Title:** **Introduction to composites.**
Location: University of Surrey, Guildford.
Duration: 5 days.
Starting: 4 September 1989.
Content: The basic concepts and practices of composite materials.
Contact: Dr S L Ogin on 0483 571281.
- Title:** **Instrumentation measurement and control in process engineering.**
Location: Leeds University.
Duration: 5 days.
Starting: 11 September 1989.
Content: Flow. Temperature. Level. Pressure. Basic theory. Control valve operation. Automatic control. Intrinsic safety. On-line measurement of chemical composition.
Contact: Dr M J Pitt on 0532 332423 or 332440.
- Title:** **Computation of external and internal high-speed flow.**
Location: UMIST.
Duration: 5 days.
Starting: 11 September 1989.
Content: A broad coverage of current approaches to the computation of high-speed compressible external and internal flows of relevance to aeronautical and mechanical engineering, with turbomachinery applications being included in the latter area.
Contact: Dr M A Leschziner on 061-236 3311×2350/2351.
- Title:** **Energy management.**
Location: Portsmouth Polytechnic.
Duration: 5 days.
Starting: 18 September 1989.
Content: Energy utilisation in boilers. Air conditioning systems. Heat pumps and low temperature heat recovery. Insulation in building, energy and its energy tariffs. Energy management spread sheets. Practical sessions.
Contact: Dr M R I Purvis on 0705 842329.
- Title:** **Rapid solidification.**
Location: University of Surrey, Guildford.
Duration: 5 days.
Starting: 18 September 1989.
Content: The fundamental and practical aspects of rapid solidification processing. Ferrous, aluminium, copper, magnesium and titanium based RSP alloys. Production methods, microstructural effects, amorphous and microcrystalline conditions.
Contact: Dr P Tsakiropoulos on 0483 571281.
- Title:** **Membrane separation processes: fundamentals and applications.**
Location: University College of Swansea.
Duration: 3 days.
Starting: 19 September 1989.
Content: The course will relate the fundamental properties of membranes and theories of membrane operation to industrial applications. The focus will be on microfiltration, ultrafiltration and reverse osmosis.
Contact: Conference Section, IChemE on 0788 78214.
- Title:** **Incineration and energy from waste.**
Location: University of Leeds.
Duration: 3 days.
Starting: 20 September 1989.
Content: Basic combustion. Combustion of solid wastes. Combustion of liquids, pastes and gases. Heat transfer and energy recovery aspects of incineration. Modelling combustion chamber aerodynamics. Refractory materials for incinerators. Chimney design. Pollution from incineration. Flue gas emissions control. Waste incineration in the UK. Energy recovery from waste. Industrial experiences of incineration of different types of waste.
Contact: Helen Whitehouse on 0532 333237.
- Title:** **Practical quantitative hazard assessment.**
Location: Harrogate.
Duration: 5 days.
- Starting:** 24 September 1989.
Content: Risk assessment strategy. Qualitative event identification by the HAZOP study method. Hazard frequency criteria, target setting and criticality. Principles of logic tree construction. The practical application of fault rate and human error data. Exercises, workshops and case studies.
Contact: Conference Section, IChemE on 0788 78214.
- Title:** **Fire and explosion.**
Location: Leeds University.
Duration: 5 days.
Starting: 25 September 1989.
Content: The major aspects of fires and explosions, including case studies. Hazard analysis techniques and explosion hazards.
Contact: Department of CPE on 0532 333235 or 333241.
- Title:** **Surface analysis by electron spectroscopy: an introduction to XPS and scanning auger microscopy.**
Location: University of Surrey, Guildford.
Duration: 5 days.
Starting: 25 September 1989.
Content: An intensive introduction to the techniques of X-ray photoelectron spectroscopy and auger electron spectroscopy, together with scanning auger microscopy.
Contact: Prof P J Goodhew on 0483 571281.
- Title:** **Combustion fundamentals.**
Location: Imperial College, London.
Duration: 5 days.
Starting: 25 September 1989.
Content: Fuels. The chemistry of slow combustion reactions and spontaneous ignition. Conditions for flame propagation in gas mixtures, their ignition, explosion and detonation. The thermodynamics, structure and radiation of flames. Diffusion flames, fires and the burning of droplets. Flame propagation. Flames on burners, their stability and shape. The effect of turbulence, the principles of modelling.
Contact: Prof F J Weinberg on 01-589 5111×4360/4498.



EVENTS

August 1989

Ecology 89

Conference and exhibition, 28-31 August, Gothenburg, Sweden. Details from Congress Manager, The Swedish Exhibition Centre, PO Box 5222, S-402 24, Gothenburg, Sweden. Tel: +46-31 160 330, TX: 20600.

September 1989

Uranium Institute

Annual symposium, London, 6-8 September 1989. Details from the Secretary General, Uranium Institute, 12th floor, Bowater House, 68 Knightsbridge, London SW1X 7LT. Tel: 01-225 030, tlx: 917611 URINST G, fax: 01-225 0308.

Filtech Conference

Conference, 12-14 September, Karlsruhe, FRG. Details from The Filtration Society, 7 Manor Close, Oadby, Leicester LE2 4FE, England.

Energy for Tomorrow

14th WEC Congress, Montreal, Canada, 17-22 September 1989. Details from British National Committee, World Energy Conference, 34 St James's Street, London SW1A 1HD. Tel: 01-930 3966, tlx 264707 WECIHQ G, fax: 925 0452.

The Grove Anniversary Fuel Cell Symposium

Conference, 18-21 September, London. Details from Georgina Mason, IBC Technical Services Ltd, Bath House, 56 Holborn Viaduct, London EC1A 2EX. Tel: 01-236 4080, Fax: 01-489 0849, TX: 888870.

Alternative Coal Based Power Generating Systems

Conference, 21 September, London. Details from Conference Section, The Institution of Chemical Engineers, 165-171 Railway Terrace, Rugby CV21 3HQ, England. Tel: 0788 78214, Fax: 0788 60833, TX: 311780.

Explosions in Industry

Discussion meeting, 21-23 September, 1989, Aberystwyth, Wales. Details from Dr H J Michels, Secretary, UKELG, Department of Chemical Engineering and Chemical Technology, Imperial College, London SW7 2BY.

Renewable Energy Power Supplies for Telecomms

Seminar, 25 September, London (organised by BWEA/Institution of Electrical Engineers). Details from John Fawkes, Marlec Engineering Co Ltd, Unit K, Cavendish Courtyard, Sallow Road, Corby NN17 1DZ, England.

CIPE '89

Conference, 25-28 September, Leeds, England. Details from Conference Section, Institution of Chemical Engineers, 165 Railway Terrace, Rugby CV21 3HQ, England. Tel: 0788 78214, Fax: 0788 60833, TX: 311780.

Ceramics

Forum, 25-29 September, Limoges, France. Details from: Gerard Majewski, Charge de Mission, CREEL, 27 Boulevard de la Corderie, 87000 Limoges, France. Tel: Int +55 45 18 30, fax: Int +55 77 77 89.

Pittsburgh Coal Conference

International Conference, 25-29 September, Pittsburgh, USA. Details from Pittsburgh Coal Conference, MEMS, One Northgate Square, 2 Garden Center Drive, Suite 211, PO Box 270, Greensburg, PA 15601, USA.

Electricity privatisation: trans-Atlantic lessons for Britain

Conference, 27 September, London. Details from Carol Patey, Public Issue Conferences, D C Gardner, 5-9 New Street, London EC2M 4TP. Tel: 01-283 7962. Fax: 01-283 3973.

October 1989

BCURA Coal Science Lecture

Lecture, 2 October, London. Details from Brian Dashfield, British Coal Corporation, Stoke Orchard, Cheltenham, Glos GL52 4RZ, England. Tel: 024-267 3361, Fax: 024-267 6506, TX: 43568.

Organisation of the local energy supply

Conference, 2-3 October, Baden-Baden, West Germany. Details from Dipl-Ing H Webner, VDI, Postfach 1139, 4000 Düsseldorf 1, FRG. Tel: +(02 11) 62 14 329 414.

The profession: privatisation and competition

Seminar, 3 October, London (Regents College). Details from: Mrs B O'Donoghue, Conference Office, Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA. Tel: 01-222 7722.

Energy Policy and the Environment

Conference, 9 October 1989, London. Details from Stephen Winkworth, Administrator, UK-ISES, King's College, Campden Hill Road, London W8 7AH. Tel: 01-938 2919.

Landward Oil & Gas Conference

One day seminar, 9 October, London. Details from Conference Organiser, IBC Technical Services Ltd, Bath House, 56 Holborn Viaduct, London EC1A 2EX.

Underground coal gasification

International symposium, 1989, Delft University of Technology, The Netherlands, 9-11 October 1989. Details from Delft University of Technology, Congress Office/Mrs M H P Komen-Zimmerman, PO Box 5048, NL-2600 GA Delft, The Netherlands. Tel: +31 15 781340, tlx: 38151 butud nl, fax: +31 15 781855.

CoalTrans '89

International conference and exhibition, 16-18 October, London. Details from Conference Manager, CS Publications Ltd, McMillan House, 54 Cheam Common Road, Worcester Park, Surrey KT4 8RJ, England. Tel: 01-330 3911, TX: 8953141.

Building Energy Management Systems Update

One day conference and exhibition (organised by Institute of Energy, North East Branch), 18 October, Wallsend, Newcastle upon Tyne, England. Details from Mr M G Burbage-Atter, Conference Organiser, 8 Duchy Drive, Heaton, Bradford BD9 5NL. Tel: 0274 496590.

Human Reliability in Nuclear Power

Conference, 19-20 October, Cafe Royal, London. Details from Sara Mountford, IBC Technical Services Ltd, Bath House, 56 Holborn Viaduct, London EC1A 2AX.

Energy, Environment and Technological Innovation

Conference, 22-26 October, Central University of Venezuela, Caracas, Venezuela. Details from Publicis Inc, Parque Central, Nivel Lecuna, Ofic. No. 29, Entrada Tunel, Postal 17614, Caracas, Venezuela. Tel: +582 5729975, Fax: +582 5736642.

Coal Science

Conference, 23-27 October, Tokyo, Japan. Details from: Dr Masami Takayasu, Secretariat for ICCS, Coal Conversion Department, NEDO, Sunshine 60 Building, 1-1, Higashi-Ikebukuro 3-chrome, Toshima-ku, Tokyo 170, Japan. Tel: Int +3 987 9442, tlx: J32148, fax: Int +3 981 1059.

November 1989

World Water

Conference and exhibition, Wembley, London, 14-16 November 1989. Details from Institution of Civil Engineers, 1-7 Great George Street, Westminster, London SW1P 3AA. Tel: 01-222 7722, tlx: 935637 ICEAS G; fax: 01-222 7500.

NEMEX '89

Conference and exhibition, 21-22 November 1989, NEC, Birmingham, England. Details from Energy Systems Trade Association (ESTA), PO Box 16, Stroud, Glos GL5 5EB. Tel: 045 387 3568.

October 1990

Circulating Fluidised Beds

3rd International Conference, 15-18 October, Beijing, PRC. Details from the Secretariat, International Conference on Circulating Fluidised Beds, Technical University of Nova Scotia, PO Box 1000, Halifax, Nova Scotia, Canada.

APPLIED ENERGY RESEARCH UNIVERSITY COLLEGE SWANSEA, UK

5-7 SEPTEMBER 1989

Organisation: The Institute of Energy — in association
with International Solar Energy Society

Tremendous developments are taking place in energy provision and utilisation, partly due to structural changes, such as privatisation, changing management strategies, and partly from technological advances.

Applied Energy Research is aimed at newly developed energy technologies, from research laboratories to application by industry. Major advances in strategic areas will be highlighted by keynote address by authorities in the field:

Professor Brian J Brinkworth, President of the Institute of Energy and Professor of Mechanical Engineering and Energy Studies will be speaking on '**The Challenge of the Renewables**' updating and highlighting major innovations in the renewable energy field.

Dr Neil Fricker, Manager of the Heating Plant Division at British Gas' Midlands Research Station will be exploring new methods of '**Modelling of Gas Fired Heat Exchangers**'.

Dr John Topper, Head of Assessment and Planning at British Coal's Coal Research Establishment will be evaluating '**Advanced Coal-Fired Technologies for small scale power generation**'.

Mr Frazer Ferguson, Coal Technology Division of the Department of Energy will present an informed overview of '**Energy Challenges in the Future**'.



BOOKING FORM

The registration fee includes:

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