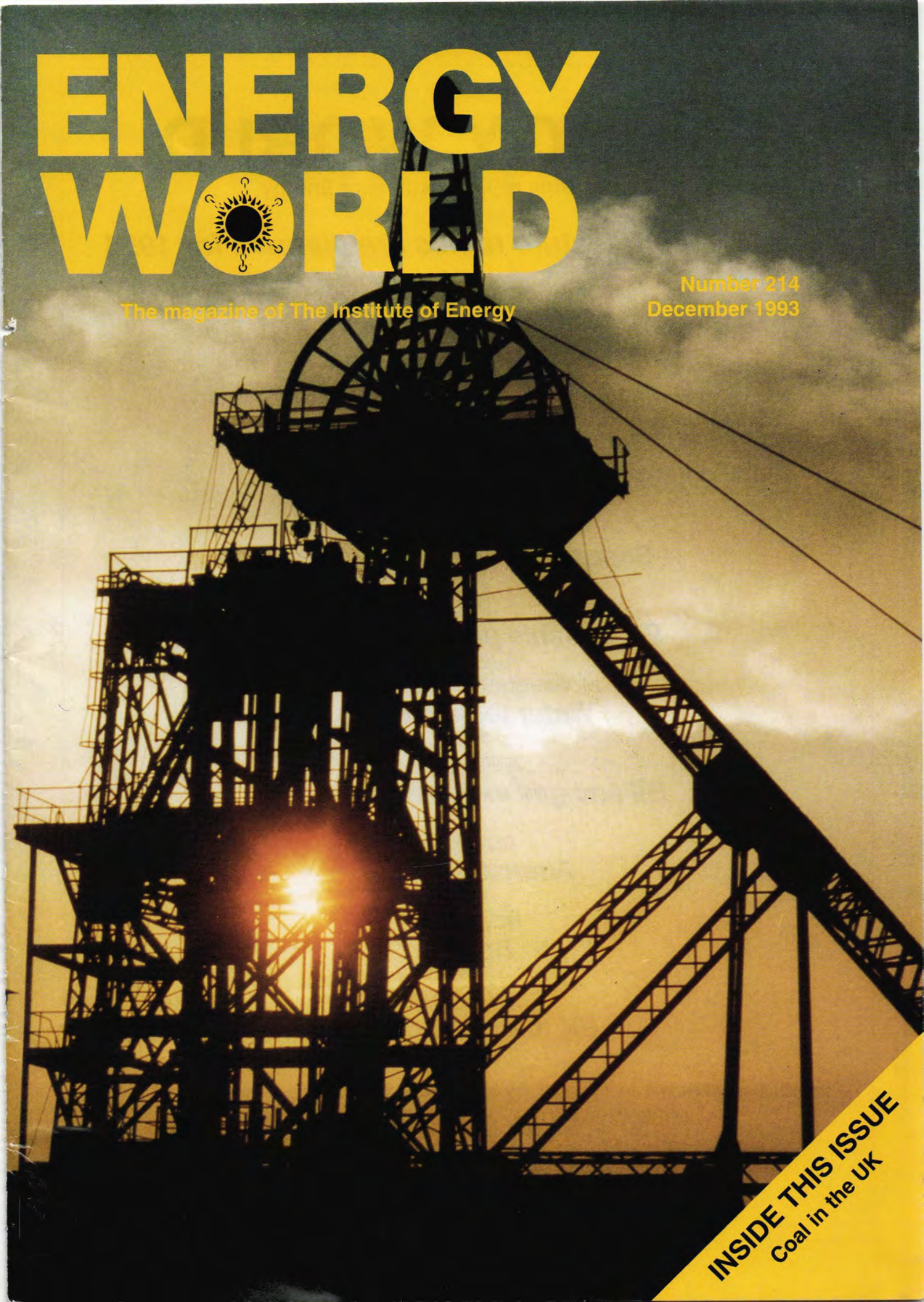
ENERGY WORLD

The magazine of The Institute of Energy

Number 214
December 1993



INSIDE THIS ISSUE
Coal in the UK

ENERGY WORLD

DECEMBER 1993 Number 214

The magazine of The Institute of Energy

Published by H Howland Associates, The Martins, East Street, Harrietsham, Kent ME17 1HH, on behalf of The Institute of Energy, 18 Devonshire Street, London W1N 2AU.
Editorial tel/fax: 0622 850100
Conferences: 071-580 0008
Administration: 071-580 7124
Membership, Education and Journal subscriptions: 071-580 0077 Fax: 071-580 4420

Editor
Johanna Fender

Advertisement sales
Harris Howland, tel: 0622 850100

Printed by Headley Brothers Ltd The Invicta Press, Ashford, Kent

THE INSTITUTE OF ENERGY

Patron
Her Majesty The Queen

TERMS OF CONTROL

Energy World is circulated free of charge to all paid up members of The Institute of Energy. To libraries, organisations and persons not in membership it is available on a single subscription of £60 (UK), £70 (overseas) for 10 issues.

ISSN 0307-7942

CONTENTS

COVER

Recent events indicate that few, if any, of the pits 'reprieved' in the Government's White Paper in April of this year, will remain in operation. The last few weeks have seen several of these collieries referred to the modified colliery review procedure — seen by many as a precursor to closure. These pits are: Silverdale and Littleton collieries in Staffordshire; Bentley and Hatfield, near Doncaster; Frickley near Wakefield; Tower colliery, the last in South Wales, and Wearmouth — the last pit in Durham. Final closure of Littleton colliery has since been formally proposed by British Coal.

Coal privatisation — what's on offer?

COAL privatisation should have been simple, but it won't be. Because it has come last in the queue, because privatisation of its principal market was uniquely complex, because so many accommodations had to be made to ensure all the participants were happy when they reached the promised land, the British coal industry has been squeezed into shapes which seem to defy conventional privatisation.

What, in fact, will be for sale?

The prospective buyer of any colliery property looks first, not at the fabric of the mine, but must examine minutely every line of the sales contracts even before analysing financial records and forward projections. The key calculation lies in setting the price according to the tonnage the customer is committed to, multiplied by the margin per tonne that can be relied upon — the forward income stream.

The great swathe of pit closures in Britain turns on the renewal terms of contracts with the two generators negotiated last April — 75 m tonnes a year, falling to 30 m within four years, plus a consumer stock lift of 20 m tonnes over 18 months. The inevitable result was contraction.

Only three years of those contracts will be left on privatisation. After 1998, what volume at what prices will be anyone's guess. The normal planning horizon of 15 years for a large mine cannot be contemplated. Gas and nuclear have escaped from the rigours of the new electricity market. Nuclear, safe behind its 50% cross subsidy, has its sights on 30% of the market, while gas, mostly with secure 15-year back-to-back contracts with the RECs could soon have capacity to supply half the electricity market in England and Wales.

The purchaser of privatised British Coal mines will have a mammoth task to recover his original outlay, secure a reasonable return, and make provision for possible closure costs of a big steam coal property all within three years.

The business will be offered for sale as five regional companies. They will certainly contain working mines — both deep and opencast — but what of British Coal's opencast land bank? A vital issue is whether the land bank will be sold along with the current operating mines, for if not, an investor will be faced not only with the high market risk and brief cover afforded by the electricity contracts, but will risk new entrants easily crossing the low opencast threshold to attack what market share he has. If, however, the privatised companies were given rights to all reserves within their territory, there could emerge local monopolies far more effective than British Coal ever was at the height of its powers.

Coal mining's greatest cost is accessing new reserves, an issue of immense importance to buyers and their bankers, who will want to know exactly what is on offer. BCC's opencast mines have an average life of just over five years — so 20% of capacity has to be renewed each year. Faced with the formidable hazards of obtaining planning permission for new sites, the regional companies will require a firm grip on their local land bank if they are to negotiate orderly long-term arrangements with local authorities. The accessible reserves at the remaining deep mines will also receive close attention. Few of these mines seem capable of continued production at the present rate for very long. Some will need substantial capital investment, but most do not seem to have the physical resources. The Selby complex in Yorkshire is a classic case. Although it represents 25% of the total capacity to be sold, its life predictions — given current production rates and working methods — vary from below 10 years to little more than 15: a very short life for such a large operation. And Selby is not unique. Few of the core mines upon which the long-term future of mining in Britain now seems to depend have accessed reserves that will last much more than 20 years.

The ruthless pressure on the coal industry has made some 'high grading' inevitable, but the intense concentration on a small number of mines producing very large outputs means high exhaustion rates as well as considerable volumes of electricity smalls suitable for only one market. The key components for a successful coal privatisation do not yet fit together.

While the coal industry concentrates on a handful of mines which appear to have a limited life at current output rates, much of the legacy of public ownership seems set to be handed on to new owners who may also be saddled with all the liabilities of eventual closure.

The DTI and the Treasury have apparently declared that coal privatisation must be a transfer of undertaking like other privatisations, although it is rumoured that British Coal is pressing strongly for everyone left in the industry on the last day of public ownership to be made redundant before the property passes. But buyers will surely want to make a completely fresh start, unsaddled by the paraphernalia of half a century of public ownership. Will they be landed with established liabilities like concessionary coal for employees and dependents, as well as the risk that other hidden obligations may emerge after take over?

If the undertakings are to be transferred as going concerns with obligations intact, it is difficult to see how the national coal assets can achieve their full market value.

Possible benefits do not yet seem to be in proper relationship with the risks new owners must run in making the investment; they must be if privatisation is to succeed. The DTI coal cart must have something really convincing in its sacks when the contents are tipped into investors' cellars. Otherwise the old horse Energy Privatisation may not go to its last feeding place with all its last round sold out.

Malcolm Edwards
Chairman, Coal Investments plc

Protests fail to stop World Bank funding for dam

THE WORLD BANK is expected to give final approval soon to Nepal's Arun III dam, *writes Rajendra Dahal of the Kathmandu Deshanter Weekly*, despite growing protests that the massive project will not solve the country's severe energy shortages, and could wreck the fragile national economy.

Campaigners are concerned that the Bank is repeating mistakes with previous large dams and is failing to consider fully the alternatives. The project could cost US$764 million and will mean resettling huge numbers of people from the site.

The Bank approved the scheme in principle in September when its loan committee agreed funding for the project. Bids have already been received from international companies vying for the major civil engineering contract. Bank officials predict that the formal go ahead will be given before the end of the year, when the team looking at the scheme's economic viability returns from Nepal. The team is likely to recommend close monitoring of the project, but no fundamental changes.

The 155 metre long, 68 metre high dam is designed to generate 201 MW of electricity.

The World Bank and its soft loans arm, the International Development Association, are the major funders in a consortium involving the Asian Development Bank and the Japanese and German governments. Linda Loenstein, former World Bank project officer for Nepal, said environmental and social implications of the dam are being taken into account. "This is not another Narmada", she said. Following intense opposition, the Bank was forced earlier this year to withdraw from the Indian Narmada dam project, which involves forcible displacement of 120 000 people.

In contrast, she said, "people in the area want Arun III very badly." Local activists disagree. They say the World Bank is so determined to go ahead with the scheme that it is ignoring opposing voices. The Kathmandu-based Alliance for Energy, formed in April to oppose the scheme, says virtually no resources have been allocated for studying alternative ways of meeting Nepal's energy shortfall.

They say Arun III's electricity generation cost is more than twice that of smaller projects already under construction in Nepal. The dam will take ten years to build, leaving the country with power shortages that will have to be met through installing diesel turbines which are expensive to run because all fossil fuels have to be imported.

Nepal is developing an effective small-scale hydro-electric industry. Local activists, as well as international experts such as Britain's Intermediate Technology Development Group, believe this is a better way to meet the country's electricity needs, which are growing by 25 MW per year.

The alliance reckons Arun III 'crowds out' consideration of these small and medium schemes. Nepal's 1993/94 budget sets aside US$17 million as local expenses for the dam, while allowing only US$100 000 for feasibility studies of other projects. This is only enough 'to find a detailed feasibility study for a 3 MW installation', according to the alliance.

"Why the hurry? The question of funding aside, is Nepal ready for the project? Can we manage investment on this scale?" asked alliance member Bikas Pandey. He says the answer is 'no'.

Even government officials admit they have been forced into a 'no-option trap' in which powerful international and local interest groups, including funding agencies and consultants, have promoted Arun III and excluded alternative projects before real comparative assessments could be made. Nepal has already spent US$25 million and eight years on the project.

"We don't have another project to replace it", said Binayak Bhadra, who is in charge of the National Planning Commission's energy portfolio. "If we do not build it now we will have to forego the US$700 million which has been pledged by different donors. So it is better to build Arun III than to lose that money."

Arun III, ironically called 'Baby Arun', as it is half the size of the original project proposed in 1985, costs 1.5 times Nepal's total annual budget. It involves US$30 million for air support alone, including helicopters to lift in cement and diesel. The 117 km access road will cost US$120 million, six times the cost of a similar 130 km road funded by the government.

Even though all external expenses will be covered by donations or soft loans, the local contribution will still be 1000 million rupees (US$28 million) annually when construction begins.

The World Bank says it is taking these potential problems into account. "The local costs will have a big impact on funds available for social sectors, such as eduction and health care," said the World Bank's Loenstein. "Questions have been raised and discussed. That's why we are carrying out this latest appraisal."

Past actions by the bank indicate that financial stringency overrides social concerns. To ensure that it will get its money back, the bank has forced the Nepal Electricity Authority to increase electricity prices by 150% within three years, making Nepal's energy prices the highest in South Asia.

Arun III has been stumbling forward since the early 1970s, urged on by international donors. In the early days the dam was supported by the authoritarian Panchayat government, so few people dared to question it openly. By 1988, even Nepal's Water and Energy Commission opposed the dam. But successive governments appear to have been seduced by the vast amounts of money on offer, and the scheme now looks set to become reality.

All round the world dams funded by the World Bank have run into problems, in the Americas, Africa and Asia.

IBPI week sees new contracts

AT THE close of the Indo-British Partnership Initiative's Bombay Week, it was announced that contracts worth more than £1 billion have been signed between Indian and UK companies in the power sector.

Robert Evans, leader of the initiative and chairman of British Gas, praised the achievements of the IBPI. Leader of the Indian initiative, Jamshed Irani, indicated that the impetus must be maintained.

A £135 million contract between GEC Alsthom UK Ltd and Powergrid India to supply a high voltage current link between western and southern electricity networks, was among those signed during the week. As were £110 million of contracts between Rolls Royce and Spectrum Power Generation, for the supply of a 200 MW CCGT power station at Godavari Andhra Pradesh, and with CESC Ltd for a 2 x 250 MW thermal power station at Chandil Bihar, worth about £275 million.

The Ashok Leyland National Power Consortium signed a principles of power purchase agreement involving investment of around £80 million by National Power plc, and with the Andhra Pradesh State Electricity Board for a new power plant at Vishakapatnam.

Following the signature of a Memorandum of Understanding in January, the Gas Authority of India Ltd (GAIL) and British Gas have reached agreement on the availability of gas, on how to develop the natural gas market, and have agreed to establish the Bombay City Gas Distribution Joint Venture Company. Subject to the final approval by the Indian Government, both parties have agreed that the company will be formed and operational by March 1994.

PowerGen and Aditya Birla Group signed a cooperation agreement involving the development, construction and operation of new private power projects, and the acquisition/refurbishment and expansion of existing plants.

Prospect of early review recedes

IN A brief reference contained in a speech to Trade Unionists for Safe Nuclear Energy, the Minister for Energy, Tim Eggar, dashed any last remaining hopes that the nuclear review will be brought forward to 1993, as promised in the coal White Paper earlier this year.

Mr Eggar also stated that he could see no case for extending the Fossil Fuel Levy beyond 1998.

Discounting future public funding to build new nuclear capacity, Mr Eggar suggested that one way of testing the market was to see if the private sector would finance, build and operate Sizewell C, which Nuclear Electric have estimated could sell electricity at less than three pence per kW/h. The Minister hinted that privatisation was "a logical development", adding that "nothing would give me greater personal satisfaction than to complete the privatisation of the ESI."

In a speech that in some ways prompted the the terms of review, Mr Eggar listed possible privatisation options, and the problems they posed. He congratulated Nuclear Electric and Scottish Nuclear for the "great strides" made since 1989, when the nuclear element was removed from the privatisation of electricity.

The UK's first waste tyres to energy power generation plant was officially opened in November at Bilston in the West Midlands. Pictured above from left to right are Brian Staples of Tarmac Construction Ltd, which designed and built the plant, and Ann Evans, managing director of Elm Energy & Recycling (UK) Ltd. The opening ceremony was performed by Professor Stephen Littlechild, director general of OFFER. The plant is rated at 25 MW.

Grants for emissions reduction

ENVIRONMENT Minister, Baroness Denton, has announced two further grants under the Environmental Technology Innovation Scheme (ETIS). The grant offers a total of £371 000 and will go to consortia consisting of Oxford University and EA Technology Ltd; and FKI Columbia and Kent Scientific & Industrial Projects Ltd.

The first grant will help fund a research project to develop an environmentally-friendly cooling unit for refrigerators and freezers. The second will help research into a technique to reduce the use of solvents. The grant offers represent half of the eligible project costs

The effect of the projects will be to reduce emissions of volatile organic compounds (VOCs) and chlorofluorocarbons (CFCs).

Business Energy Award winners

Winner of Beta category 2, the Bath Christian Trust, this art deco building was originally a cinema.

THE 1993 Business Energy Awards were announced in London in November.

The Beta (building energy efficiency) section was once again divided into new-build and refurbished categories. The latter was won by the church and concert hall belonging to the Bath Christian Trust, and the first prize for a new building went to the Employment Services' new job centre in Newport, Gwent.

In the PEP (power for efficiency and productivity) section the first prize was taken by Stilexo Industrial in the category for companies with less than 100 employees. In the category for companies with over 100 employees, Peebles Electric took first place, with a recorded energy cost saving of 94%.

Age old answer to a modern problem

BOTH the environmental and economic advantages of using wood fuel as a viable alternative to fossil fuels were highlighted at a workshop held in November.

A combination of factors has led a number of government departments, namely the DTI, MAFF and the Forestry Commission, to support the promotion of wood as a fuel. Part of the DTI's biomass programme, the project is managed by ETSU.

In an opening address, David Borham of MAFF said: "Wood fuel is not a passing wonder. Several factors ... give it powerful momentum: growing public concern for the sustainable use of resources, compatible with the environment; a need to boost rural employment; and a need to find a positive use for surplus agricultural land.

Dr C Foster of ETSU pointed out that a prime environmental interest in the subject arose from the perceived threat of global warming. Using modern methods wood fuel can provide carbon and energy benefits which would lead to an overall reduction in carbon dioxide emissions.

Edmonton extension

CONSENT has been granted to extend the Edmonton solid waste power station from a rating of 55 MW to about 90 MW.

Appointment

THE NEW deputy director general of the Office of Electricity Regulation (OFFER) in Scotland will be Graeme Sims. Mr Sims replaces Peter Carter, who is now deputy director general at OFFER's headquarters in Birmingham.

Mr Sims, 30, is currently economic adviser for OFFER Scotland.

Boost for CHP

PRESIDENT of the Board of Trade, Michael Heseltine, announced in November that he plans to exempt CHP schemes from paying the nuclear levy.

Addressing a CBI conference in London, Mr Heseltine said: "companies which generate electricity for their own use ... have to hold a supply licence if they consume less than 51% of the electricity themselves. It makes it more difficult for companies to choose CHP."

BG announces new chairman

BRITISH GAS has appointed Richard V Giordano KBE as chairman of the company to take effect from 1 January 1994, following Robert Evans' retirement on 31 December 1993.

Cornish wind farm opens

THE FIFTH windfarm to be commissioned by National Wind Power was officially opened in November.

Sited at Cold Northcott, near Launceston in Cornwall, the windfarm occupies one hectare and has 22 MS-3 300kW turbines, made by UK manufacturer, the Wind Energy Group.

National Wind Power is a joint venture between Taylor Woodrow Construction and National Power.

BREEAM launch

NEW light industrial units, DIY stores and warehouses can now be assessed for their environmental impact, using the Building Research Establishment's Environmental Assessment Method (BREEAM).

At the November launch, RIBA president, Frank Duffy, said: "the 'greening' of products, including buildings, should be seen as a contribution towards improving quality. It must not be a bolt-on afterthought, but an integral part of the design process."

BREEAM is the only scheme in Europe for measuring the overall environmental impact of buildings. It will help UK industry to meet commitments such as the phasing out of CFCs, and achieving the national carbon dioxide emissions target.

Roger Courtney of BRE emphasised the success of the first version of BREEAM for new offices which, since its launch in 1990, has been applied to around 25% of new office space.

Ecolabelling — higher profile urged

ENVIRONMENT Minister, Baroness Denton has welcomed the award of the first EC ecolabel to a major UK manufacturer.

Ecolabels are awarded to products which satisfy 'cradle to grave' environmental criteria. The aim is to provide clear and reliable guidance to consumers on which products are least harmful to the environment.

Speaking at the UK ecolabelling board, Lady Denton said: "I am delighted that the first EC ecolabel is being awarded and that the award is to a washing machine produced by a major UK manufacturer. This is an important milestone in the history of the scheme. The UK appears to be setting the pace on this scheme.

"Now the first labels have been awarded I hope that the Commission will give the work greater priority, and that member states who have as yet made no contribution will be drawn into laying an active part."

British Coal agrees in principle to licence Clipstone colliery

FOLLOWING what the company describes as 'substantial progress' in discussions with R J Budge (Mining) Ltd, British Coal has agrees in principle that a lease and licence will be granted to the company in respect of Cl;ipstone colliery, near Mansfield in Nottingham.

Further discussions are due to be held to reach agreement on outstanding technical, commercial and legal questions. Both parties are committed to finalising these talks as quickly as possible.

Chief executive of R J B Mining plc, Richard Budge doesn't foresee any of the outstanding issues causing major problems, and hopes to restart mining operations at Clipstone as soon as possible. They have already begun to recruit a team, with the help of the UDM.

Clipstone is one of 20 British Coal deep mines which have ceased production and been offered to the private sector. Production at the colliery ceased in April of this year, when it was placed on care and maintenance following publication of the coal review White Paper.

The mine has two shafts sunk between 1920-22 to a depth of 613 metres. Since then it has worked four seams, and in the last full year of operation, produced 822 000 tonnes of coal.

New IPE record

A RECORD total of 1 464 928 contracts were traded on London's international petroleum exchange (IPE) in November. This was an increase of 4.8% over the previous record, set in September. Twice that month the daily total exchange volume exceeded 110 000 contracts.

The Institute of Energy held a conference in November on *Making Energy Privatisation Work: the Future of Regulation*, at the Queen Elizabeth II Conference Centre in London. The opening address was given by Tim Eggar MP (pictured above), Minister for Energy, who countered the oft- made claim that the UK lacks an energy policy. Others among a distinguished list of speakers were Richard Caborn MP, chairman of the Trade & Industry Select Committee, David Jefferies CBE, chairman of the National Grid Company, and Lady Wilcox, chairman of the National Consumers' Council. A full conference report will appear in the next issue of *Energy World*.

Oil and gas field regulations lifted

THE Department of Trade and Industry have simplified the procedures for regulating oil and gas field development and production, as from the beginning of December 1993.

The new procedures should cut licensees' costs on a typical North Sea field by £200 000 to £300 000 at the annex B stage. A further £100 000 or more may be saved over the productive life of the field.

The traditional approach to annex B documentation has been replaced by a less formal, interactive process, focussing on the identification and resolution of issues where there is true divergence between the DTI and the licensee. Development plans will be slimline summaries — only a few pages of text will be required for a simple field.

'Small' fields (less than 20 m barrels of oil/ 60 billion cubic feet of gas]will be subjected to less rigorous assessment, with approval times being cut by more than half. Production consents will be more flexible and for longer periods.

The next issue of *Energy World* will be a combined January/February issue, and will be published in February.

Extending competition in energy supply

FROM April 1994, the next stage in the opening up of the electricity supply market to greater competition comes into effect. Electricity users with a peak demand of over 100kW (an annual billing of around £15 000) will be able to choose their supplier for the first time.

The existing tariff system will be replaced by a total of four different contracts. The first is a connection contract, made with the local regional electricity company (REC) for the use of their distribution system. The second, a supply contract, can also be taken out with your local REC, or alternatively you may wish to buy your electricity from a second tier supplier.

Next is the use of system contract, made between the supplier and the host REC. These contracts cover the pricing elements of the tariff for transportation of electricity through the distribution businesses.

Finally, a meter operator contract must be in place. If a company wishes to enter the competitive market and wants to take a contract with a supplier that is not the host REC, it will need to appoint a meter operator to take care of all the necessary metering alterations that would be required.

RECs are advising potential customers to have connection contracts in place by 1 February 1994.

Second tier customers' meters will be read remotely each day. The cost of data collection will be shared among all suppliers in the 100kW market, based on the number of customers they supply, as decreed by OFFER.

Potential suppliers, for example the RECs, have begun to launch helplines for customers wishing to discover more about the introduction of competition and how it will affect their businesses. London Electricity's helpline number is 071 725 3137. Midlands Electricity's Powerline service can be contacted on 021 423 3018.

CHP — innovation in the air

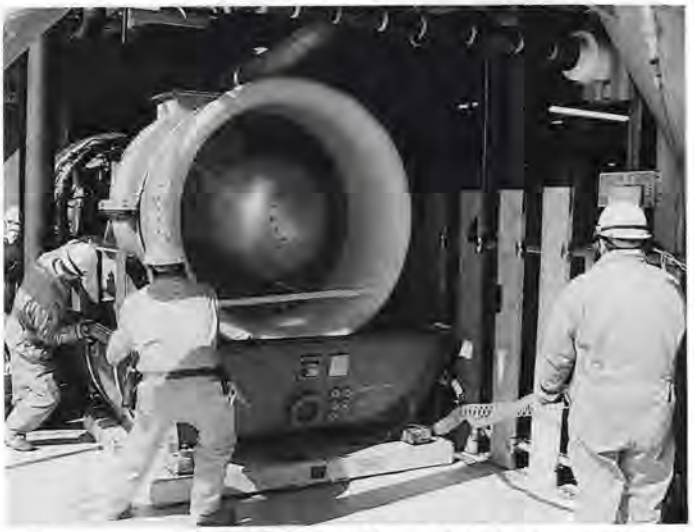
BACK in 1989, Biddle Air Systems, a company which up until then had been mainly concerned with air handling units, fan units, industrial heaters and air curtains, was inspired to enter the power generation market.

The Government's publication of *Our Common Inheritance* along with a new enthusiasm for combined heat and power systems gave Biddle the idea for an entirely new type of CHP system. The company built a prototype at their Nuneaton factory, and have spent the last three years testing it. The first unit is due to be delivered to the customer, a large supermarket chain, in January 1994.

Biddle have been granted the UK patent for their product, called 'Air CHP', and have applied for the international patent. The company claim an impressive 95% efficiency of energy conversion for their units, which transfer waste heat from the engine cooling system and exhaust to the airstream via a heat exchanger. In addition, oil cooler and engine surface heat is recovered directly into the airstream.

The application for the new range of fully-packaged units is different to that for conventional CHP. The recovered heat, in the form of direct warm air is ideal for buildings with large areas and a 24 hour requirement for heat and power, such as warehouses, hotel complexes, supermarkets and airport buildings.

Among the advantages of the system are a simpler heat exchange process and the ability to provide simultaneous air and water heating. Estimated payback, based on 4000 hours pa operation, is three years, and possibly even less if stand-by generation capacity is required.



Three 8 tonnes GE LM 5000 gas turbines took to the air recently for delivery on Marathon Oil UK's East Brae platform. The company recommissioned air film transporters originally supplied to Marathon seven years ago for the Brae B platform.

The air film equipment gave the total freedom of movement necessary to manoeuvre the bulky engines through a complex movement path with tight clearances, as well as keeping the floor loadings low and well distributed, avoiding potential damage to the platform deck structure.

Air film specialists, Cawley Marine Industrial Ltd (CMI), involved in the original supply of equipment, were called in to refurbish the transporters, as well as to provide operator training and to assist Marathon's engineers in carrying out initial trials with a full-weight, full-sized mock up of a turbine.

Following the training and trials, the three turbines were installed in quick succession without problems.

For further information contact Tony Cawley, CMI Ltd, PO Box 12, Twyford, Berks RG10 9LS. Tel: 0734 402783; fax: 0734 404525.

Partners in power

A NEW £3 million mini-power station at Albright & Wilson's chemical works at Oldbury in the West Midlands was opened in November by John Spellar MP.

The CHP plant is owned by National Power and will generate over 30 million units of electricity and produce about 70 000 tonnes of steam each year, most of which will be purchased by Albright & Wilson for use on their site.

The plant is based on the latest gas turbine technology and, with an overall energy utilisation of about twice that of a conventional power station, the environment will benefit as well as helping the company to control their energy costs.

The scheme is National Power's first industrial CHP plant to be completed. National Power are currently constructing four other CHP plants at customer sites, including a £6 million plant on Albright & Wilson's site at Whitehaven, Cumbria.

For further information contact Mark Thomas of National Power Cogen on 021 702 1133.

EDAS advises

AN ENERGY study undertaken by Energy Design Advice Scheme consultants Short Ford and Associates on behalf of the Greenwich Enterprise Board has concluded that if its heating, ventilation and lighting recommendations are undertaken, a proposed light industrial complex at Horn Lane, Greenwich in south east London would be the 'most energy efficient light industrial premises in the country.'

The Greenwich Enterprise Board required that the proposed project was designed to the highest environmental standards. The industrial workshop units will encourage the formation and growth of small business in the area.

EDAS is a discretionary initiative sponsored by the DTI, and can offer applicants with eligible projects up to one day's advice paid for by the scheme.

Coal research:

present activities, future needs

*by Dr Alan Walker, BSc PhD FRSC CChem**

Despite an apparently dismal future for the UK coal industry, and the status of coal research, Dr Alan Walker believes the undeniable need for coal utilisation will ensure the endurance of coal research in the UK.

THE VARIETY of coal, which holds a fascination for scientists, can be a source of frustration to engineers developing new coal technologies. Thus pilot-scale development work and initial plant operation tends to concentrate on the use of a single coal or a group of nominally similar coals. Later, when the need arises to optimise an established process, and to generalise its application to a wide range of coals differing in character, a deeper basic understanding of the chemical and physical processes involved, and the influence of coal properties thereon, is required.

Current coal research and future needs will follow this general pattern. Thus, for established uses, such as pulverised fuel combustion and coke making, present research is aimed at fine tuning of the processes, while basic operating parameters are still being sought for the newer applications in coal gasification and liquefaction. Environmental concerns and recent legislation have necessitated investigations of means of abatement of environmentally-undesirable species emitted by established processes, and promoted the development of clean coal technologies.

Coal combustion represents the largest current UK market for coal. The predominant combustion technology is pulverised fuel (pf) firing for power generation, with chain-grate stokers and fluidised bed combustors also being used for steam raising. All can be regarded as established processes so that research is aimed primarily at process optimisation and mitigation of the environmental impact.

Coal combustion is a two-stage process: coal devolatilisation being followed by reaction of the char and volatiles with the combustion air. In the process, ash released fouls heat transfer surfaces and damages brickwork, while sulphur and nitrogen in the coal form environmentally-unfriendly SO_2 and NOx.

For both pf-fired and fluidised bed combustors, equipment varying widely in size and thermal output is presently being used to seek a clear understanding of the influence of coal properties on rates of devolatilisation and char burn-out, and on combustion performance in general. The aim of this work is to obtain the detailed information necessary to develop further quantitative models of the behaviour of coals in combustion systems so that control strategies can be extended and maximum efficiency achieved. Improved efficiency has environmental as well as economic benefits.

Abatement of SO_2 emissions from existing pf-fired plant is currently being achieved by retrofitting flue gas desulphurisation (FGD) equipment, while low-NOx burners and fuel staging reduce NOx emissions. In fluidised bed combustors, limestone is used as a SO_2 sorbent, while the low temperature favours N_2O rather than NOx formation. Development studies on gaseous abatement systems, supported by extensive laboratory investigations of the chemical reactions involved in the formation of gaseous pollutants, are being carried out so that present and future emission standards can be met.

The future of large-scale coal combustion will depend on it being both economically and environmentally acceptable. Optimisation of plant performance and the control of emission levels both depend on the ability to understand the physical and chemical processes at work in a given combustion system. Continued research on improving the characterisation of coals for combustion, and on better understanding the combustion of coals (and blends of coals) in pf furnaces will be required.

A better appreciation of the distribution and association of mineral matter in coal is also needed, so that slagging and fouling can be predicted.

To aid in the reduction of NOx emission levels, considerable further work will be required to understand the complex nitrogen chemistry occurring under pf and fluidised bed combustion (FBC) conditions. Also depending on the emission standards prescribed, studies of selective catalytic and non-catalytic reduction (SCR and SNCR) of NOx may be required. Trace element emissions may also require attention.

A developing application of coal combustion is the direct injection of coal into blast furnace tuyeres. Coal combustion at tuyere level supplies heat and carbon units for the process, thus reducing the coke requirement. Whilst direct injection is currently a small consumer of coal, it is both economically and environmentally attractive. Consequently, efforts are being directed to maximising the level of coal injection. This requires a knowledge of coal devolatilisation and oxidation under blast furnace conditions, and further studies are needed to optimise and control the process.

Gasification

Coal gasification, followed by combustion of the cleaned gas in a gas turbine (integrated gasification combined cycle {IGCC}) is the favourite future method of generating power from coal in an environmentally-friendly fashion. The slagging gasifier, successfully developed by British Gas as the first stage of a synthetic natural gas production unit, is commercially available as the gasifier stage of such a system. However, in the approach favoured by British Coal, coal is partially gasified in air inside a pressurised gasifier, and produces a low-CV gas for the turbine and a char to be burnt in an atmosphere-pressure, circulating fluidised bed combustor to produce steam. Present research on coal gasification is aimed primarily at assisting the development of this British Coal Topping Cycle (BCTC) power generation system. Increased Government funding for clean coal technologies, particularly for Topping Cycle studies, has recently been announced.

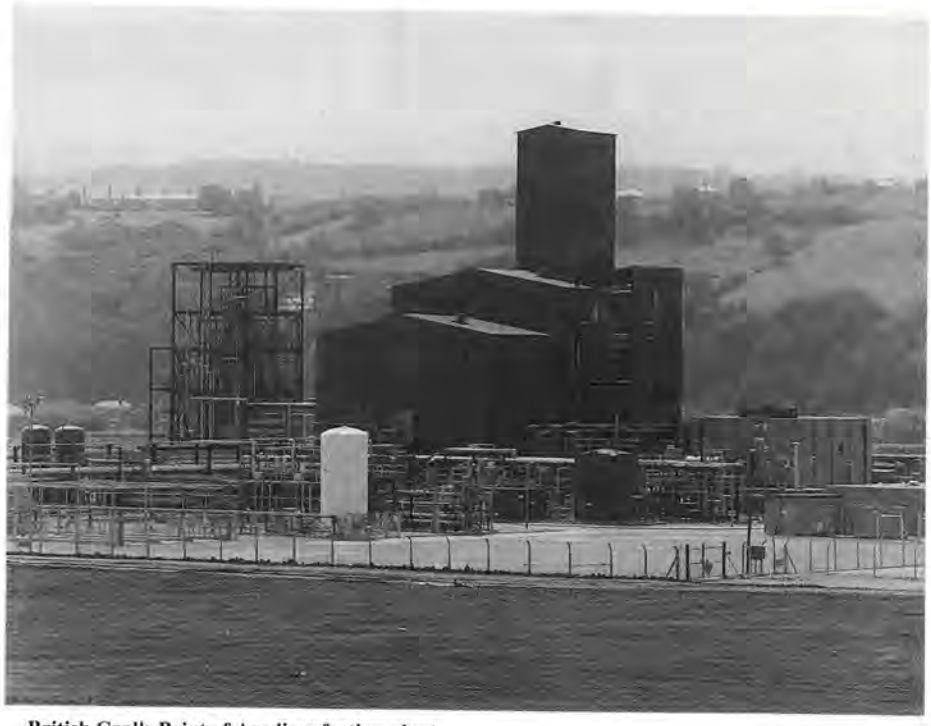
Current pilot-scale work for the BCTC is aimed at developing and proving the gasifier performance, devising control strategies and

**Editor, Coal Research Forum Newsletter, Carbon Research Group, Loughborough University of Technology*

investigating the effect of process variables on system efficiency, costs and pollution aspects. NOx and SOx abatement methods are being investigated, as are means of removing particles from hot gases. Meanwhile, fundamental studies of the mechanisms of partial gasification and residual char combustion that influence fuel performance and gaseous emissions are currently being carried out on a laboratory scale. These aim to gain a deeper understanding of the reactions involved and to provide data for process modelling.

As development proceeds, it will becomes increasingly important to widen the range of usable coals. This requires an understanding of the effect of coal properties on the Topping Cycle processes. New tests, using high heating rates, to characterise the gasification behaviour of coals and the combustion of their chars in a relevant manner will be necessary.

Further studies into gas cleaning processes will be required, with particular emphasis on the filtration of fine particulate matter, the removal of HCI and alkali salt species and the control of NOx and SOx emissions. NOx and SOx control will be facilitated by a clearer knowledge of the reactions of their precursors, H_2S, NH_3, and so on, and their interaction with sorbents and catalysts. Integration of the system is a major uncertainty, which will require attention at the demonstration stage.



British Coal's Point of Ayr liquefaction plant.

Liquefaction

Coal liquefaction research in the UK is targeted solely at the direct process in which the coal structure is first partially broken down in recycled solvent, by a process of hydrogen transfer from solvent to coal, to produce a coal solution. Hydrocracking of the resulting coal solution then yields liquids with the desired boiling ranges. Considerable research effort is directed to support of the 2.5 t/d liquefaction facility now being operated by British Coal at Point of Ayr.

At the moment research is being carried out on aspects of both the dissolution and hydrocracking stages. Investigations are proceeding on the mechanism of hydrogen transfer in the dissolution stage, including studies of the influence of solvent composition. Hydrocracking catalysts are deactivated by metal and carbon deposition, so means of removal of trace elements from coal solutions are being sought. Methods of characterisation of feed coals, solvents, coal solutions and liquid products are being developed.

As development continues, attention will need to be focussed on optimising the efficiency of the process and minimising the costs. To do so will require a more detailed understanding of the mechanism of the hydrogen-transfer reactions involved in coal dissolution, and the influence of catalysts thereon, and an appreciation of the relationship between coal characteristics and liquefaction potential. More effective catalysts and supports for hydrocracking are needed, as are measures both to retard catalyst deactivation and to regenerate spent catalysts. Hydrogen costs are relatively high, and viable alternatives to pure hydrogen require investigation.

The market for coal for the production of blast furnace and foundry coke is small, but important. The cost of coke represents a high proportion of the production cost of iron. Present economic pressures demand high-quality coke at minimum cost, while the high capital cost of coke ovens makes it essential to ensure a long life for existing coke ovens. There is no accurate, widely-applicable method of predicting the quality of metallurgical coke from a knowledge of coal properties. Hence, with changing patterns of coal supplies, blend formulation for cokemaking requires constant attention.

Current research on carbonisation includes studies of the mechanism of coking leading to the prediction of coke quality from knowledge of the behaviour of blend components and thereby improving methods for the selection of coal for carbonisation. Coking pressures, which if excessive can damage oven

The Coal Research Forum

Based at Stoke Orchard in Cheltenham, the Coal Research Forum was formed in 1989 to bring together scientists interested in coal research, whether employed in industry or in an academic institution. Its aims are to encourage, promote and coordinate basic research on coal, coal products and coal utilisation in the UK. An executive committee supervises the overall direction of the Forum, but many activities are organised by the research divisions, which presently cover carbonisation, pyrolysis and briquetting, coal characterisation, coal combustion, coal gasification and coal liquefaction. Efforts are being made to establish a coal preparation division.

Recently the chairmen of the existing research divisions were asked to obtain from their members details of their current research activities and perceived future research needs. The wide membership of the Forum assured consideration of most aspects of coal research. The information gained is being assembled into a report which will be available shortly. This paper presents a summary of the information collected. It represents a consensus of opinion amongst those members of the coal community who recognise the need for an ongoing national policy for coal research in the UK.

walls, are a worry, and the measurement and control of coking pressures are receiving attention. Research on the physics and chemistry of the briquetting of coals is in progress.

Work on areas of research already outlined is likely to continue into the future as sources of coking coal change and widen. In addition, investigations are needed of ways of maximising the yield of coke in the size range required by the user. This requires studies of the mechanism of fissure formation and the factors influencing the size and distribution of fissures in the coking charge. The potential for reducing the cost of an oven charge by incorporating cheaper coals, in a pelletised or briquetted form needs further investigation.

Coal characterisation

Coal characterisation is an area of fundamental importance to all areas of coal utilisation. It encompasses a wide range of types of study, from standard analytical methods to non-routine test methods and investigatory work designed to meet a particular need. The equipment used ranges in size from bench top to commercial scale. Characterisation methods are being developed to monitor commercial processes, to assess coals, to aid process development and to assess the environmental impact of coal utilisation.

Many of the standard analytical methods presently available were developed for the coking industry, but are now being widely applied. This is valid for certain analyses, eg, elemental composition, but not for others, such as volatile matter, whose value depends on the test conditions. New characterisation methods are being developed to enable the performance of coal in a range of new processes to be assessed.

Other important aspects of work on coal characterisation include extending knowledge of the structure of coal, and assessing the potential of the newest analytical techniques in the characterisation of coal.

Whilst much characterisation work is in progress, further work is needed. The problem, fundamental to all coal utilisation processes, is a lack of appropriate methods of characterising coals coupled with an absence of detailed knowledge of the way coal behaviour influences the processes. Future characterisation research must address this problem to allow process optimisation. There is also a need for standardisation of test procedures.

International concern for the protection of the environment led to the EC Large Combustion Plant Directive (LCPD) limiting the emission of air pollutants from large combustion plants. This set emission limit values for SO_2 and NOx and particulate matter for new plants, as well as national reductions for existing plant. The national requirements for the LCPD have since been incorporated into UK legislation, as part of the Environmental Protection Act (EPA) 1990. The implementation of this legislation has made it imperative to investigate clean coal technologies.

Under the EPA, operators are required to apply the best available techniques not entailing excessive cost (BATNEEC) to all aspects of process operation. For existing pf-fired plants, aside from careful coal selection, low-NOx burners, fuel and air staging, FGD and SCR and SNCR are appropriate technologies. However, application of SCR and SNCR in the UK is not currently classified as BATNEEC, due to the costs and technical uncertainties involved. This situation could change if emission levels were further reduced. Combined coal gasification/gas turbine plants offer the prospect of inherently cleaner coal utilisation for future power generation from coal, while coal selection or novels methods of coal cleaning may also be beneficial.

The aim of current research is to develop reliable technologies for SO_2, NOx and particulate matter abatement with low capital and operating costs. Technologies for application at both the coal preparation and utilisation stages are being sought. Generally the utilisation technologies, perhaps in different form, will be capable of operation on all types of coal-firing equipment. Development work

Inside the Topping Cycle test rig at Grimethorpe, since closed.

is being supported by fundamental research on the processes involved. The development of inherently clean coal technologies is a prime objective, but post combustion and utilisation techniques are also required. Other environmental concerns currently receiving attention include the disposal of residues from FGD, FBC and coal conversion processes and release and control of hydrocarbons during combustion.

Many of the present areas of research will continue for a number of years to come. To aid problem solving in existing plants and in the design of new plants, especially if emission standards become more stringent, there is a need for better understanding of the mechanisms involved in different emission and pollution control processes so that suitable process control models can be developed. The production of CO_2 during the combustion of fossil fuels is likely to be the environmental issue of the future. Feasibility studies to assess the technical problems and the costs of removing CO_2 from the flue gas, followed by suitable disposal options may need to be undertaken. More detailed characterisation of residues from new coal technologies will be needed against a background of more stringent legislation on waste disposal.

As a summary of the views of existing coal research workers, this article inevitably has an element of wish fulfilment with regard to future research needs, although no consideration has been given to funding sources. In fact, in the long term coal research in the UK may be facing a less certain future. Privatisation of the electricity generating industry has led to in-house coal research concentrating on the shorter-term problems associated with existing pf-fired plant. A privatised coal industry — significantly smaller even than the present one — will probably take a similarly short-term view. Consequently, long-term development of the Topping Cycle and coal liquefaction may be dependent on continued government funding, through the DTI and the EC. Successive UK governments will be faced with difficult choices, and, as the size of the UK coal industry is reduced, will increasingly question the level of funding for coal research.

The outlook is not totally cheerless, however. While in the short term, UK demand for coal may fall, worldwide demand is expected to increase. In the USA demand is forecast to double by 2040. In the EC as a whole, hard coal production continues to decline steadily, while imports from third countries (now 41% of total tonnage within the EC) exhibit a contrary long-term trend. And the UK market is not unique. Large-scale coal utilisation in the UK is likely to continue. On this basis, especially in the light of intensifying environmental concerns, the need for coal utilisation research will persist into the foreseeable future. The Coal Research Forum provides an appropriate focal point for the UK coal community's identification of needed research. ❑

Acknowledgments

The detailed information on current activities and future needs, on which this article is based, was provided by the Coal Research Forum divisional chairmen: Mr G M Kimber, Dr A J Oliver, Prof J W Patrick, Dr N P M Patterson and Dr K M Thomas. Thanks are also due to the CRF secretary, Dr D J A McCaffrey, and to other members of the CRF executive committee who read and made helpful comments on the major part of this paper.

Cooking coal

*by William R McWhinnie and Parisa Monsef-Mirzai**

Research being carried out at Aston University has demonstrated the value of microwave heating methodology in the science of coal analysis. Although in the short to medium term the cost of microwave energy will prove a disincentive, in the longer term these applications could be exploited.

DESPITE the rapid decline of the UK coal mining industry, it is certain that both the UK and other member states of the EC will continue to rely, for the foreseeable future, on the combustion of solid fuel for the generation of a very substantial portion of the Community's electric power demand. Looking further ahead, perhaps now more speculatively, it may be that into the 21st century it will be necessary to revisit coal as a source of both feedstocks for the chemical industry and of transport fuels.

Given the certainties and possibilities above, it makes good sense that a substantial national and international research effort in coal science should be maintained on a long-term basis. It is reasonable that a significant portion of that effort should be devoted to the development of more efficient and more environmentally friendly ways of utilising coal as a source of energy. It is also reasonable that exploration of means to enable 'value added' products to be obtained from coal should be encouraged. The needs of other users of coal and coal products (eg, coke) such as the steel industry, should not be overlooked in the development of a research strategy for coal towards the millennium.

Coal is a complex material which has proved remarkably resistant to systematic investigation. Even the term 'coal' covers a range of materials extending from peat and brown coal through high carbon content (>90%) anthracites. The term 'structure' of coal cannot have the same meaning as, say, 'structure' of a well known molecular species such as anthracene. Rather, perhaps, we should talk of structural features which may characterise coals of particular rank and origin. Knowledge of these structural features is important for the utilisation of coal. An obvious example is that knowledge of the distribution of sulphur will be important if clean combustion of coal is the objective. Less obviously, the distribution of the oxygen content of a coal across functional groups such as phenolic -OH is important to hydroliquefaction processes, since the process must effect the removal of oxygen if the production of hydrocarbon products is the aim of the process. In addition to sulphur oxides (SOx) which arise from the sulphur content of coal, the combustion process will convert the nitrogen content to nitrogen oxides (NOx) which are also environmentally harmful. This knowledge of the distribution and chemical binding of nitrogen in the coal matrix is desirable.

The field of materials science (and coal is

within that context a material) has benefited enormously from the development of a range of new physical methods which may be applied to the study of non-or micro-crystalline materials. Examples which have been applied to coal research include solid state ('magic' angle spinning) nuclear magnetic resonance spectroscopy (MASNMR), extended x-ray absorption fine structure (EXAFS), and x-ray absorption near edge structure (XANES). Often the effective use of those modern physical methods requires the chemical derivitisation of a particular functional group, HO say. That functionalisation may be less simple than imagined since the reaction between the coal and the derivitising reagent is of necessity heterogenous, and there must always be uncertainty as to whether the reaction has proceeded to equilibrium.

Advantages of microwave heating

Polar molecules are those with permanent dipole moments. If the molecules are placed in an electric field the molecular dipole will align with that field. If the field changes direction, the molecular electric dipole will realign with the new field direction. Electro magnetic radiation is a good example of a rapidly fluctuating electric field and within the microwave region of the spectrum the electric field fluctuates sufficiently rapidly for the molecular dipoles to log behind the fluctuations of the field. This viscous 'drag' manifests itself as heat formed *within* the polar, usually liquid, medium. Since heating is from within, the sample heats extremely rapidly and, if a polar liquid were constrained within a sealed Teflon container (Teflon is transparent to microwaves), superheating of the liquid can occur. If that liquid is used as a solvent for reactants in a chemical process, the rate of the process may be enormously accelerated by a simple Arrhenius effect. For example, it has been reported that esterifications which take 16 hours on the open bench may be accomplished in two minutes in a simple domestic microwave oven when carried out in sealed Teflon containers. Using similarly simple apparatus the heterogenous ion exchange of a smectite clay takes but five minutes compared with one week using a conventional procedure. It occurred to us that reactions of coals may be similarly accelerated and this proved to be the case.

As already mentioned, an effective hydroliquefaction process must remove oxygen from coal, hence both the quantity of oxygen present and its distribution between functional groups are matters of importance. For medium to high rank coals it is accepted that the majority of the oxygen content is associated with phenolic -OH groups, hence the objective is generally to determine -OH content. Analytically this is usually accomplished by derivitising the -OH group, eg, by acetylation, the acetyl-groups may then be hydrolysed to acetic acid which is distilled from the reaction medium and titrated. Four distinct experimental steps may be identified in such a procedure. When microwave heating was applied to the initial acetylation step, it was noted that higher absolute estimates of -OH content were obtained, although the variation of -OH content with rank of coal followed a previously established trend. The significance of this result is that it now seems unlikely that the previously used conventional methods of acetylation had been effective in reacting all the -OH groups.

More recent work has focused attention on the development of an analytical method involving a single wet stage. We selected silylation of -OH groups with the trimethylsilyl-group as a means of introducing a group that could be examined by quantitative MASNMR spectroscopy utilising the ^{26}Si nucleus.

Although some care must be taken when using solid state NMR spectroscopy quantitatively, and it must be accepted that the overall accuracy will be less than for other methods, we have again been successful in demonstrating the superiority of microwave methods, we have again been successful in demonstrating the superiority of microwave methods for the silylation of coal. Samples of Creswell coal undergo complete silylation of -OH groups in 35 minutes in the microwave oven compared with 24 hours using refluxing reagents on the bench. The less porous Cortonwood coal undergoes complete silylation in three hours in the microwave oven, but on the bench the reaction is still incomplete after 30 hours.

Work with model compounds warns that the degree of reaction, even in the microwave oven, depends on the steric hindrance of -OH groups and also on the steric demand of the reagent. Thus, since we are now confident that we can drive any derivitisation reaction to equilibrium in the microwave oven, by selection of a series of reagents of differing steric demand, eg, CH_3-, $(CH_3)_3Si$-, $(C_4H_9)_3Sn$- the possibility opens up of being able to 'map' the steric environments of -OH groups in a given coal. For whatever purpose the chemistry is done, we now confidently suggest that derivitisation of coal functional groups using microwave heating must now be the method of preference.

Microwave ovens and reactors which are readily available operate at a frequency of 2.45 GHz. At that frequency samples of medium to high rank coals heat slowly. There exist other substances however which can heat very rapidly indeed at that frequency, eg, some oxides such as copper (II) oxide, CuO, which is non-stoicheiometric and the mixed valance iron (II)/(III) oxide, magnetite, Fe_3O_4. Graphite heats very rapidly indeed, as do cokes and coal chars which have undergone some graphitisation.

We are not the first to have attempted coal pyrolysis using microwaves. Earlier work has used the presence of metal strips to set up a plasma. Some Australian work has been reported in which low rank coals, eg, lignites, which are rich in polar groups, have been heated with metal oxides, and have pyrolysed to a char which then smelts the oxide. It would appear that the char is an effective sorber of microwave energy.

Our concept was to mix medium rank coals with oxides such as CuO or Fe_3O_4, or with a metallurgical coke, in a silica container fitted with an inlet for dinitrogen gas. The gas may exit through a spiral condenser which may be cooled with solid carbon dioxide within the microwave reactor. The exit gases then traverse two other CO_2 cooled condensers external to the oven. On application of microwave power the samples heat rapidly to maximum temperatures of 1100-1300°C in three minutes. Volatile matter is rapidly evolved and both condensable and gaseous components may be collected for analysis. The tars, chars and gases are analysed by a wide range of techniques and the conclusion reached is that despite the high final temperatures, the majority of the volatiles are evolved in the lower temperature regime (400-600°C). The char can initiate further pyrolyses giving hope of a continuous process. The most encouraging aspect of this new methodology is the excellent tar yields available, eg, up to 49% from Creswell coal using copper (II) oxide.

The downside at the moment is that microwave energy is a noble form of energy, ie, it is expensive. However, extrapolation of thoughts to the future costs nothing, and we may speculate that optimisation of microwave frequency and reactor design in a land where electricity may be relatively cheap, could open the door to a clean and effective method of obtaining useful chemical raw materials from coal.

Environmental aspects

The natural sulphur and nitrogen contents of coal will ensure that, unless preventative action is taken, when it is combusted some NOx and SOx will be formed. A number of options are available to prevent these emissions to the atmosphere, namely pre-treatment (sorb gases, eg, SOx using limestone).

Pre-treatment to remove mineral sulphur is relatively easy. Much sulphur in coal is 'inorganic', generally present as the iron-bearing

** Department of Chemical Engineering and Applied Chemistry, Aston University*

mineral pyrite, FeS_2. Interesting uses of microwave heat treatment have been made which convert the weakly magnetic pyrite to the more strongly magnetic pyrrhotite, FeS, which may then be magnetically separated.

Some sulphur in coal is 'organic', that is it is located in the coal structure where it will be present mainly in thiophenic rings, but also to some extent as thio-ether groups. This sulphur is much more difficult to remove. A microwave treatment with caustic alkali has been reported, but the coal looses volatiles under the severe conditions used (temperatures in excess of 400°C) and a significant loss of calorific value results. Currently we are attempting to evaluate new approaches which utilise the ability of microwave heating to drive reactions rapidly to equilibrium. Thus a range of organometallic reagents known to react with thiophene in processes leading ultimately to the loss of sulphur, are being evaluated for their effectiveness in sulphur removal whilst causing minimal disruption of the organic structure of coal.

We have demonstrated that microwave heating methodology should have a sound future when used in connection with coal analysis and investigations of structural features of coals. The cost of microwave energy makes it less probable that immediate large-scale applications in pyrolysis would be economic, but it is not impossible that in the longer term the process could be more attractive. In the medium term, the technique is more likely to have large scale application when the ability of the method to accelerate *specific* chemical reactions can be exploited. ❑

SUPPLEMENT

Clean coal technologies:

future in the European Community energy scene

*by Pablo Fernandez Ruiz**

The 1993 Robens Coal Science Lecture was given by Pablo Fernandez Ruiz of DGXVII in October. He argued that coal should be seen as the important component it really is in the energy mix of Europe. The following article is based on the text of his lecture.

IT IS a great honour and my pleasure to have been invited to give the 1993 Robens Coal Science Lecture, and it is a great privilege to be able to address all of you in this forum at the Royal Institution.

In what follows I will gladly provide you with my personal views about coal utilisation and specifically about the role clean coal technologies should play in the European Community energy scene.

I understand that this lecture is named after Lord Robens, who dedicated a large part of his life to working for the coal industry. In my case, my direct relation to coal has not been long, but I must admit, has been very intensive. And I have come into direct contact with the coal world and in particular, coal technology, in moments of great difficulty and challenge. The coal production industry in the EC is under great pressure to provide viable operations; it requires demanding companies and governments in member states to move towards fully competitive operation while not creating unacceptable social and economic, and consequently, political situations.

The coal utilisation industries, both in the metallurgical as well as in the power generation sectors, are finding difficulties as coal use is perceived by the European public as damaging to the environment and in some cases, below the threshold of acceptability.

Adding to all this, the world, and particularly the EC, is immersed in an economic crisis which is affecting all sectors of economic activity. The importance of this crisis is such that it is already producing its effects in the budget of some of the EC programmes related to coal (specifically the ECSC programme).

Within this context, coming in contact with the coal world at this moment may not seem very attractive in the first instance, as present difficulties may suggest a dull and difficult future. But a deeper analysis may show this in a different light. This is the subject of my presentation.

To properly understand the role of coal as an energy source in the EC and the world, it would be most helpful to review independently the present consumption of energy by main fuel in the EC and that of the world, and then share with you the available predictions of the role of coal in the energy scene for the medium future, coming from different sources of information. For the latter I would propose those of the EC itself, IEA sources and the UN Economic Commission for Europe. This will allow us to have a realistic view of what is today the contribution of coal and what the reliable sources of information predict it will be in the future.

For the energy consumption of the European Community and a short term energy outlook, I would refer firstly to the data provided in the annual energy review of the Commission of the European Communities published in April 1993. The overall primary energy consumption by source in the EC for the years 1990 to 1993 allows us to see how coal compares to other energy sources. We can see the evolution of the contribution of coal and other sources. It is important to note the role of oil, and that more than 65% of this energy is imported. In summary, for 1992 solid fuels accounted for 22% of primary energy consumption, while natural gas has provided 19%, oil 44% and nuclear 13.5%.

It is evident that nowadays demand for solid fuel is increasingly linked to the power sector. Electricity consumption in the EC continued a steady growth in 1991. Final electricity demand increased by 1.5% in 1992, and predictions for 1993 and 1994 depend very much on the real economic growth figures and weather conditions, which are so difficult to predict. At present solid fuel is the major contributor to electricity in the EC, and nuclear has a similar share.

Of available capacity in the EC, the actual shares in power generation capacities for 1992 show that conventional thermal provided almost 59%. The conventional thermal power generation capacity is formed by solid fuels, oil, natural gas and renewables. The shares they provide show solid fuels at 66% of the total. Consequently, in 1992 the available power generation capacity in the EC was as follows: 40.1% solid fuels, 37.4% nuclear, 10.5% oil, 7.6% natural gas, 3.2% from hydro and 1.2% renewables. The conclusion is simple: today the fundamental pillars of electricity generation in the EC are solid fuels and nuclear.

World shares of primary fuels in gross con-

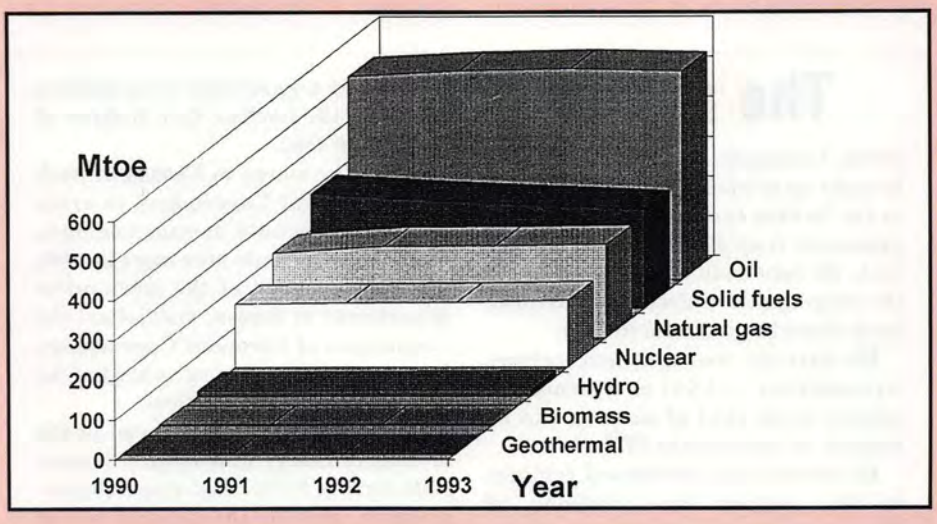
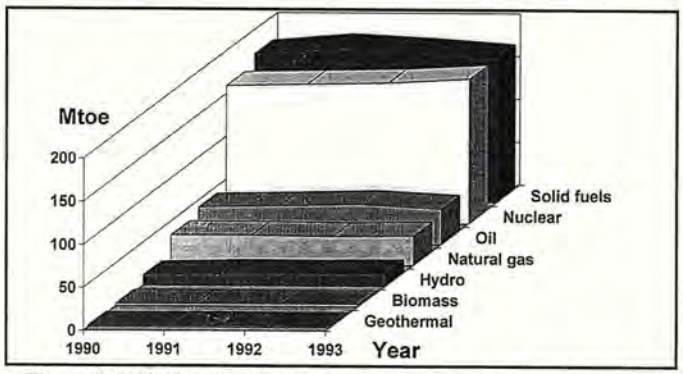


Figure 1: Primary energy consumption by source in the EC 1990-93.



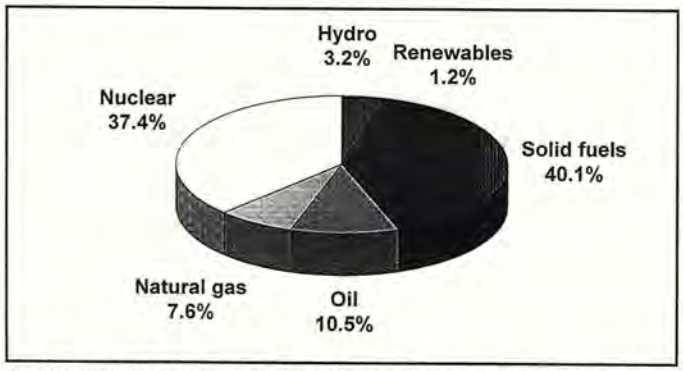


Figure 2 (left): Inputs of primary energy sources to power generation in the EC 1990-93. Figure 3 (right): Shares of inputs of primary energy sources to power generation in the EC 1992.

sumption (1991) are oil 38.1%, solid fuels 25.6%, natural gas 20.9%, nuclear 6.5%, biomass 6.3%, hydro 2.3%, geothermal 0.3%. The share of solid fuels is even greater than in the EC, around 26% of the total. Solid fuels are an important contributor to the world energy scene.

When evaluating the electricity supply for the world in the year 2005 (based on EC data), the contribution of coal to electricity is of even greater importance. In fact its importance will continue to grow, at least until the year 2005. The quality of its utilisation and the impact on the environment should be of great concern to us all.

This is confirmed by IEA predictions, as well as those of the UN Economic Commission for Europe. It is estimated that coal use will increase worldwide by almost 30% by the year 2000. Coal is expected to have the largest absolute growth of all sources, increasing at a greater rate worldwide than in the EC.

At the World Energy Congress in September 1992 in Madrid, the Commission of the EC published updated predictions of energy utilisation in the EC to 2000 and 2005 in *A view to the future.* The use of solid fuel gradually increases, while natural gas picks up quite strongly. For power generation too solid fuel grows in absolute terms until 2005, and continues to be one of the two major pillars of power generation, along with nuclear.

It is true that long-term, or even medium-term, predictions can be inaccurate. The complexity of the problem is such that uncertainties surrounding certain assumptions may discourage belief in forecasts. One such uncertainty concerns the future of nuclear power, which could have a major impact on the demand for fossil fuels. Assumptions about action to combat global warming may also influence the outcome. But the objective of this presentation is not to discuss forecasts, but to contrast different predictions from different sources. Exact values are not important for the purpose of our discussion, trends are.

In estimating coal consumption for electricity generation in the EC, different scenarios have been considered by using different hypotheses of departure cases. It is true that the present economic crisis increases the uncertainty surrounding predictions, but under all the different scenarios, coal consumption increases to the year 2000.

We can conclude that the two pillars of electricity production in the EC are coal and nuclear, but both are under attack by the European public, due to lack of acceptance. They are perceived with distrust as being potentially damaging to the environment. Both sectors have competed strongly, one against the other, to maintain or even increase their share of the electricity production market. Gas has entered the competition and will take a share of the electricity production market as well. This competition is beneficial for the consumer, but due to the sheer size of their respective share of the generation market, both are needed, and a scenario where one will decrease substantially is not a realistic one.

So, after the evaluation of the energy scene of the EC and of the world, both now and in the future, we can safely draw the following conclusions: that coal is an important contributor to electricity production in the EC and worldwide; and that coal will remain an important contributor at least in the next 10 to 15 years.

Coal is presently proving a substantial and useful contributor to the energy scene, both in Europe and the world as a whole, and there are reasons to believe that this will continue into the future. If this is so, a useful exercise would be to analyse the context within which this need would evolve, evaluating its positive and negative aspects, and how additional measures may affect its performance.

I shall evaluate the following aspects: environmental impact of the use of coal; contribution of coal (EC and foreign) to security of supply; technology and economic activity; and public perception of coal use and other energy sources. These are the main outstanding boundary conditions of coal utilisation. Others could be included, but it would require a much longer analysis to arrive at the same conclusion.

The processes to convert coal into energy (electricity in our case), involve the use of 'technology'. The quality of this technology will provide the level of efficiency of the conversion process, emissions levels, quality and quantity of waste, and the level of investment needed to implement it. These boundary conditions will be evaluated to include the influence of technology as well.

Environmental impact

It is no secret that the major problem facing coal utilisation, both now and in the future, is the impact of its use upon the environment.

When coal is mined it carries additional mineral matter which contains elements that

The author

Pablo Fernandez Ruiz was born and brought up in Madrid, where he studied at the British Institute School, having graduated from high school in Illinois, USA. He went on to study engineering at the Politechnical University at Madrid, from where he graduated in 1970.

His first job was at Construcciones Aeronauticas (CASA) as a structural analyst in the field of aircraft, and he finished his doctorate in 1975.

He worked as a mechanical engineer in the nuclear fuels division of Westinghouse Electric Corporation in Pittsburg, USA from 1975-77, returning to Spain as a supervisor of mechanical design in the nuclear fuel division of Enusa until 1982.

In 1982 he moved to Canada to work for the Federal Government in areas related to structural damage tolerance. He returned to Spain once more in 1986, this time as head of the mechanical department at Enusa, and joined the Commission of European Communities, Euratom, in Luxembourg as head of the division of nuclear inspections.

Since 1991 he has been head of the division of energy technologies, responsible for the ECSC coal research programme, and for the rational use of energy and solid fuels sectors of THERMIE.

in the processes of transformation of coal to energy, such as combustion, gasification or pyrolysis, may be released to the environment as potential pollutants. Throughout the EC levels of emissions to the environment of all possible pollutants are clearly regulated. It is difficult to envisage exactly the future of emissions limitation in the EC, but it is easy to argue that it will go in the direction of greater restriction.

The main areas of threat to the environment can be grouped as: grit and dust, SO_2, NOx, trace elements and CO_2.

When burning or gasifying coal or lignite, grit and dust may be emitted. Devices such as cyclones, electrostatic precipitators, wet washers and filters are used to eliminate or reduce these. These easily meet present and foreseeable future standards, although further development is necessary to improve efficiency and reduce cost. In principle, grit and dust emissions should pose no unsolvable problem to coal plant of the future.

Coal and other fuels contain sulphur compounds which on combustion may release SO_2 into the atmosphere. Rain and other atmospheric actions may bring it back to ground level, affecting the water system and damaging plants — mainly forests. There are different systems to reduce SO_2: by cleaning the coal before it is used; or by removing the SO_2 from the flue gas.

Present systems of cleaning coal can reduce sulphur content by up to 30%, but the remaining sulphur is bound within the coal structure.

Flue gas desulphurisation (FGD) processes are used extensively throughout the world (but not sufficiently in the EC). These include the dry sorbent process, spraying drying systems, or by wet processes. These systems have varying efficiencies, and produce increased costs. These areas need to be worked on.

There are also systems where sulphur is removed with the ash in the combustion system.

In summary there are commercially available solutions, but the efficiency and cost elements require improvement.

Nitrogen oxides are formed when fossil fuels are burned, between the nitrogen and oxygen in the air at the temperatures reached in combustion, and by the oxidation of some nitrogen compounds in coal. Together with hydrocarbons from vehicle exhausts, these can form ozone in sunlight. Ozone is thought to be one cause of tree damage.

These gases can also cause acid rain. There are several of techniques to reduce the generation of these nitrogen oxides produced in coal combustion. One way is to remove them from the flue gases, but combustion modifications in the furnace can be very effective. These are called primary measures. For example, by designing the burner and layout

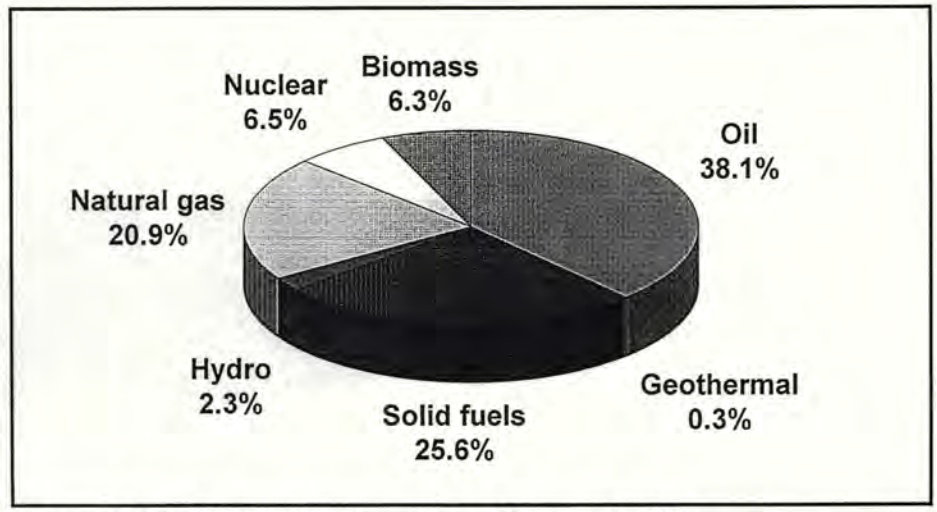


Figure 4: Shares of primary energy sources in world consumption 1991.

in such a way that there is a lack of available oxygen to combine with the nitrogen, the formation of these nitrogen oxides is reduced. This will of course reduce the full combustion of the coal, and further stages should be designed to complete combustion.

Other systems exist as well, such as reburning (injecting gas into the furnace). All these measures require further development and testing, even though systems are presently being used successfully.

During coal combustion, other pollutants can be released partially to the atmosphere, such as chlorine, lead, calcium or arsenic. They are usually retained in the ash, and while efficiencies in the dust removal systems are increasingly following stricter limits, their emission will continue to diminish.

During combustion all fossil fuels release carbon dioxide. Carbon dioxide, along with methane, nitrous oxide and chlorofluorocarbons (CFCs) and others form what are called 'greenhouse gases', and may be the cause of a possible warming up of the planet. There are uncertainties as to the magnitude and timescale of this possible thermal warming due to the man made emissions, and as to the significance of the effect of reducing the emission of carbon dioxide from coal burning.

As all of us are aware that carbon dioxide has become a politically sensitive issue in the EC. The joint Energy/Environment Council of the EC decided on 29 October 1990 "to take actions aiming at reaching stabilisation of the total CO_2 emissions by the year 2000 at 1990 levels in the EC as a whole". This objective was confirmed by the joint Energy/Environment Council on 13 December 1991, and most recently at the United Nations Conference on Environment and Development, when the Community member states reaffirmed this objective when signing the Convention Climate Change.

Complex measures with a wide effect must be put into practice in order to achieve this CO_2 stabilisation objective. So a Community strategy was formally proposed to limit car-

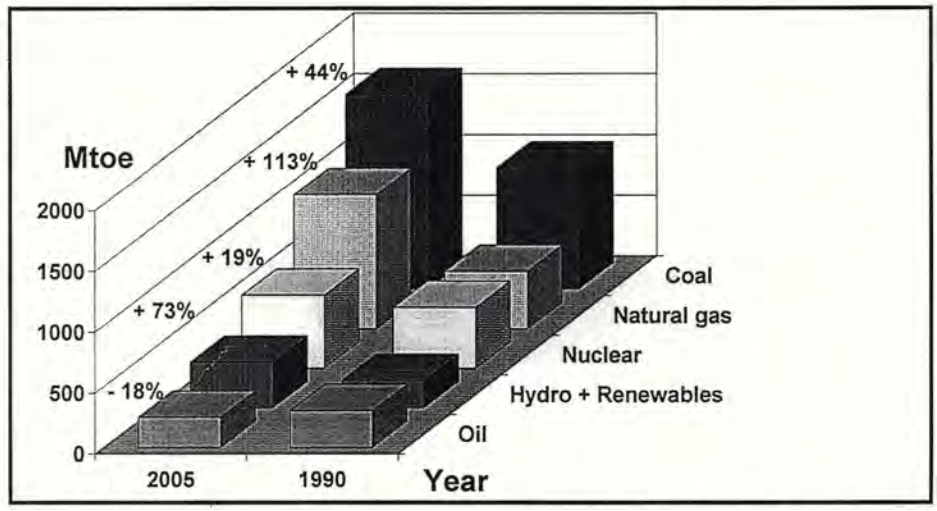


Figure 5: World electricity supply by primary energy source in 1990 and 2005 (EC data).

bon dioxide emissions and to improve energy efficiency. It was based on the following actions:

- specific actions for greater penetration for renewable energy sources (ALTENER);
- by improving energy efficiency (SAVE programme);
- Council decision for a monitoring mechanism of Community CO_2 and other greenhouse gas emissions;
- proposal for a Council Directive introducing a tax on carbon dioxide emissions and energy;
- 1993 call for tender in the frame of the THERMIE programme, focusing on the reduction of CO_2 emissions.

All these measures still have a difficult challenge to overcome to be able to achieve the objectives, even though the economic crisis will help by reducing energy demand.

The technological response to the carbon dioxide problem does not seem to be a direct one. CO_2 may be separated from the flue gas, but the only solutions envisaged are long-term storage or ocean disposal (still uncertain). If not, the only possibility is to increase efficiencies, that is to burn less coal for the same output of useful energy. This can be done at production level or at user sites. The latter is achieved by reducing demand for energy, through better insulation and control systems, integrating generation and demand. The first measure — improving the efficiency of power generation — will also provide better energy prices for consumers and make coal more competitive, while the second approach will allow consumers to use less energy whilst retaining their quality of life.

The term 'security of supply' is a subjective concept. We all believe we know what it is, but when trying to define the level of security of supply at a given moment, it is easier to compare with another situation rather than provide a measurement or value to the concept. It is easier to evaluate whether certain aspects, actions, measures or situations will improve or impair security of supply, rather than providing a value or a number that measures it.

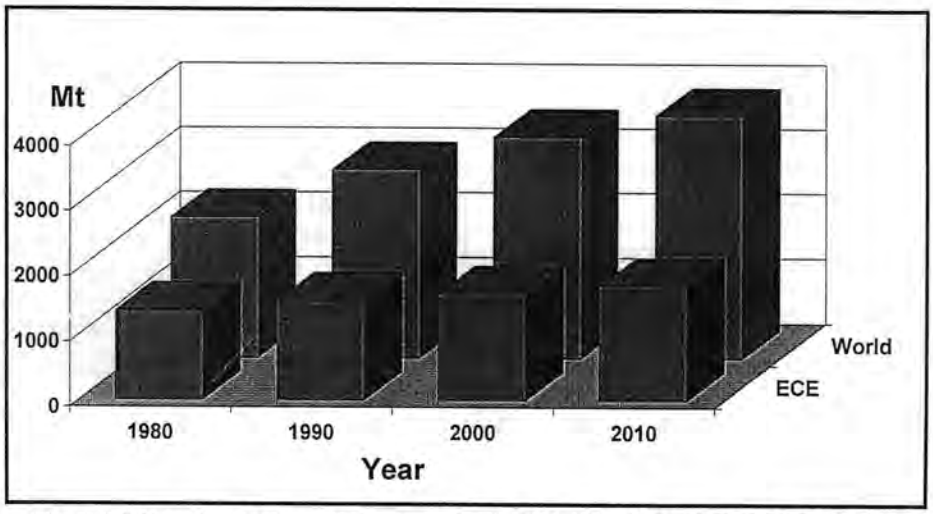


Figure 6: ECE and world steam coal consumption in 1980, 1990, 2000 and 2005 (UN/ECE data).

Because of this, I will not try to generate voluminous arguments on the contribution of coal utilisation (EC and world coal together, distribution to be defined by the market) to security of supply. However I would like to make the following points:

- the presence of coal in the energy scene adds an important competitor to oil, gas and nuclear that will always put pressure on prices for the benefit of the consumer. It is nevertheless one additional alternative as an energy source, which will always increase availability;
- coal is the most abundant fossil fuel: with proven recoverable reserves, five times the size of proven oil reserves, can be produced for a period four to five times longer than oil;
- reserves are substantially distributed throughout the world, in both OECD and non-OECD countries. The diversification can provide reliability of supply, not withstanding that the EC is a producer of coal;
- price of seaborne coal has been constantly steady or decreasing, even though the volume of seaborne coal trade has been increasing, and is predicted to continue;
- technology, an asset in the EC, can increase the level of economic recoverable reserves by allowing cheaper, more effective mining, and can allow the use of lower quality coal while respecting environmental standards, by the development of clean coal technologies.

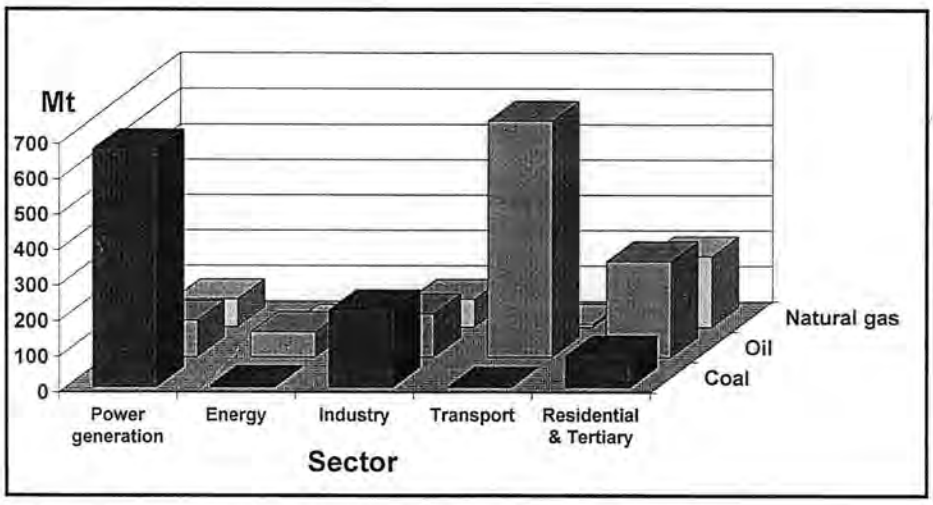


Figure 7: CO_2 emissions by sector and fuel in the EC 1991 (EC data).

Technology and economic activity

The economic outlook for the Community has deteriorated significantly over the last year. The economic crisis in which the developed world is immersed is known to us all.

As energy plays an important role in the economic activity of a developed society, the policy actions that will be taken to recover from this crisis will have to consider energy, and will affect energy policy.

One of the primary effects of this crisis has been the massive destruction of employment and its consequences. This makes it imperative to generate economic activity, maintaining and increasing the competitiveness of EC industry to help recover this loss of employment. All driving forces to relaunch economic growth will be supported by our policy makers.

The generation and implementation at industrial level of clean coal technologies is clearly related to large investments and to heavy industry, at present declining and in need of fresh demands. At this moment, not only the creation, but the application at indus-

trial level of clean coal technologies cannot be forgotten as an important tool for the creation of economic activity.

As you may know, the EC funds, through its THERMIE programme, industrial projects that demonstrate innovative technologies. We have taken one of these projects in the area of solid fuels as a reference to make an in-depth study of the effects of the employment produced by this type of project. It aims to produce 300 MWe through gasification of coal integrated with a combined cycle. The overall budget is 650 MECU. The EC has cooperated with support at around 6%. Preliminary results indicate that without considering induced employment — only direct and indirect employment — more than 10 000 jobs for one year will be maintained in heavy industry.

The average age of EC coal burning plants is 20 years. Investment decisions are thus needed in the very near future. New clean coal technologies may form a percentage of new coal-fired plant, which will provide over 40% of the EC's electricity by 2005.

Naturally, the decision to launch important actions should be based on the achievement of policy objectives. The implementation at industrial level of new clean coal technology creates employment; provides cheaper and more secure energy supply, and improves the environment and the public image of coal.

The EC countries are world leaders in coal utilisation technology. So in evaluating the possible role of EC clean coal technologies in creating economic activity, the competitiveness of EC technology in the world, and its potential for markets beyond EC borders should be taken into account. The recent UN symposium on new coal utilisation technologies, held in Helsinki last May, has evaluated the role of coal in energy production in countries with economies in transition.

Coal has played such an important role in these countries: an average of 65% of electricity in central and eastern Europe is generated from coal. In the transition to market economies the environmental problems associated with coal, as well as the efficiency of its use, will have to be considered. This will require a full restructuring of the energy sector, as well as objectives being reached on limiting SOx emissions, which has already happened in some CIS countries. The enormous investment needed means this may not happen. Refurbishment and retrofitting are more likely and more practical, with repowering helping to finance the improvements.

The role of EC know how is easy to foresee, there is an obligation to develop those economies in the direction of market-orientated economies.

I would like to bring to your attention what the European public thinks about energy.

A Eurobarometer poll has been performed for the seventh time since 1982 throughout the EC, on the request of the Directorate General for Energy, to discover what are the judgements, worries and concerns, and priorities of our fellow citizens towards energy.

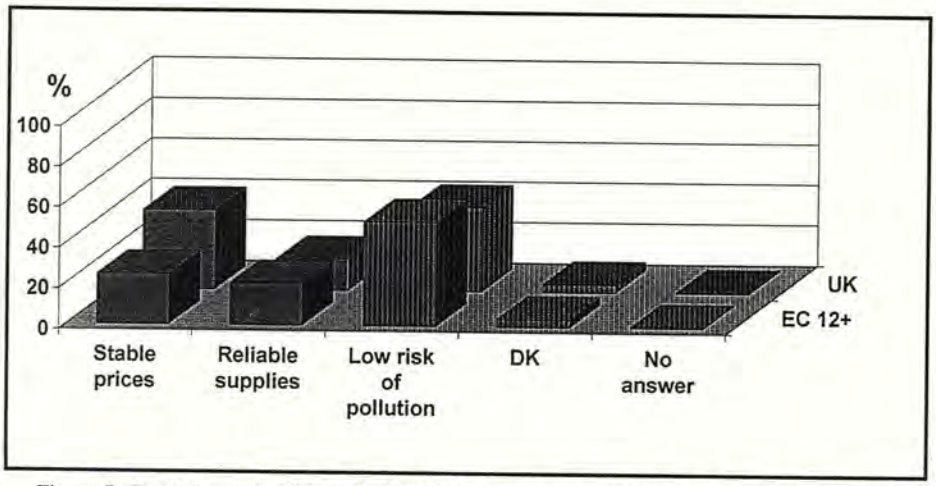


Figure 8: Eurobarometer 39.1 — Spring 1993. Question 15: "And what is most important to you, as far as energy resources over the next ten years or so are concerned?"(DK = don't know)

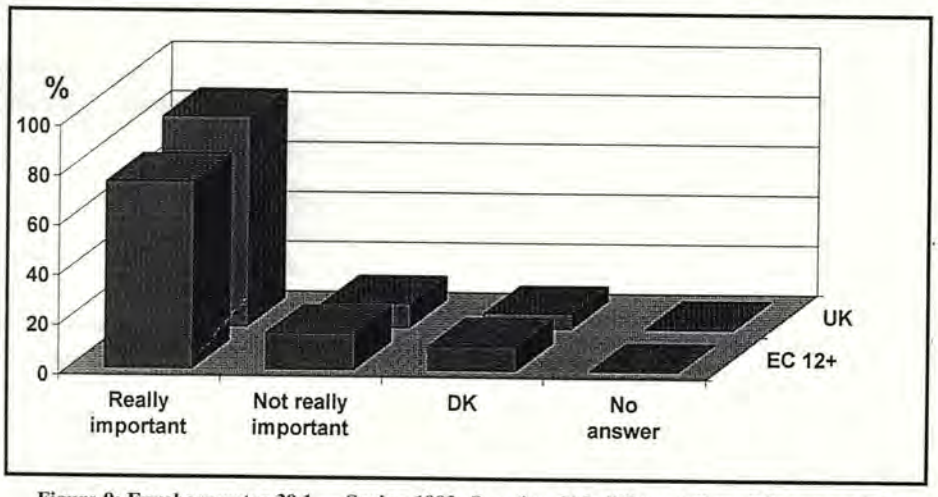


Figure 9: Eurobarometer 39.1 — Spring 1993. Question 6A3: "Please tell me if in your opinion the more widespread use of new, efficient energy technologies is something really important or not really important to aim for." (DK = don't know)

I would not offer an in-depth evaluation of the information provided in this poll, but I believe important conclusions can be extracted from it in relation to the use of solid fuels.

The European public gives great importance to security of supply. It has increased as a priority constantly since 1987, and is considered by 66% as a 'very important subject' (80% in the UK).

But of course, the most important subject in their view is the environmental impact of the use of energy. 88% considered it very important in 1991, and the figure has increased constantly since 1987. The EC public was well informed about the existence of global warming, acid rain and destruction of the ozone layer.

It is of little surprise then that, in 1993, 93% considered it very important that there should be adoption of common laws for the protection of the environment; or that 97.2% consider it really important to aim for cleaner air in towns and cities.

70% of those consulted in 1993 consider as very serious the problems of global warming, acid rain and ozone depletion.

The use of solid fuels, oil and private car traffic are viewed as the major causes of the greenhouse effect, with the use of inefficient, outdated energy technologies considered quite important as well.

Acid rain, in their view, is caused mainly by the use of chemical products in industry and agriculture, followed by the increase in car traffic, use of solid fuels and oil. The use of inefficient and outdated energy technologies is referred to in addition as an important cause of acid rain.

The ozone layer destruction gets similar treatment, even though in this case the use of chemical products in industry and car traffic are considered the major responsible agents.

An important aspect to outline is that under the question of opinion of more widespread use of new, efficient energy technologies, 83% of those consulted considered this subject as really important. In parallel, the relation of the different energy sources with the

subjects of price stability, security of supply and 'less risk in relation to pollution' offer the following conclusions:

- solid fuels, oil and nuclear energy are the least stable from a price point of view;
- solid fuels, oil and nuclear energy are the least secure from a supply point of view, while gas and renewable energies fared better;
- oil, solid fuels and nuclear energy are in this order for the greatest pollution risk, in the view of the Community's public (1993).

Such studies tend to attract scepticism, but it must be remembered that this type of information can be an extremely useful tool. It must also be remembered that solid fuels, oil and nuclear energy are, together with gas, the pillars of energy production at present and in the coming 10 to 15 years. We can therefore conclude that the EC public does not like the present situation, nor will they be getting what they want in ten years' time. Public institutions should take note. In a democracy it is the government's obligation to give the public what it wants. In the case of energy, without a deeper evaluation, the European public is indicating it would prefer something different.

When looking at these survey responses, I think it is fair to ask ourselves if the public is properly informed. The answer is 'no'. Both industry and public bodies together with the media should make an effort to improve the situation, as the responsibility is theirs. This demands an in-depth analysis by all parties involved, as the clear environmental benefits of modern technologies, such as fluidised bed combustion, seem difficult to pass on to the public.

On the one hand the EC will need to burn more coal to meet electricity demand, whilst on the other, this seems to be unacceptable to the public as it is considered detrimental to the environment. Additionally it is known that coal reserves throughout the world are more extensive than either oil or gas, to the tune of five times the size, and is more evenly spread and more accessible. On top of this its price maintains stable values. So in a world with a scarcity of energy resources, it is reasonable to maintain coal as an important contributor to the energy scene.

The only answer is to develop technologies to allow coal to be used in a manner that does not harm the environment, which is economically viable, and to pass this information on to the public and the decision makers.

I would like to stress that in today's world, it is my impression that helping the public to understand and accept clean, efficient and economically viable coal technologies, is as important as having the technologies. The need for this acceptance should not be underestimated: if success is not achieved, today's problem will remain.

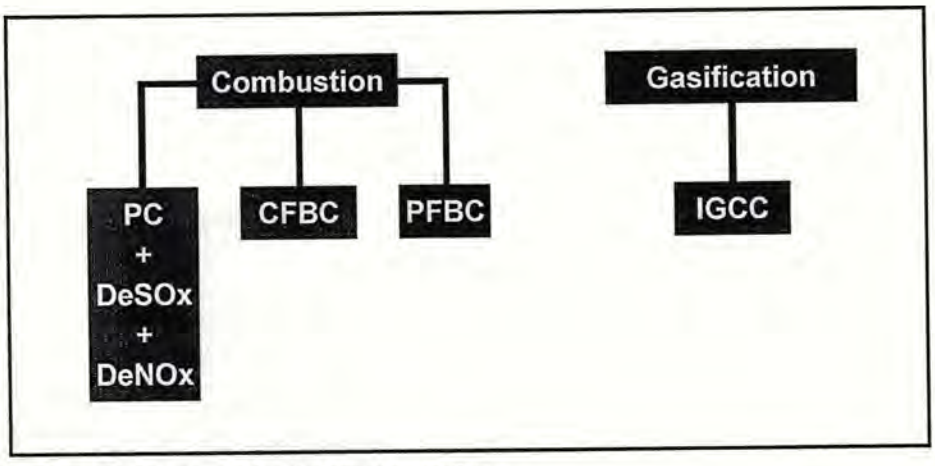


Figure 10: Clean use of coal for power generation.

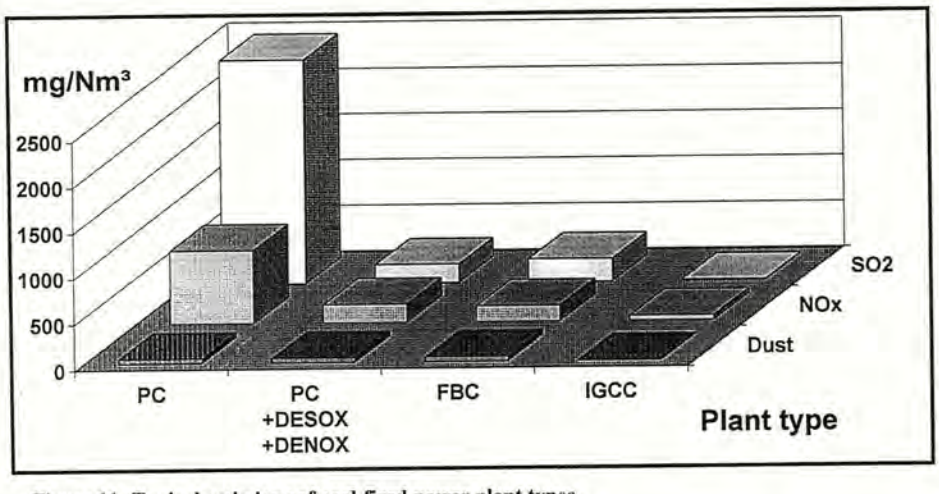


Figure 11: Typical emissions of coal-fired power plant types.

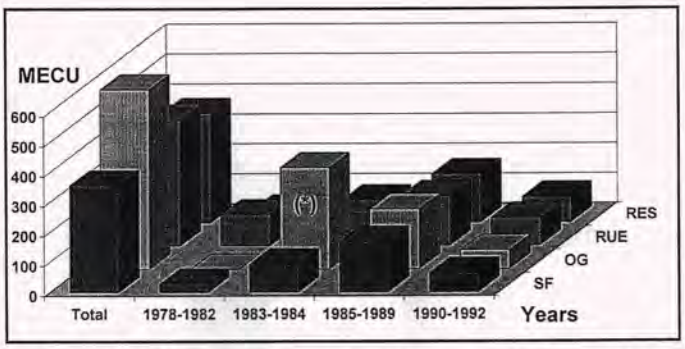
Global action

Clean coal technologies are the solution to environmental problems created by the use of coal; coal is a positive ingredient in the security of supply issue, and clean coal technologies are of a strategic value and should be maintained.

In the deep economic crisis the world is immersed in at present, it is absolutely required to be even more effective and efficient in the use of resources available, and to provide real value for money. All driving forces should be used in order to create economic activity, to improve the competitiveness of EC industry and generate employment. The application of clean coal technologies, both in the EC and outside EC borders, can generate an important demand in manpower in the heavy industry and related sectors in the EC, with important investment required.

The public regrets the lack of full use of advanced technologies, and doesn't like what seems to be the unavoidable future for the next 15 years, due to the environmental impact of coal use, even though they are not aware of the real improvements that have been made in this area in recent years. It is absolutely essential not only to develop and implement clean coal technologies, but also to pass the message on to the public by 'positive information actions'.

At the same time, member states of the EC are developing their own initiatives in the area of clean coal technologies, because of the pressures of public opinion, but the economic crisis is affecting their activities. A coordination of actions by member states in order to avoid duplication of efforts would seem justified. All this, in my personal view, indicates the need for a global Community



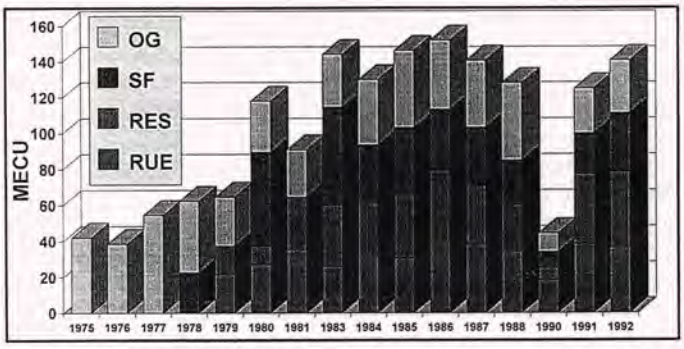


Figure 12: (left) Financial support for EC energy technology projects by sector until 1972. (*) = 1973-1984. Figure 13: (right) Financial support for EC energy technology projects by sector 1975-1992. (OG = oil and gas, SF = solid fuels, RUE = rational use of energy, RES = renewable energy sources).

action in the generation and application at industrial level of clean coal technologies, with the objective of improving the environmental impact of the use of coal. It would provide an important increase in economic and industrial activity, and hence employment, of heavy industry and associated sectors, helping our neighbours to the east of the EC, and other developing countries to improve their environment, and help to inform the public about progress made. The Community should avoid undue duplication of efforts, coordinating actions by member states, whilst ensuring concerted action for the next 10 to 15 years.

A fair question would be: which technologies and what is meant by 'generation and application' of clean coal technologies?

Technologies not widely used at the industrial level are pointless at a time of economic difficulty. Possessing technologies which will never be put into practice demonstrates failure. It is the realistic technologies for the future which should be supported, in response to the needs of the moment.

In what follows I will not try to develop a high level technical analysis of technologies which should be supported, but the requirements they should respond to, and the applications needed.

Independent of the technical requirements for a reliable, economic and safe generation of electricity, the main overall objectives to be accomplished are:

- improving the impact of coal use on the environment, by reducing emissions and the quality and quantity of waste;
- reducing the costs of environmentally related components;
- improving the efficiency of conversion, both to provide economic incentives and a reduction in CO_2; and
- introducing simplicity, reducing investment needed for implementation.

Two major distinct lines will have to be implemented:

- action on new plants;
- repowering, retrofitting, refurbishment of existing plants, searching for synergies with other energy sources which may help to provide the economic incentive for the decision on investment.

There are developments where gas, in conjunction with coal, has a potential to provide important improvements in efficiencies of existing plants. These types of possibilities should be fully developed. The development of new plants should be divided into two different types of action: demonstration plants and new technologies within the EC; and application of well-proven technologies outside the EC. Upgrading plant requires a modular approach to optimise environmental impact and efficiency.

At present there are three major technologies for converting coal to electricity. These are: pulverised coal firing with deSOx and deNOx systems; fluidised bed combustion, and gasification with combined cycle. Each of these has a potential for improvement of their efficiency, and in competition manufacturers and utilities continue to make steps forward. It is not only the technical excellence of a technology but many other factors which will decide which technology will take the lead, such as market forces, cost and availability of resources, regulatory effects and so on. The objective of the demonstration phase should show not only the technical feasibility but also the real economic cost of each application. The technologies also tend to be interdependent, and they have many concepts and solutions in common.

The pulverised coal-fired steam power plant can improve its efficiency on a limited basis, but also offers great availability and reliability. Fluidised bed combustion consists of burning coal in a bed of hot ash or added sand, through which air is blown to provide the reaction. The bed behaves like a boiling liquid, allowing for good heat transmission at temperatures typically of 800—900°C. Limestone can be added to the bed in order to react with the sulphur in the coal, which then becomes solid products which can be removed from the ash. The temperatures are low enough to reduce the amount of nitrogen oxide formed in the bed.

This technology is in the demonstration phase. The circulating fluidised bed combustor has a very successful example of a 125 MW unit at Carling in France. It can burn fuel of very low calorific value, high ash content, and high moisture content, ie, very low quality fuel. But by the addition of limestone, and through staged low temperatures in the combustion process, the emissions to atmosphere are very low.

The pressurised fluidised bed technology is

Table 1: ECSC coal research programme

Year	No of projects supported	Support in MECU
1985	54	18.9
1986	60	21.9
1987	57	21.9
1988	61	21.9
1989	81	26.7
1990	89	33.7
1991	128	47.8
1992	121	44.7
Total	**651**	**237.5**

in the early stage of demonstration, but steps should be taken to ensure that the future objective should be joint demonstration of these two concepts: the circulating pressurised fluidised bed combustion system.

Gasification of coal integrated with a combined cycle is of utmost importance for the high efficiency it can provide and for the low emissions to atmosphere during its operation. Coal is converted to gas by blowing oxygen or air, and the gas is chemically and mechanically cleaned before combustion at lower temperatures in a gas turbine in a combined cycle. The overall efficiency can be as high as 45%: a reduction in CO_2 of the order of 18% in comparison to conventional technologies.

Any developments involving two of these technologies should also be supported, such as the topping cycle, which combines the concepts of fluidised bed with partial gasification of coal. This offers enormous possibilities, but the economies are yet to be demonstrated at full scale.

Common to all these developments is the continuous raising of steam, and the materials and design required to achieve this. Consequently, EC industry should be encouraged to develop, demonstrate and build new plants, and to develop and implement improvements in existing plant, both inside and outside the EC. This requires economic support at the early stages of a technology, and the EC should integrate capacity and provide common initiatives, as well as small-scale economic support and financial guarantees at more 'mature' levels of demonstration. Finally, it should provide the financial mechanisms to help implement fully matured technologies.

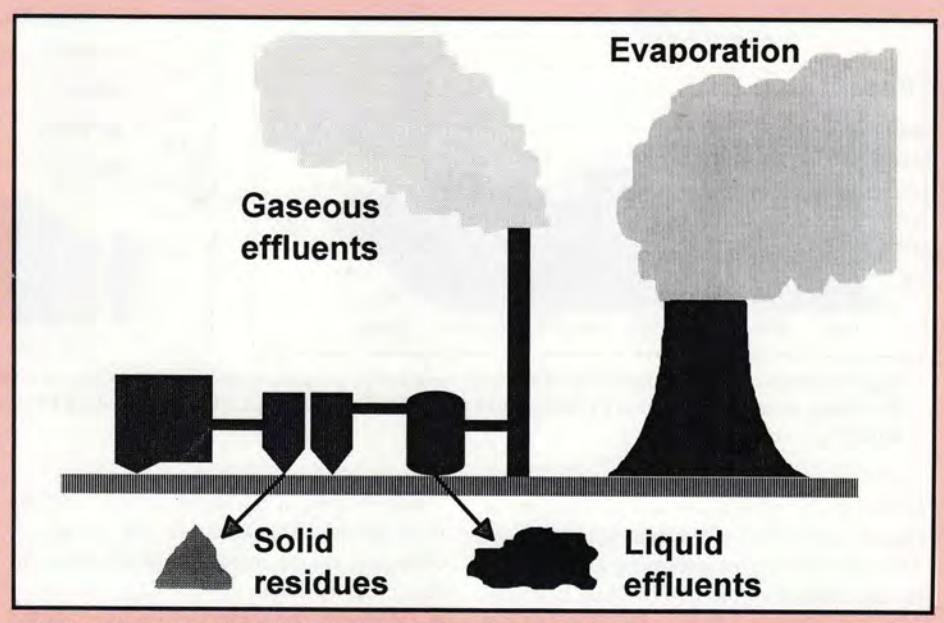


Figure 14: Impact of a coal-fired power plant on the environment.

Coal utilisation and the EC

For many years the Commission of the European Communities has supported the three stages of research, development and demonstration in the area of production and utilisation of solid fuels. In fact, the EC first responded to the Coal and Steel European Treaty in the early 1950s.

Under article 55, this treaty supported R & D in the area of mining and coal utilisation. Between 1985 and 1992, a total of 651 projects have been supported to the tune of 238 MECU.

It is well known that the EC acts in those areas where a Community dimension is justified, and hence all programmes exist if they can demonstrate their contribution to EC policy. At present the three major lines followed by the ECSC coal research programme are: improvement of the environmental impact of coal production and utilisation and improvement of the public understanding of coal's role; improvement of the cost effectiveness of the production and utilisation of coal; and the rational use of resources.

At present, owing to the fact that the coal mining industry is shrinking its operation, and considering the coal utilisation will increase, the ratio of financial support is 40% for mining operations and 60% for coal utilisation activities. The programme is of an applied nature, ie, suited to the productivity needs of industry. Unfortunately the economic crisis has affected the overall budget of the ECSC Treaty, and the resources available for 1994 will be substantially smaller than those of 1993.

The EEC Treaty has two main tools for supporting coal utilisation technologies: the JOULE programme and the THERMIE programme. JOULE is part of the Framework programme and dedicates funds for R&D. The THERMIE programme has supported demonstration of technology for the last four years in four sectors related to energy: one is the solid fuel sector. But the EC has supported demonstration in this area since 1978, with the Demonstration programme to assist pilot projects on liquefaction and gasification of solid fuels. In 1983 the demonstration programme covered combustion of solid fuels, and substitution of hydrocarbons by solid fuels. In 1990, THERMIE was introduced as the major energy programme, and will last until 1994.

Since 1978, 147 projects have been supported with 357 MECU in the area of solid fuels, Figure 13 provides information of how resources have been distributed between the four sectors of the previous programme: rational use of energy, renewable energy sources, solid fuels and oil and gas.

The new THERMIE, following the Treaty of Maastrict, will be included in the Framework Programme as technology demonstration is under the R&D Framework Programme. The continuity of funds will probably be assured until 1999 to levels similar to those already provided for the past years. But many aspects on the functioning of the programme have yet to be clarified.

To be included under the same programme as our Commission colleagues of research is a useful addition in the sense that the coordination of our activities with them can be strengthened. But we must be certain that the two very clearly differentiated steps of R&D and demonstration at commercial stage, can be fully achieved in both cases.

We must be aware that we are living in a very different situation compared to that of previous years. Some of our politicians are clearly passing the message that the present economic crisis shows that we must change our view of reality. We need to be much more effective and efficient in what we are doing.

If we look at the real situation in Europe, avoiding idealistic objectives that will never be met, both now and in the future, it is clear that we must support the development of clean coal technologies in the EC. The generation of electricity will continue to rely heavily on coal for the foreseeable future. Europe has the most advanced coal utilisation technology in the world, and energy policy requires an improvement in the environmental impact of the unavoidable use of coal.

The solution seems clear: let us work together so that the decisions taken are the best for our EC industry, and consequently for us.

I would like to thank you very much for your attention. ❑

British Coal's blended coals make finer fuel

by Johanna Fender

AS THE last element within the UK energy and electricity supply industry to be privatised, with the exception of nuclear power, British Coal has been finding it increasingly difficult to compete effectively in what is often described as a market rigged against their product.

But what this adversity has demonstrated is the adaptability and flexibility of an industry which has been sometimes criticised for displaying neither of these two attributes.

On the industrial sales side of their business, British Coal has had to face three major problems over recent months. The competitive state of the marketplace holds many disadvantages for a publicly-owned industry amongst the privatised utilities. To compound these difficulties, the price of oil continues to fall, and despite the increase in the gas tariff to industrial users, natural gas is perceived by many as an all-round attractive proposition. Environmental constraints, which have contributed to the popularity of gas, make coal, on the surface of it at least, a less attractive option in industries which are having to meet increasingly stringent environmental legislation. To cap it all the coal industry has suffered the closure of a number of pits in the last year, this is entirely due to the contracting market in sales to the two major UK generators. This adds up to a daunting prospect for an industry which is under increasing pressure as the prospect of privatisation looms. But British Coal's industrial branch are determined to keep their existing customers loyal, and to retain their share of the market despite the threats from oil, gas, electricity and imported coal.

As part of their strategy to retain their share of the market, British Coal aim to improve their product quality and availability to their industrial sales customers — a 6 million tonne market, comprising industrial, commercial and public sector users of between 50 and 250 000 tonnes of coal per annum. This represents nothing short of a cultural revolution, which is taking place throughout British Coal. Dr Roger Clayton, manager of industrial sales, summed up the nature of the transition: "People in British Coal have grown up with the idea that our core business is producing coal and finding markets for it. That is no longer the case. They are now facing up to the fact that we are in the business to service the needs of our customers, which means finding out what they want and then providing it."

Faced with changing customer and market requirements, British Coal has branched into blending coal to create 'designer' fuels.

The move from a production-led to a market-led approach has had its fair share of resistance within the company; but with an industry in retreat, ever more exposed to free market competition from oil, gas and imported coal, it has become increasingly obvious that this cultural shift is the only way forward.

Dr Clayton's team has responded by treating the situation as a classic marketing problem, where the central issue is one of product quality and service. First they focus on what the customer wants, identifying where the supplier is both failing and succeeding. Then commitment is sought from everyone in the supply chain to meet the customer's expectations of quality. Finally, implementation of quality control procedures and systems is undertaken, to give the customer reliable quality assurance.

A programme of action began with coal quality seminars — hard-talking sessions involving all relevant parties, to identify past problems and mistakes in both the product and service. Coal quality workshops then establish how quality can be improved and maintained. Once the talking is over British Coal prepares an individual charter for each customer, outlining specific commitments and attendant schedules.

Blending

The transition from a production to market-led approach will increasingly affect the way coal is produced, handled and distributed. Several years ago there was recognised a need for high quality, competitively priced 'designer' fuels, tailormade to match the precise needs of British Coal's industrial and commercial customers, and to meet increasingly high environmental standards. Two-and-a-half years ago British Coal began to look into the best systems, techniques and equipment for blending coals, and to identify suitable geographic locations to provide a comprehensive new service at strategic points throughout the UK.

British Coal's Research Establishment (CRE) conducted trials on proposed blends on full-scale, fully instrumented boilers to establish how they behave under site conditions. When a blend is required the feedstock coals are assessed for combustion, fouling and slagging properties. With the aid of computer models it is then possible to predict blend proportions which include important characteristics, such as combustion performance, ash fusion temperature parameters, as well as slagging and fouling behaviour. A proposed blend is then burned in a full-scale stoker, to see how it behaves in real conditions. A special fouling probe accurately measures any boiler deposits formed, comparing them with standard coals. Full-scale blending only begins when the scientific assessment and the full-scale firing trials have proved satisfactory.

This new approach to quality of product and service is in line with the requirements of BS5750. British Coal began a programme of work to achieve accreditation to BS5750 at sites where coal is processed and despatched to customers. Two deep mine coal preparation plants and two opencast disposal points were selected as pilot sites, and all four gained accreditation in 1991. By the early part of this year all their despatch points had gained registration against BS5750 Part II.

The programme of work towards accreditation has since been extended to include other activities within British Coal, such as ports, stocking sites and marketing functions. The extension also includes blending sites, and in October this year Thamesport, located on the Isle of Grain in Kent, also gained BS5750 accreditation.

Many controls had to be implemented to ensure efficient site operation, as one would expect for a nationally recognised quality system. All blending and measuring equip-

ment critical to coal quality is now carefully monitored for correct operation, while all coal stocking bays and stockpiles are clearly identified and separated to prevent fuel contamination. Coal sampling is performed to BS1017 guidelines, while vehicle loading procedures enable hauliers to collect the right quality and quantity of coal. Approved suppliers or materials and services are similarly monitored and assessed on a regular basis. Indeed the BS5750 quality system itself will be regularly reviewed and amended to meet the needs of the market.

Coal Energy Services

Another major part of British Coal's industrial sales strategy is to expand the level of services made available to customers. To this end Coal Energy Services (CES) was set up to design, fund, build and operate plant for industrial and commercial customers, in short, providing a comprehensive contract energy management service. CES combines the personal touch of a consultancy with the vast resources, experience and skills of British Coal. In its short history CES has built up a turnover of around £12 million, mainly in the public authority and health care sectors.

CES is strong in every field of energy management, with their services backed up by British Coal's technical service and research establishment. It provides contracts which completely remove the problems of boiler plant operation and servicing. They begin with an in-depth survey of an organisation's energy usage, identifying areas for improvement, including an assessment of boiler plant condition and performance capabilities. The survey indicates operational life and maintenance requirements, allowing customers to plan ahead for phased spending against budget. Heat losses are also indicated, and suggestions made as to how these can be reduced. If new control systems are required there is full specification along with recommendations for correct operational procedure.

The CES energy management contract seeks to ensure the best service available, removing operational problems, guaranteeing the cost effective use of the customers' energy plant. CES will take over day-to-day operation and management of boiler plant, accepting full responsibility for fuel purchasing, operation, maintenance, repairs, water treatment and insurance inspections. Professional financial advice is also available, tailored to the exact needs of the user and their capital investment programme.

British Coal recognises the importance of developing their business in line with the requirements of their customers — hence the coal quality workshops and seminars already mentioned. Listening to their needs is not necessarily sufficient: they must be properly researched.

British Coal's blending facility at Thamesport.

As part of an attempt to forge closer links with local authorities BRITISH COAL launched, in 1991, a national Caretaker of the Year Award to find the best kept school or college boilerhouse in the UK, using coal supplied by British Coal. The award has the additional advantage of promoting high standards of operation, safety and maintenance, as well as improving working procedures for staff and their equipment. The scheme proved more popular than ever this year, with a record number of entries of an even higher standard. From the customers point of view, keeping their coal-fired boiler in top condition, operating at high efficiency results in lower operating costs, longer plant life, and improved environmental and safety performance.

The scheme has proved so successful that during 1992 and 1993 it was expanded to include two new categories: Local Authority Boilerhouse of the Year and Hospital Boilerhouse of the Year.

Research & new technology

CRE at Stoke Orchard in Gloucestershire, which has done much of the research into blending coals, has an important role to play in developing new techniques for coal handling, combustion and storage, to ensure that coal remains a cost-effective, efficient and amenable option.

Since its formation in 1948, CRE has been closely associated with manufacturers of boilers, furnaces, coal handling and other equipment. This collaboration has resulted in much new plant, representing a wider choice for the industrial customer.

This year British Coal won a major commendation in the PA Group's awards for significant contributions to responsible environmental management, with an aerodynamically designed grate bar for industrial coal-fired boilers.

Engineers at CRE spent four years designing the grate, which reduces grit flows and particulate emissions, cuts down on smoke and increases thermal efficiency. Like many of the best ideas: simple but very effective. The grate is designed for retrofitting existing boilers, enabling industrial customers to maximise boiler efficiency whilst also helping them to comply with environmental law. The new grate is suitable for all static and tipping grate sprinkler stokers, including GWB, Robey and Saacke.

Another recent development from CRE is a novel flue gas clean-up system, which reduces chimney grit emissions from top feed boilers. The system is capable of reducing stack emissions to one third of the current legal requirement, and has been standardised for commercial viability, with the same pipework, fan and external cyclone suitable for a variety of boiler sizes. Where particulate removal is not possible with cyclone separators alone, CRE will advise customers on other alternative technologies, such as bag filtration, electrostatic precipitators and high temperature ceramic filters.

CHP and district heating

An early, ground-breaking scheme by British Coal has been refurbished this year. The Nottingham District Heating installation has just undergone a £5 million upgrade. The plant, which incinerates municipal solid waste (msw), with coal as a top-up fuel, is the largest combined heat and power (CHP) scheme in the UK. It is operated by British Coal in partnership with Nottingham City Council and Nottinghamshire County Council.

The recent upgrading involved the installation of an ABB steam turbine, uprating the system from 3 MW to 10 MW, allowing 15% more msw to be incinerated. The project was carried out by CES.

Despite a rapidly changing energy market and the environmental challenge, British Coal is fighting hard — and winning — to retain its industrial customers in an increasingly competitive marketplace. The key to their success so far has been their flexibility, coupled with the excellent back up of CES and CRE, and a wealth of experience in coal utilisation unrivalled within the UK. ❑

Engineering — a key aspect of the UK nuclear policy review

*by Eur Ing F John L Bindon and Sally Butcher**

In anticipation of the forthcoming nuclear review, a forum on issues relevant to the industry was held at the Institution of Electrical Engineers HQ in London, in association with the Institute of Energy and the Watt Committee on Energy.

FOLLOWING the passing of the Electricity Act in July 1989, which lead to the privatisation of the electricity supply industry (ESI), a moratorium on the nuclear industry was issued by the UK Government in the autumn of the same year.

The moratorium was preceded by an announcement that nuclear power stations would remain under Government control. This saw the establishment of Nuclear Electric plc and Scottish Nuclear Ltd.

After the coal debacle in the latter part of 1992, the Government set up two Select Committees to review the position of the coal industry. One of these committees reported in March 1993, and included amongst its recommendations was the need to bring forward the 1994 Nuclear Power Review to 1993.

Regrettably, although the present Government accepted this particular recommendation, by mid November 1993 no decision about a Review body has resulted.

In order to bring into the open a meaningful discussion and debate, the Institution of Electrical Engineers (IEE) arranged a one-day forum, so that those attending would have the opportunity to hear the views of leading figures, and to express their own views in discussion within one or more of five major sessions, covering what are perceived as the most important issues.

The event attracted the attention of engineers and scientists, financial managers, generators and suppliers, environmentalists, civil servants and journalists and many others wanting to understand the issues underlying the question of the future of our nuclear energy industry.

The forum was organised by the IEE in association with eight other professional bodies, including the Institute of Energy.

The forum was divided into five sections, dealing with energy policy, the environment, industry, economics and safety. The first, introductory, session put forward the proposition that this country will need nuclear power by the year 2020. Professor Ian Fells argued that our country's prosperity demanded a sensible and balanced energy portfolio, one in which nuclear power could help provide for a cleaner environment. The UK Government has put its signature to a number of commitments born out of the Rio Earth Summit in 1992. Guarantees were promised, along with agreements focussing on pollutants and concerns over increasing levels of CO_2, which contributes to global warming. The UK Government commitment aims to restrict CO_2 levels by the year 2000 to no more than their 1990 levels.

Ian Fells explored possible ways this might occur, looking at renewables, energy efficiency and conservation. All could contribute, but none to the degree of nuclear power, which could make a significant contribution to the reduction of the amount of CO_2 going into the atmosphere.

Responding to Ian Fells' clear support for a nuclear element in the energy mix, Dr Michael Grubb from the Royal Institution of International Affairs (RIIA) took what he described as an agnostic view. The question as to whether we need nuclear power is problematic. That did not imply complacency. The absolute need for nuclear power is not the question: it is more the *role of* nuclear power in the overall contribution to Britain's future needs. There remains a scepticism around future investment, with little indication that new nuclear power plant will prove an attractive proposition for financial input from the market.

It is possible we may not have a coal industry by 2020. However, despite the prophets of doom, oil and gas reserves have increased rather than declined, signaling increased generation from gas in the new combined cycle gas turbine (CCGT) stations. Renewable energies have disadvantages, and advancing the energy efficient resource factor is more difficult than many assume.

An example demonstrating the differences in physical size and electrical output is demonstrated well in the equation that 550 wind turbines rated at 450 kW produce the same amount of power as Sizewell B will generate. The land space required would be approaching the size equivalent of the Isle of Wight, making the wind farm's load factor average only around 30% over a year. Some 3000 km of roadways would be needed to provide access, with around 1000 km of cabling. This example, given by a later speaker, demonstrates the magnitude of the problem facing renewables against conventional modes of generation.

An important point on atmosphere pollutants was raised by Dr Jeffrey Lewins. Despite the good intentions of western countries in seeking to reduce emissions, the problem was essentially a global one, closely linked to population growth. Over the years to 2020, with the expansion of coal-fired stations in countries such as China and India, it sensible to examine all possible alternatives, and nuclear power development must be included. The international dimension continued to crop up throughout the forum.

The second, environmental session provided an interesting debate between Dr Greg Butler of British Nuclear Fuels plc (BNFL) and Dr Green of Friends of the Earth. Greg Butler defined his approach to the environment by demonstrating ways in which nuclear power can make substantial contribution. Nuclear power is level on costs with other forms of generation based on normal operations, he claimed. If all external costs are taken into consideration, it out shines other forms. For those who maintain nuclear waste is an environmental issue when considered in perspective against other fuel cycles, the advantage is again with nuclear. All radioactive waste produced in the UK amounts to less than 0.001 of all the toxic wastes created by the country's chemical industries. There are no significant scientific problems associated with the disposal of nuclear waste, it is only a matter of political

Technical Division, Nuclear Electric plc

support and public acceptability.

On accidents, public perception of the risks has, and continues to pose a very difficult problem. Severe accidents, such as Bhopal, Seveso and Three Mile Island are often quoted in the same breath, yet only Three Mile Island had no direct attributable effects on the public and the environment, and released no significant amounts of harmful material. As for Chernobyl — the world's worst accident involving nuclear power — such a reactor would be unlicensable in either the UK or any other western countries, due to their rigorous safety contraints. Much has improved since 1986 in international cooperation surrounding safety by the greatly improved understanding with CIS countries. Dr Butler demonstrated his points concerning environmental damage, accidents and nuclear waste by comparison with other forms of generation, including renewables, in a manner which clearly showed nuclear's advantages.

Dr Patrick Green of FoE in his response focussed on nuclear risk scenarios which when examined by the financial markets found the latter unconvinced by the points put forward by Dr Butler. The central question to be answered is: was the market supportive? Clearly in his view the answer was an emphatic 'no'.

He looked at nuclear performance in the UK over 40 years and believed he was right that the public found it wanting. Claims by the nuclear industry had to be far more clearly demonstrated by matching performance. There is a public fear of accidents and the waste legacy. The problems surrounding the safe disposal and storage of nuclear waste remained, and to date the Government had shown no coherent policy on the matter. The work of Nirex was seen as questionable, due to the lack of Treasury support. Dr Green pressed Nirex and the industry in general to produce a robust safety case. The build up of waste volumes was already well past a critical point, but would continue to grow as decommissioning aged reactors provide greater and greater volumes. There are more effective ways of reducing CO_2 than by increased use of nuclear power. The issue of accidents gave rise to the question of ultimate responsibility. Privatising nuclear power would make it more difficult to provide answers to questions such as these.

This debate was the nearest the forum came to conflict, sparking a lively debate from the floor, and giving organising chairman, Professor David Lidgate, a difficult summing-up task.

The third session examined whether the nuclear industry is beneficial to the UK economy. Here Paul Smith of Nuclear Electric plc outline by a successive of overheads the economic and industrial advantages Sizewell B had provided, not just in employment in East Anglia, but nationwide. Many engineering companies in the UK had been involved in providing skilled workers, plant and equipment, and so benefits to the economy had occurred far and wide. The Sizewell B project was a success story. The plant was built faster than any other in the UK in the last 30 years, and was within budget. The work achieved had provided Nuclear Electric with overseas opportunities, as it had clearly demonstrated UK's engineering expertise. The hope was that the review would establish a reward to the industry by agreeing to the building of a twin reactor at Sizewell: Sizewell C. The sooner a start could be made on this the better.

The response by John Walker of the Oxford Economic Forecasting unit did much to suggest support for the nuclear industry in providing opportunities that would be beneficial to the UK. He examined with some care the need for a stable economy, coupled with growth and decisive public finance vis a vis the public sector borrowing requirement (PSBR) against public funding. What was clearly needed was a public convinced by the nuclear argument and a long-term approach to nuclear development, ensuring the high technology skills remained within the industry.

'Can nuclear power pay its way?' was the economic question posed for the fourth session of the day. Here the speaker was Stephen Ogle, financial director of Nuclear Electric plc, with Jonathan Hardy of UBS Philips and Drew responding.

Stephen Ogle began by looking at the key objectives set by Nuclear Electric plc at the time of vesting of the electricity industry into separate companies. The existing nuclear business in England and Wales was to be managed in such a way that its performance would create a climate in which the company could compete successfully in the electricity market. This objective had been reached, as evidence drawn from the 1992/93 Annual Reports and Accounts show. Output had risen along with an ever increasing cost pattern, leading to a market share of 22%.

Another key objective set in 1990 was well on the way to being achieved: to build and commission Sizewell B to both time and cost. Again there was clear evidence of this being achieved. In September 1989 the Secretary of State for Energy made the following statement: "Investment in further PWR stations will not be approved in 1994 unless that are assessed to be economic over their life as a whole. The benefits of fuel diversity and the environmental advantages of non-fossil fuel-fired generation will need to be taken into account in this investment."

Mr Ogle began by looking at avoidable unit costs of generation, the right base, he claimed, from which to make comparisons. He showed that such calculations as avoidable costs for fossil fuelled stations were more difficult to assess.

Coal or gas prices were such that it is difficult to compare with the more stable uranium price. Gaseous emissions necessitate the showing of calculations embodying stations both with and without FGD.

Even at the optimistic end of the fuel cost range, a new coal station is no cheaper than a PWR, while the costs for CCGTs straddle the future anticipated costs for nuclear.

On the question of proposed EC environmental tax, a figure of $10 per barrel of oil equivalent split 50/50 between the energy and carbon contents would have a substantial impact on the average costs of coal and gas-fired plant.

Finally, the matter of financing new investment, we have to recognise th political reality. The current position of the PSBR means that the Government will continue to drive many industrial and commercial activities into the private domain. And given the progress of both Nuclear Electric and Scottish Nuclear, both companies believe they have a saleable business. In response Jonathan Hardy posed the question 'Would investors be prepared to buy a nuclear only generating company? Would investors pay the net asset value?' This he examined in the light of a number of key issues, including risk. On the question of business risk he covered decommissioning operations and construction. Regulation risks might encompass tighter environmental standards, while the financial risks must be addressed by the risk to equity matching periods of high gearing for construction costs, implying higher volatility of earnings.

Mr Hardy used a model designed to take into account all the risks by attaching values thought to be acceptable. His views indicated that Nuclear Power could be sold off, but not in its present form. At present there is no clear policy on which prospective shareholders could base a decision, but given time, with competent management, a business plan could be formulated, leading to a successful floatation.

The final session explored the key issue of safety. Richard Killick, director of safety at Scottish Nuclear and Trevor Kletz, senior visiting fellow at Loughborough University, offered complementary views of safety. Mr Killick emphasised the importance of public perception, Mr Kletz argued the merits of intrinsic safety through plant design. Neither challenged the idea that nuclear power is safe and getting safer.

Safety is a matter of personal perception, and attitudes cannot be changed by scientific demonstration alone. The process is gradual, requiring a degree of trust, which is in turn dependent on informed understanding. How safety is perceived by the public is crucial, a point recognised by critics of the nuclear industry. There is a need to get across the concept of relative risk, so the public achieve a balanced view.

Continuing expenditure on safety is required to improve safe operation of reactors in Russia and the CIS countries: a further accident of Chernobyl proportions would undermine public trust to such a degree that there would be no nuclear power industry by 2020.

Mr Kletz drew on his experience in chemical engineering with ICI to illustrate the principles of intrinsically safe systems, citing the case of nitroglycerine manufacture. In contrast the nuclear industry relies on complex added-on protection equipment, which could fail or fall into neglect. The PWR design is smaller and inherently safer, making it easier to 'sell' to the public. These would be a preferable option in developing countries, where the safety infrastructure may be less vigorous.

During the discussion the debate heard of Nuclear Electric's improving safety record from Dick Taylor, safety strategy manager. He emphasised that safety makes good business sense — in a 'quality' company, safety and commercial operation go hand in hand. Nuclear Electric benchmarks itself against the chemical industry on industrial safety, and against other utilities vis a vis radiation doses, and is performing as well as any utility worldwide.

Trevor Kletz left the forum with the thought that safety in the UK would be effectively improved if the industry gave some of the money it currently spends on improving already safe systems to the NHS or RoSPA. The public, however, do not fear road accidents so much as they fear the unknown or the potential scale of another Chernobyl.

This forum, attended by about 80 people, did much to offer an uninhibited debate on the whole future of UK nuclear policy. There does appear to be growing support for a nuclear component to ensure stability within the ESI. Diversity, flexibility and a measure of competition should be maintained in the high technology electricity industry, continuing to support growing prosperity and both urban and rural development. ❑

Packaging and the environment

A conference report by R G Loram

Germany is perceived to have led the way in many areas of environmental legislation, including recycling of waste. In his conference report R G Loram challenges this assumption, and takes an in-depth look at recycling from the packaging industry's point of view.

THE Financial Times second international conference on the subject of packaging and the environment was well timed to address the aftermath of Germany's ill-considered attempt to enforce recycling by legislation.

The UK government view was that packaging should be reduced, recycled where ever possible and only burned to recover energy as a last resort. Mr Gummer gave the opening address, having noted that recycling was popular, he said "we have to start from where the people are." He didn't query whether the voters were right.

The Germans have moved on from that position with their Packaging Ordinance, and the Duales System Deutschland (DSD) company set up to implement it. The result has been an enormous surplus of recovered paper and plastic products which DSD has been exporting to other European countries at highly subsidised prices. Collected waste paper in the UK is now being landfilled, with a 'plastics mountain' growing by the day. All this at a cost to the German consumer of DM6 billion — so far.

The Dutch approach starts at the same baseline, but is more pragmatic, taking the form of a covenant between the government and the packaging industry, in place of the straightjacket of legislation. The aim is to reduce by 2000 the quantity of new packaging on the market to the 1986 level, and to reprocess, to as high a grade as possible, a minimum of 60% of unreusable packaging. Landfilling would cease by 2000, with all unrecycled waste being incinerated.

The French approach is more pragmatic still. 'Eco-emballage' is a scheme exploring practical ways to create markets for recycled material, and cost-effective methods for extracting that material from the waste stream. Much the same is being done by industry in the UK, but with little help from the Government.

Draft directive

In the EC a draft Packaging Directive is still evolving, and no one is bold enough to predict a launch date. The draft directive, however, sees incineration with energy recovery as a legitimate form of waste use.

Mr Gummer was fully aware of the damage done by the German legislation, but, somewhat unreasonably he had given the UK packaging industry less than four months to report as to how they would set about recycling between 50% and 75% of waste. If his timescale was not met he would be forced to legislate, although unfortunately he did not offer any suggestions as to how the industry might go about this thorny task.

The German Secretary of State for the Environment, Nature Conservation and Nuclear Safety, Herr Clemens Stroetemann, did his best to defend the Packaging Ordinance, but it is unlikely that he convinced anyone that it was anything other than a thoroughly ill-conceived piece of legislation. He said that it embodied a new philosophy: that producers should be held responsible for their products from cradle to grave, a

concept which, when examined to see what it actually means in practical terms, raises a list of questions as long as your arm. The problems from which Germany now suffers, and which she has inflicted on her neighbours, arise from those questions not having been asked, let alone answered.

The way in which the DSD works is that packaging producers pay a fee to the company in return for the right to place a green dot on their packages. This green dot entitles consumers to return the packaging to the retailer, who then passes it on to the wholesaler, from where it is passed on to the DSD for recycling. In theory the cost of the green dot is passed on to the consumer. This appears to be a purely inflationary process, as there is no evidence of any complementary savings in waste disposal costs.

Public enthusiasm

Several things had gone wrong, according to Hr Stroetemann. The public had been too enthusiastic in returning the packaging; companies had been displaying green dots on their packaging without paying for them (although one would have thought this was easily monitored); and the industry failed to provide the recycling facilities — the Ordinance itself was quite innocent! As a result the DSD was heading fast for bankruptcy, and since it was prevented by law from landfilling or incinerating surplus materials, had resorted to heavily subsidising their export to other countries.

The sad thing is, when I was visiting German incinerators in February 1992, the scheme was in its infancy, and yet the operators were already aware of the problems, and predicted that the scheme would get into trouble. One of its limitations is that materials must be recycled or reused as substances, rather than used for energy recovery. Hr Stroetemann hinted that the review of the scheme — to be brought forward — might relax this final requirement.

The Netherlands Government's view was put by Hans Alders, Minister of Housing, Physical Planning and the Environment. He took as his theme the 'packaging problem', and the necessity to protect the environment from its effects. He also subscribed to the 'cradle to grave' theory, and said: "To achieve the goals of sustainable development as regards waste, an important starting point of my policy is that the manufacturers of products and packaging should be responsible for those products from cradle to grave, from development of a product until the waste product. That means that they will have interest in more prevention and recycling of waste products and materials. Therefore we need to have markets for secondary raw materials. To ensure that there are financial and economic incentives for these products, my basic premise is that the cost of collecting and reprocessing a product at the waste stage should be included in its price. That way there will be a guarantee from the outset that sufficient funds will be available for collection and reprocessing."

Covenant

These are fine words, but how do you make a manufacturer responsible for something which is no longer his property and over which he has no further control? There are some sensible provisos in the Covenant, which will help to ensure that participants do not get boxed in by over ambitious targets that is is not possible to achieve. One, quoted by Mr Alders, says: "If research shows that the replacement of one-way packaging by re-useable packaging would clearly cause less damage to the environment, and that there are no predominant objections in terms of the sellability of the product, the packaging chain undertakes to switch to re-useable packaging at the same one of one-way packaging."

The escape route is the obverse of this statement. Two others were quoted by Bert Paalman, a director of a large Dutch packaging company, as conditions the industry stipulated before accepting the Covenant. One was that incineration with energy recovery must be permitted in order to handle surplus quantities of waste paper, and the second was that the re-use of recycled packaging materials was to be regarded as equal to the re-use of packaging materials. The latter is necessary because much of the recycled material used in packaging comes from sources other than recovered packaging.

Mr Alders claimed the Covenant was working. When it was signed in June 1991, more than 125 firms agreed to it, and that number has since risen to over 200. He did not report any measurable results, but it must be remembered that targets are calculated on a 10-year timescale.

He was distinctly miffed at the latest draft of the EC Packaging Directive which, he thought, not only set targets that were too low, but set them over an impracticably short timescale. He could not agree that the quantities set "would ensure a high level of protection of the environment" — in the words of the draft — he had a different view of what that entailed and said that the Netherlands would not sign such a weak directive.

Industry perspective

It would be too long winded to try and summarise individually all the excellent contributions made by the speakers representing the packaging industry. All were eminent in their field, although there was an inevitable degree of repetition, as speakers from similar parts of the industry, but from different countries, made the same points. This was no bad thing, as it left Governments in no doubt that their views were widely held.

I think the most significant aspect to strike the outside observer is the sheer complexity of the subject. Consider, for example, the fact that the legislation and agreements are on a national or regional basis, but the packaging industry operates in an international market, as do the producers of commodities inside the packaging. A UK brewer asked Mr Alders about imports, and he replied that importers would have to meet packaging requirements. Leaving aside the fact that those requirements are only loosely formulated, and no law exists to enforce them, such national moves have been ruled an illegal restraint on trade by the European Court, when Germany tried to insist that all beer containers be returnable.

Another major complexity is the many different types of packaging, often competing to do the same job. Beverages are a good example. They can be offered in steel or aluminium cans, plastic bottles, glass bottles, cardboard cartons and now plastic pouch refills. If anyone is going to try and pick winners on environmental grounds, in a way that overrides the market, they will have to base their judgements on very clear scientific evidence, which currently doesn't exist.

Life cycle analysis

There was much talk of 'life cycle analysis' (LCA), but a certain lack of unanimity as to what it meant. The common perception seemed to be that it involved analysing the energy and money spent on a packaging product, from production of the raw material to its conversion into a package, its use and any recycling processes to its final demise (including energy recovery). Work is said to have been done on certain forms of packaging, but no one seemed to know of any results actually being available. This is an interesting concept, but it demands painstaking execution to be able to lay claim to any validity. A value would have to be given to the amount conveyed by a package in its lifetime.

Colin Williams, president of SCA Packaging, stated "It takes more energy to produce a kilo of recycled paper than to produce a kilo of virgin paper". Paper is recycled because it provides a cheaper raw material — so it becomes a question of how much transport energy (and pollution) is involved in getting the two raw materials from source to mill. When one considers that trees grown for papermaking are a relatively young stock, and therefore good converters of CO_2 to O_2 and that waste paper is a more environmentally friendly fuel than fossil fuels, it could well turn out that recycling paper is environmentally damaging! The next logical question is: how about recycling plastics? Is there any proof that this is a 'green' activity?

Plastic film

Consider two dogmas beloved of the environmental activists: there is too much packaging, which is damaging the environment; and that plastic packaging is the worst offender, with plastic film cast in the role of arch villain, as it is totally uneconomic to collect, is usually contaminated and is difficult to reprocess. The reprocessing problem arise from the fact that plastic film is usually multi-layered, being composed of at least two plastics — a layer of polythylene to exclude or retain moisture, and a layer of polyamide, to exclude oxygen. The packaging industry has made enormous strides in the past decade or two in the reduction in the overall weight of packaging used. This has been done for good commercial reasons. It has been achieved by the use of plastic film. Viktor Williams of Du Pont de Nemours International SA summed it up: " ... the European food industry has elected to wrap roughly 50% of our food using plastic packaging. At the same time all this lightweight, flexible, multi-layer plastic packaging represents less than 5% of the total plastic packaging waste.

"Yet even in the face of all these savings, it is all too often that plastics are singled out for criticism. Why? Because popular 'wisdom' says that packaging materials should be selected for their recyclability only. Now, in principal, that may be a good criterion. But when we look at the overall environmental impact of that decision, we see that the package that is often the most recyclable is also the heaviest or most voluminous.

"To prove my point, I'd like to quote some statistics from the Market Research Association for Packaging (Germany) regarding the multi-layer plastic used in Germany in 1991. The study examined the implications of substituting Germany's 1991 consumption of 32 000 tonnes of multi-layer packaging by other materials. It was estimated that 72 000 tonnes of paper, 100 000 tonnes of glass, 110 000 tonnes of steel and 9 000 tonnes of aluminium - a total of 293 000 tonnes — would be needed to package Germany's food that year to replace the 32 000 tonnes of multi-layer plastics.

"But there is more. Not only would there be nine times more packaging weight, four and half times more energy would be needed to produce the packaging, and the cost would increase by more than three times.

"The APPF (the Alliance of Plastic Packaging for Food, of which he is chairman) took the implications of the study one stage further. Let's assume that 90% of the substitute materials can be collected, and that 90% of that quantity can be sorted, and then that 95% of that sorted can be recycled.

"That means from an original 293 000 tonnes, a total of 226 000 tonnes could be recycled. That leaves 67 000 tonnes of waste for disposal by other means — either energy recovery or landfill. Wait a minute — 67 000 tonnes of residue waste to landfill? Wasn't that to substitute for 32 000 tonnes of multi-layer packaging?

"Yes indeed, that is more than twice as much waste to be disposed of, by weight. What's more, if a certain amount of the substitute materials could be combusted — such as paper — there would be 36% lower energy recovery than with plastics.

"In conclusion, multi-layer plastic packaging minimises the quantity of waste destined for landfill; uses less energy to produce; its energy content can be effectively recovered and, on top of all that, it is a cost-effective solution."

Now, acknowledging that Mr Williams is in the business of promoting plastic film packaging, he does have a point — doesn't he?

A related topic was raised by David Vetch of Proctor & Gamble Europe. His company pioneered the use of recycled plastics in detergent bottles, as well as thin-walled plastic pouches in which the consumer may purchase refills for rigid bottles. This has proved popular, and even after allowing for the cardboard transport packaging of the pouches, the total saving is material is around 50%. The pouches, however, were not suitable for recycling, but it should be noted that although the bottles contain a proportion of recycled material as the middle layer of a sandwich construction, they could not all be recycled themselves for that purpose, and some other application would need to be found.

Economic feasibility

Mr Paalman took the sober view that " ... a limited part of the waste flow, about 20%, will be recycled into secondary raw material. Beyond that level the economic feasibility reduces sharply."

Recycling is only a modern buzz-word for materials reclamation, which has been the basis of a thriving reclamation industry for the past 150 years. If it is commercially viable to reclaim material from any source, it will be done. If reclamation is not commercially viable, it is incumbent on environmental lobbyists and Governments to demonstrate clearly why such activities should be subsidised, whether by the taxpayer or the consumer. To date both parties have signally failed to do so. That is not to say that there will never be a good reason for overriding the market, there may well be, but it must be demonstrated.

Life cycle analysis may be a suitable vehicle for achieving this, but the protagonists of recycling must be prepared to discover that a thorough investigation may not throw up the results they expect. What governments can usefully do is to assist with the research, perhaps through LCA, to define the true environmental parameters, and to try and find economic new methods of creating markets for recovered materials. Those economics must include the costs of recovery. They do not need to cajole industry into doing research — it is already in there, beavering away.

The draft EC Packaging Directive speaks of a 'high level of environmental protection', but the need for the Directive would be clearer if the Commission explained exactly how packaging is threatening the environment. Properly managed landfill can be a considerable environmental benefit. The case against it is that it makes no sense to bury all that potential fuel in the ground. What then? Litter? That is another subject altogether, and only loosely connected with packaging. Please could the Commission explain what they have in mind?

Parody of the truth

What the industry wants is for the environmental lobbyists to desist from sloganising. One speaker, remembering his youthful reading of George Orwell's *Animal Farm*, recalled the animals chanting 'four legs good, two legs bad' — a parody of the truth — and thought he could discern Orwellian voices today, chanting 'packaging bad, recycling good'. Equally a parody of the truth. To carry the literary theme a bit further, one might remark that the assertion in Lewis Carroll's *Hunting of the Snark* that 'what I say three times is true' is unlikely to cut much ice with businessmen, engineers and scientists struggling to survive in the real world, whilst sharing the same environment as the lobbyists and politicians.

And to the political parrots who repeat these slogans, understanding neither their meaning nor their implication, one might offer the simple, but wise, advise barked by a fierce little gunnery instructor to my sub-lieutenants class: "if you don't know — find out!"

Finally, what is the likely outcome of all this debate, and how will it affect the energy scene? There are signs that the legislators are beginning to realise that there are serious practical limitations on the amounts of various materials that can be recycled without distortions of the market, which are no one's long-term interest. And they are coming to accept that reusing as a fuel those combustible materials which cannot be economically recycled is a sensible alternative. We may expect the philosophy that wastes should be used for energy recovery rather than landfilled to be more widely advocated in the future. ❑

1993 Faraday Award goes to Institute Fellow

THE Royal Society's Council has made the Michael Faraday Award for 1993 to Institute of Energy Fellow and past President, Ian Fells, Professor of Energy Conversion at the University of Newcastle upon Tyne.

The award was made for his many written articles for the national press and popular science journals, his public lectures on many platforms, and his major contribution in broadcasting, where he has had an input to over 350 radio and television programmes.

Professor Fells' contributions are two-fold — as a perceptive and expert commentator on energy policy, and as a deft and entertaining demonstrator of scientific phenomena, processes and puzzles.

His abilities as a presenter of engineering and science broadcasts have been seen in a whole range of successful and popular programmes: *Take Nobody's Word for it, QED* and *Horizon*, as well as children's series such as *Young Scientist of the Year* and *The Great Egg Race*.

He has held his current post at the University of Newcastle upon Tyne since 1975, and has published some 200 papers on combustion, fuel cells, rocket propulsion, energy economics and policy. As a lucid international commentator he has contributed very widely to public debates, not least through the broadcast media on such programmes as the *Today* programme, *The World Tonight, The Jimmy Young Programme* and *File on Four*. He has also been a special advisor to both parliamentary houses on energy and the environment.

Professor Fells received his award at the Royal Society's anniversary meeting at the end of November, having given his award lecture earlier in the month.

The annual award is given on the recommendation of COPUS to the scientist who has done most to further the public understanding of science in the UK.

Professor Ian Fells

The Institute of Energy

Presidential officers and honorary officers 1994/5

The undermentioned have been elected by Council to take office following the annual general meeting on 5 May 1994.

D G JEFFERIES to become president; **P H J JOHNSON** to become president-elect; **J G COLLIER** to become vice-president; **H F FERGUSON** — honorary secretary; **M B PITTWOOD** — honorary treasurer.

Election of Council 1994/95

Following the AGM, the undermentioned will retire and are not eligible for re-election:
K A GALLOWAY, C POSTINS (IEng representative)

The undermentioned will retire but are eligible for re-election:
J R AGG, A W T CLEAVER, DR C HOWARTH, DR G W WATERHOUSE

The undermentioned co-opted member will retire but is eligible for election:
DR J C WHITEHEAD

The undermentioned have been nominated by Council:
J R AGG, A W T CLEAVER, DR C HOWARTH, DR G W WATERHOUSE, DR J C WHITEHEAD, J BAILEY (IEng representative), **S TAULBUT** (IEng representative)

Any 10 Corporate Members may nominate in writing any duly qualified person to serve on Council.

Any three Corporate or Associate Members may also nominate in writing an Incorporated Engineer to serve on Council. A vote for Associate Members would be by Associate Members only.

All nominations, together with the written consent of the nominee to serve, should reach the Secretary of the Institute not later than eight weeks before the AGM, but preferably earlier. (Members are not, however, permitted to join in the nomination of more than three persons in any one year.)

Accomplished report

'Privatising British Electricity — Restructuring and Resistance' by Andrew Holmes. Published by Financial Times, London, 1992.

THIS Management Report, published by the FT under the authorship of the late Andrew Holmes, must rank as one of the most accomplished and knowledgeable pieces of literature encompassing the UK electricity industry.

It covers the history of the industry before privatisation and examines the objectives of privatisation, presenting an insight into the political/industrial interchanges surrounding all the problems encountered from 1987 onwards.

The facts which are carefully portrayed from the time of the Electricity Bill in July 1989, including Parkinson's replacement by John Wakeham. It provides the reader with a most interesting account, dealing as it does with the removal of the nuclear component from the privatisation process, and the resignation of Lord Marshall, the last chairman of the CEGB.

The following chapters cover the manner in which pricing and other related issues were discussed leading to the floatation of the RECs and the generators. The book tells something of the attempt by private bidders, Hanson and others, to claim a stake in what was seen as a possible future bonanza from profits. All the companies which today form the private sector in this most important industry are examined. Their progress and performance in the new electricity market gives some idea of the problems which were experienced in setting up the pool and the contract system.

Andrew Holmes deals with nuclear power, natural gas and coal as fuels for electricity generation by looking at the new methods being adopted, the new policies, new measures and the way in which the old system and its manpower have had to change quickly to meet the rapidly developing scene.

Regulation and its future is carefully described and the report concludes by attempting to forecast whether the privatisation operation will be seen as so advantageous that other countries will be encouraged to adopt similar methods.

The intellectual, technical and financial exposition of this work must not be underated. It already contains the seeds of truth in the events which have occurred since the author's untimely death in September 1993.

Andrew Holmes found the electricity system working today following privatisation, not because of its so-called freedom from Governmental interference, but more to the fact that many of the rules established for the regulatory framework are being disregarded. Many may argue with that point, but the author's assessment is critical of what he saw as a very knowledgeable observer. One of the most positive elements is seen to be the hope for the independence of the National Grid system, bringing as it does third party access. The operation and performance of the National Grid Company will, Andrew Holmes forecast, be greatly improved when it is removed from its anomalous position in the ownership of the 12 RECs.

The author, in the concluding parts of this excellent report, sees the privatisation experiment as being at present a long way from its original goals. It is not seen as an entire failure, but the chance of drastic changes occurring are now almost impossible. The electricity industry is so huge that its sheer size and complexity will prevent any fundamental or radical moves being made for several decades. The author saw one of the root causes bedevilling the whole process lay in the Government's attempt to sell off the nuclear industry. At a time when both Nuclear Electric and Scottish Nuclear power stations are making excellent annual returns in performance, time alone will decide the industry's eventual position on the nuclear issue.

Eur Ing F John L Bindon

● *An obituary of Andrew Holmes appeared in the October issue of Energy World.*

A scholarly exposition

'Dilemma of Swedish Energy Policy' by Ragnar Lofstedt. Published by Avebury Studies in Green Research,

A CASE-BOUND book from the centre for environmental strategy at the University of Surrey, this study is the result of joint funding by the National Science Foundation and the Swedish Council for Planning and Coordination of Research. It would appear to be in whole or part a PhD thesis, and is certainly a scholarly exposition.

But what is the dilemma? Of course, the nuclear one, and how effectively to reduce energy use. A key to the author's approach appears early — on page two: 'Since Sweden has limited indigenous energy sources, the only acceptable alternatives to replace the lost nuclear capacity would appear to be wind power, biomass and energy conservation.' In the same paragraph the decision to shut down Sweden's nuclear production by 2010 is questioned. Somewhat unnecessarily since the decision not to do so has recently, one understands, actually been made. Sweden needs the power, has nothing with which to replace it.

If, in fact, the immediate dilemma has been resolved, does this book have a place? The answer is affirmative if only in drawing the line between technical energy conservation measures and behavioural likewise. Unfortunately for the balance of this work, there is far too little space devoted to the former, despite the acknowledgement: 'Today electricity accounts for (only) 33% of Sweden's energy use.'

Lack of an index does not enable the Stockholm example to be found. The chief executive of Stockholm Energi has recently confirmed that this capital city has an energy demand where the ratio of heat to power is at least two to one. Mr Lofstedt really should have taken this into consideration and examined the effect on total electricity demand if enforced (taxes or other measures) by expansion of distributed heat from combined heat and power (CHP) installations.

In mentioning Vaxjo, one of the most determined Swedish cities employing CHP, he omits mention of heat pumps to condense flue gases and remove all pollution at source. Was that a failure, or is it success merely deferred? An extremely important experiment in this context.

Other data, assembled to represent Sweden's CHP activity, shows a heat to power ratio of 12.2 to one in favour of heat. The discrepancy of the three figures suggests the need both for dedicated research, and another thesis dispassionately examining the balance of technical and behavioural influences, with an informed forecast of effect to follow action linked to both.

The user survey, the questions and answers employed and the painstaking research done are exemplary; the conclusions may or may not have been influenced by the virtual separation of fundamentals. Readers might think Mr Lofstedt's 33% for electricity should have given him pause to direct at least some comment to the heat and power ratio and the effect on Sweden's overall energy dilemma.

Norman Jenkins

Recently published

'Vietnam: opportunities in a developing oil and gas market'
Published by MDIS Publications Ltd, 1993, 120 pp, £395.00 inc p&p. Available from MDIS Publications Ltd, 8 Eastgate Square, Chichester, W Sussex PO19 1JN. Fax: 0243 533418

'Large industrial thread fasteners'
by J S Mitchell, published by Highgate Publications, 1993, 40 pp, £11.95 (P/B) £16.95 (H/B). Available from Highgate Publications (Beverley) Ltd, 24 Wylies Road, Beverley, N Humberside HU17 7AP.

Diesel engine for private motoring

THE OCTOBER issue of *Energy World* carried an item about Project 275 ('The diesel debate'), a proposed attempt to break a series of speed records for diesel powered cars. The item mentioned that the Institute of Energy is lending its name to the project as a way of promoting development in diesel power. This letter is intended to inform our membership about the background which led to the Institute's association with the project.

Last November the Institute of Energy organised a conference on *Energy, Transport and the Environment* in which fuel consumption, emissions and alternative fuels were discussed. This led some of our members to observe that the average motorist's view of the diesel engine is still something rather noisy, smelly, short on power and falling a long way short of the macho image sought, but not necessarily admitted, by many when buying a car. However, there is much in the old saying 'racing improves the breed', and there has been little doubt that competitive motor sport has been a major stimulus to the technological advances in the petrol engine which are now commonplace in the family car.

The Institute believes there is considerable scope to improve the performance of the diesel engine, its fuel, and its public image by the same route. The benefits are clear. The diesel engine has an inherent advantage over the petrol engine, in that it requires a lower fuel/air ratio, and consequently has better fuel consumption, and lower emissions of carbon dioxide and partly-burned hydrocarbons.

The latter is less of a problem in these days of mandatory catalytic converters on new cars. However, converters on petrol engine exhausts increase carbon dioxide emissions.

The recent press reports suggesting that diesel is not so 'green' as the manufacturers would have us believe reflect only a snapshot of the present position, and we believe that a vigorous programme on diesel engine and fuel development would establish the advantages of diesel power beyond doubt.

We see the Institute as having a role in seeking to raise the profile and image of diesel power in the public mind, as a means of helping to stimulate a market-driven incentive for greater efforts in diesel development. These speed record attempts are seen as an early opportunity to do this.

Another way with which we would wish to be associated is through competition in the touring car categories. There is already an equivalence formula used by the RAC Motorsport Division for comparing petrol and diesel engine capacities, and a turbo diesel car has been competing this year with some success. Regrettably the prestigious British Touring Car Championship remains restricted to petrol engined cars of up to two litres capacity, and we believe that opening the championship to diesel engines would provide further stimulus to the development of diesel power and efficiency.

This initiative is regarded as a logical step in the Institute's 'future shape' programme in the area of energy and the environment, and consistent with the Government's commitment to stabilise emissions of CO_2 and seek environmental improvement.

H F Ferguson
Honorary Secretary

Realistic opportunity

AND SO the spectre of pit closures fails to disappear. The country's richest long-term source of accessible energy is plunged into suspended animation, while prime fuel reserves are squandered in the 'dash for gas', and the short-term grab for profits.

Meanwhile, *Energy World* keeps reminding us that the UK is at the forefront in world development of FGD for the clean burning of coal. We are also told that combined heat and power (CHP) gives us the opportunity to improve fuel utilisation from around 30% to a miserly 80% during power generation.

Can anybody explain therefore, why attention does not appear to have been given to combining these two technologies in an effort to tackle our most pressing economic and environmental problems? Surely clean burning coal-fired CHP represents a realistic opportunity that should not be overlooked in efforts to formulate a cohesive national energy policy that will carry us well into the next century and beyond.

Ian McKay *(Associate)*
Kettering, Northants

The editor welcomes letters from readers on any issue within the energy field for publication in *Energy World*. Correspondents are requested to keep their letters to a maximum of 500 words. Send your views to: The Editor, Energy World, H Howland Associates, The Martins, East Street, Harrietsham, Kent ME17 1HH, or fax: 0622 850100.

Engineering Council's 1994 Environment award launched

THE Engineering Council has launched its 1994 Environment Award for Engineers — the prestigious annual competition that demonstrates how engineers are making positive contributions to protecting the environment.

The award has prizes totalling £6000, with the winning engineer or team of engineers winning a first prize of £3000. The second prize is £2000 and the third, £1000.

Mr Denis Filer of the Council said: "The Environment Award for Engineers encourages engineers and technicians to demonstrate their skill and versatility in giving some priority to environmental issues when planning projects and finding solutions to environmental problems.

"All engineers should have ideas on helping to solve today's environmental problems and how to lessen future environmental damage."

The 1994 Environment Award for Engineers is open to individuals who must be registered with the Council as Chartered Engineers (CEng), Incorporated Engineers (IEng) or Engineering Technicians (EngTech), or to teams of engineers and technicians which must include at least one member who is registered. Entrants must have been responsible for the design, manufacture or construction of an engineering process which provides an engineering solution to an environmental problem.

The 1993 Environment Award for Engineers was won by consultant engineer Mr Anthony Convery for finding a solution to recycling waste concrete from readymix lorries and on-site concrete mixers. Mr Covery , of Cookstown, Co Tyrone, developed the concept and produced the prototype machine to separate sand, aggregates and liquid for re-use in future mixes.

Details of the competition and and entry forms can be obtained from the Engineering Council, 10 Maltravers Street, London WC2R 3ER, tel: 071 240 7891.

Bursaries for 'top flight' students

NEARLY 3500 schools and further education colleges throughout the UK will shortly be receiving details of a new initiative to encourage high-achieving students into accredited engineering degree courses.

The 'top flight' bursary scheme will provide suitably qualified students with £500 per year, in addition to their maintenance grants for the duration of their undergraduate courses.

Students embarking on engineering degree courses in the autumn of 1994, 1995 and 1996 will be eligible to apply for the bursaries providing they have A level grades of at least AAB or the equivalent grades in another qualification. The requirement for Scottish students will be SCE Higher grade, five subjects at grade A or equivalent. Candidates holding other awards or sponsorships are still eligible to apply for this bursary.

Altogether £10 million of funds has been provided by the Department for Education for the scheme, which will be administered by the Engineering Council.

Details of the scheme are contained in a leaflet issued by the Engineering Council. Copies of the leaflet have been sent to 2500 public sector schools and further education colleges and also to over 900 independent schools in England and Wales.

The new scheme is regarded by both the Government and the Engineering Council as an important contribution to making engineering a more attractive educational and career goal for young people.

Tim Boswell, Parliamentary Under-Secretary of State for Education, said: "By seeking to encourage high calibre students into engineering this scheme will raise awareness of the value of engineering, and should ultimately help British industry to compete more successfully in world markets.

"Up to 2000 students a year are expected to qualify for the bursaries, and applications will be accepted from students attending sandwich and part-time courses as well as full-time courses."

Sir John Fairclough of the Engineering Council said: "This initiative should demonstrate in the most direct manner possible that engineering can be financially rewarding as well as an intellectually stimulating career option for young people to follow.

"Recent research by the Engineering Council has shown that engineering is a well-paid profession with high levels of job satisfaction. Making that evident to young people before they decide what subject they should study at university is bound to have a positive effect on the numbers and quality of those who opt to study engineering at degree level."

Copies of the leaflet *Top Flight: bursaries for engineering students* are available from the Engineering Council, 10 Maltravers Street, London WC2R 3ER.

£20 000 in prizes for top young engineers

BRITAIN'S brightest young inventors will be competing for prizes totalling £20 000 in the Young Engineers for Britain 1994 competition.

The competition, which is organised by the Engineering Council, is now open for entries from young people aged from 11 to 19 in full-time education or working in industry. The overall national winner — the Young Engineer for Britain 1994 — will receive a personal prize of £1000, a trophy and £1500 for their school or organisation.

Nearly 1000 young people took part in regional finals of the competition this year, and the 1993 Young Engineer for Britain is 16-year-old Lucy Porter, of Bath Avon, who invented a swing exerciser for children with special needs who are unable to use their legs.

As well as prizes for class winners, special prizes in 1994 include the WISE (Women Into Science and Engineering) award of £800 for the best project by a girl or team of girls. The Boots Company prize of £800 is for the best project meeting a healthcare or medical need; and a prize of £800 for the best project by a student or team of students studying for a BTEC qualification. There is also a £600 prize from the Department for Education for the school entering for the first time with the most imaginative project.

The aims of the competition are to encourage young people to undertake engineering project work and to strengthen links between education and industry. Regional finals will be held in June and July 1994 and the national final will be held in London in September.

The most simple of projects can compete with quite sophisticated devices. Entries can be either from individuals or from teams of up to four.

The principal sponsors of the competition are Lloyd's Register, one of the world's leading marine, offshore and industrial technical inspection and advisory organisations, and National Westminster Bank.

Other major sponsors include: Adwest, BICC Group, British Aerospace, BP Oil, Courtaulds, GEC, IBM, ICI, London Electricity, National Grid Company, Nuclear Electric, Ove Arup Partnership, Railtrack, Rolls-Royce, Shell UK Exploration and Production, Tarmac Construction, Thames Water, The Scientific Instrument Makers Company, TI Group, Unilever, Vickers and Wimpey Worldwide.

Prizes and other support are also provided by other industrial companies, professional engineering institutions and educational bodies.

Entry forms are available from the Engineering Council.

EVENTS

January 1994

Combined cycle power generation
International conference, January, Calcutta, India. Details from Prof Prabir Basu Dept of Mechanical Engineering, Technical University of Nova Scotia, PO Box 1000, 1360 Barrington Street, Halifax, NS, Canada B3J 2X4. Tel: 902 420 7531; fax: 902 420 7640.

Applied rheology
Course, 10-13 January, Stevenage. Details from Miss S Gartside, Warren Spring Laboratory, Gunnels Wood Road, Stevenage, Herts SG1 2BX. Tel: 0438 741122 next 2366; fax: 0438 360858.

Neutral computing applications
Conference, 12-13 January, London. Details from Ila Patel, tel: 0932 821947; or Howard James, tel: 0705 843151/268668.

The future of the nuclear industry
Conference, 18—19 January, London. Details from Liz Hide, IBC Technical Services Ltd; tel: 071 637 4383; fax: 071 631 3214

Massive magentostrictives & piezoelectric composites
Evening seminar, 20 January, Southampton. Details from Laura Brown, USITT, University of Southampton, Highfield, Southampton SO9 5NH. Tel: 0703 593545; fax: 0703 592738

Middle East Electricity '94
Exhibition, 23-26 January, Dubai. Details from Yvonne Kemp, Project Manager, Middle East Electricity '94, Suite 12, Accurist House, 44 Baker Street, London W1M 1DH. Tel: 071 935 8537; fax: 071 935 8161.

Managing environmental accidents
Course, 24 January, Leeds. Details from Miss Julie Charlton, Dept of Fuel & Energy, University of Leeds, LS2 9JT. Tel: 0532 332494; fax: 0532 332511/440572.

Coalbed methane extraction
Conference, 24—25 January, London. Details from Richard Keown, IBC Technical Services, Gilmoora House, 57-61 Mortimer Street, London W1N 7TD. Tel: 071 637 4383; fax: 071 637 3214.

Mediterranean oil & gas exhibition and conference
25-27 January, Naxxar, Malta. Details from Spearhead Exhibitions Ltd, Rowe House, 55-59 Fife Road, Kingston upon Thames, Surrey KT1 1TA. Tel: 081 549 5831; fax: 081 541 5657 /5016, 081 547 2807.

Combustion instrumentation and control
Course, 31 January — 2 February, Leeds. Details from Miss Julie Charlton, Dept of Fuel & Energy, University of Leeds, Leeds LS2 9JT. Tel: 0532 332494; fax: 0532 332511/ 440572.

February 1994

Spark ignition engine emissions
Short course, 14-18 February, Leeds. Details from Miss Julie Charlton, Dept of Fuel & Energy, University of Leeds, LS2 9JT. Tel: 0532 332494; fax: 0532 332511/440572.

Fire engineering strategies for complex buildings
Seminar, 17 February, Manchester. Details from Mid Career College, PO Box 20, Cambridge CB1 5DG. Tel: 0223 880016; fax: 0223 881604.

Sheffield University CEFT Society annual dinner dance
25 February, Sheffield, speaker Syd Abbott, Chevron. Details from the Dinner Committee, tel: 0742 768555, ext 5252; fax: 0742 780611

March 1994

Modelling uncertainty
Two-day course, March, Cambridge. Details from Rebecca Simons, Course Administrator, University of Cambridge Programme for Industry, 1 Trumpington Street, Cambridge CB2 1QA. Tel: 0223 332722; fax: 0223 301122.

Advances in turbo-engineering
Conference, 2/3 March, Aachen, Germany. Details from VDI-GET PO Box 10 11 39, W-4000 Dusseldorf 1 Germany.

Safety in Europe
Sixth Clancey Lecture by Dr Helmut F Holtbecker, 16 March, London. Details from the Vice-Chancellor's Office, City University, Northampton Square, London EC1V 0HB. Tel: 071 477 8002.

GasTrade '94
International conference, 16-18 March, Hong Kong. Details from GasTrade Ltd, 82 Rivington Street, London EC2A 3AY. Tel: James Ball on 071 613 0087; fax: 071 613 0094; or Brian Singleton on 0932 856848; fax: 0932 828149.

Coal utilisation & fuel systems
International technical conference, 21-24 March, Clearwater, Florida, USA. Details from Coal utilisation & fuel systems, 1156 Fifteenth Street NW, Suite 525, Washington DC 20005, USA.

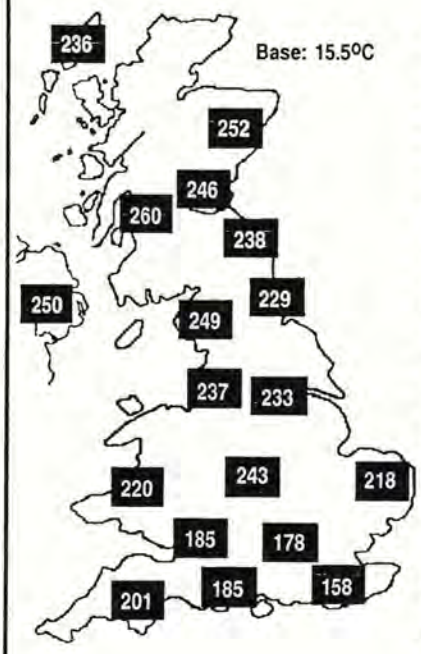
Environmental technology '94
Conference & exhibition, 22-24 March, Birmingham. Details from Michelle Peacock, tel: 081 9948 98825; fax: 081 948 9989.

April 1994

2nd European congress of economics and management of energy in industry
Conference, 5-9 April, Lisbon, Portugal. Details from ECEMEI, c/o Prof Albino Reis, Rua Gago Coutinho, 185-187 - 4435 Rio Tinto, Portugal. Tel: 351 2 9730747/9734624; fax: 351 2 9730746.

DEGREE DAYS: OCTOBER 1993

Source: **Degree days direct**



These regional figures, calculated from daily outside air temperatures, provide an index of demand for space heating over the month and thus enable excessive consumption to be detected.

A well-controlled heating system should manifest a straight line relationship between monthly fuel used and the local degree-day value; any significant deviation from this 'target characteristic' is likely to signal the onset of avoidable waste (such as a stopped timeswitch or an open isolating valve).

Readers can get more information on the use of degree days from Vilnis Vesma, 17 Church Street, Newent, Glos GL18 1PU (0531-821350)

 Because different observing stations are used, the figures given here will not necessarily agree exactly with those from other information providers.

Your Invitation to

ENERGY IN CENTRAL AND EASTERN EUROPE
Political Initiatives and Opportunities for Business

Organised by

The Institute of Energy and The Parliamentary Group for Energy Studies

Chairman, Conference Co-ordinating Committee
Professor Nigel Lucas, Imperial College, Centre for Environmental Technology

Wednesday, 9 March 1994
The Church House Conference Centre, Dean's Yard, Westminster, London SW1

Energy for Eastern and Central Europe is the key to the successful transition of these countries to prosperous market economies. The countries are generally characterised by an over capacity of old and obsolescent plant, sometimes dangerous. Future demand for energy is very uncertain. Political, financial and technical support from Western Europe is important to help with judicious renovation and new investment. New markets and new institutions are needed to facilitate the commercial process. This seminar will look at the political and economic initiatives of the major actors, their reception in the host countries and the opportunities which are created for UK business.

- *UK and EC programmes and initiatives*
- *Options for institutional and structural change*
- *The relevance of Western experience*
- *The role of financial and technical assistance*
- *Financial needs and how they may be met*
- *The risks and uncertainties of reform*
- *A view of Western co-operation and joint ventures*

INTERNATIONAL INITIATIVES

Chairman's Introduction
Dr Michael Clark MP
Chairman of the Parliamentary Group for Energy Studies

Opening Address
Tim Eggar MP, Minister for Energy

Randal Fischer
Team Leader, Energy Resources
European Bank for Reconstruction & Development

Milan Czerny
Deputy Minister for Industry and Trade of the Czech Republic

- *Practical difficulties and practical experience*
- *Achievements to date*
- *Prospects for joint ventures*
- *Upgrading of gas, electricity and heat networks*
- *Opportunities for UK industry*
- *Managing the risks*
- *Making the contacts*

EXPERIENCE & OPPORTUNITIES FOR THE UK

Chairman's Introduction
Professor James Harrison
President of The Institute of Energy

Opportunities for British Expertise
Dr John Rhys
Director, NERA Economic Consultants

Networks
Russell Herbert
Managing Director, Global Gas

Power Generation
Dr Alf Roberts
Commercial Director, PowerGen plc

BOOKING FORM (CEE)
Energy in Central & Eastern Europe

Title

First Name

Surname

Designation

Organisation

Address

Daytime telephone number and fax:

☐ I am a member of one of the above organising societies and enclose a cheque for the concessionary rate: £200 + VAT at 17.5% totalling **£235.**

OR

☐ I am not a member of the above societies and enclose a cheque for the rate of £217.39 + VAT at 17.5% totalling **£250.**

The Institute of Energy: Registered Charity: No 205936

Please return your booking, with cheque made payable to **"The Institute of Energy"** to: **Judith Higgins, The Institute of Energy, 18 Devonshire Street, London W1N 2AU, UK. Tel: 071 580 0008, Fax: 071 580 4420.**