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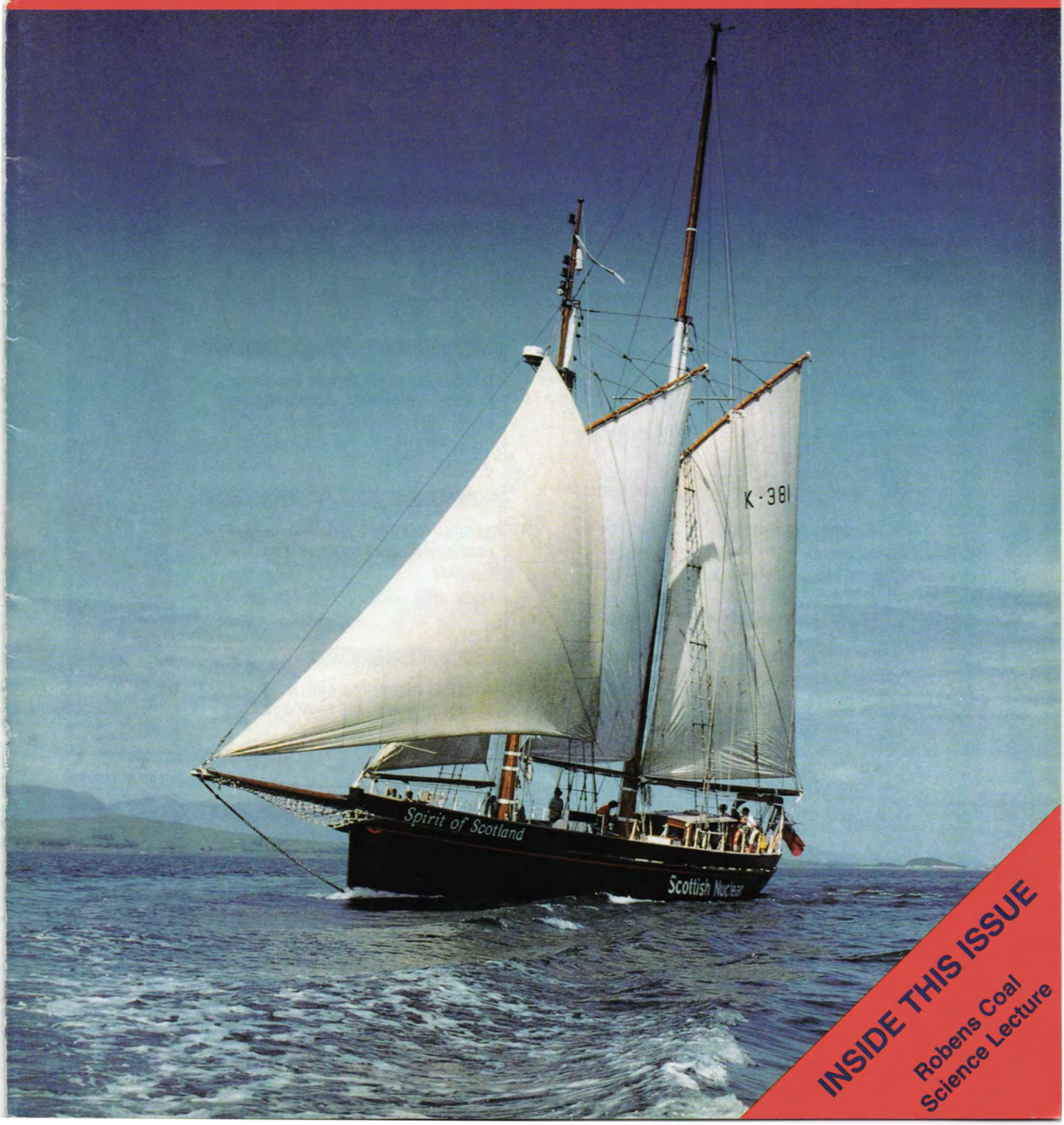

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Editorial: 01622 850100
fax: 01622 850977
Administration: 0171-580 7124
Membership, Education and Journal subscriptions: 0171-580 0077 fax: 0171-580 4420

Editor
Johanna Fender

Advertisement sales
David Speculand, Adept, tel: 01472 388808; fax: 01472 388697

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COVER

The *Spirit of Scotland,* a 90 ft replica Victorian schooner, is owned and operated by the national charity Fairbridge, and sponsored by Scottish Nuclear. Earlier this year Scottish Nuclear decided to extend its existing £85 000 per year sponsorship support for a further two years, underlining its role as an environmentally-friendly and socially responsible company. The gaff-rigged, Clyde-registered ship is used by Fairbridge to provide new opportunities and training for disadvantaged young people from inner cities across the UK.

The emerging energy market

THE DECISION to refer National Power's bid for Southern and PowerGen's bid for Midlands has brought a temporary halt to the restructuring of the British energy market. Whilst politicians have blundered from case to case, lacking any clear policy upon which to base their decisions, the market has been redefining the future structure of the industry. It's time politicians caught up with reality and set out a clear policy.

1994 was, in retrospect, the beginning of the end for the stylised model of the energy market neatly divided up along textbook lines into independent generators, independent suppliers and separate transporters and distributors. Professor Littlechild's blunders over the distribution review for the regional electricity companies and the chaos accompanying the franchise drop to 100 kW were the catalysts in electricity, and the gas bill which emerged from the MMC inquiry into British Gas contained the seeds of the destruction of the old-styled integrated gas industry.

Two key themes to emerge have been *vertical integration* and the emergence of *multi-fuel supply businesses.* Vertical integration has always been a feature of energy markets. Oil companies have secured retail outlets for their products through petrol stations. Electricity and gas companies have secured risks inherent in upstream sunk capital investments through franchise customer bases. At privatisation, this national market structure was replaced in the electricity industry by a separation between generation, transmission and distribution. Structural regulation was introduced as an act of policy.

But these radical measures at privatisation were more apparent than real. Back-to-back contracts between British Coal, the generators and the RECs replicated the main features of vertical integration. In gas, the contracts provided for long-term supplies on the back of the franchise. The duty to supply was in reality the duty to contract and British Gas — like Ruhrgas and other continental comparators — took this to mean over 20 years plus. Even new entrants — such as the so-called independent power producers (IPPs) — were permitted to enter long-term contracts with the RECs. Indeed, virtually all new entry has been based upon such contracts.

The key issue for the government is whether such longer-term contractual relationships are to be permitted after 1998. From that decision should follow its approach to the mergers and restructuring. The regulators' model appears to be based upon spot prices and short-term contracts. This will not provide a secure foundation for investment. Short-term cost cutting and the reaping of the benefits of weak fossil fuel markets and excess supply will give benefits to customers now. However, the long-term supply side — from investment through to R & D — will ultimately suffer. The market is signalling its solution: a small number of vertically integrated energy supply businesses. When the MMC has adjudicated, and the cases land back on Mr Lang's desk, he will not be able to duck the issue second time around.

The second development — the emergence of multi-fuel energy supply businesses — is also in part a consequence of 1998 and the emergence of competition. As with other deregulations — like buses and airlines — the initial response is likely to be price cutting and an erosion of margins. This will drive business towards volume, and hence to diversify into other fuels. Gas, electricity and even domestic heating oils may be jointly sold. New players — like supermarkets — may add to the pressure for new market structures. The response to date has been to handicap incumbents to ensure entry in 1998, by placing social and other obligations on the existing players. The result will initially be more competitors, but in the long run the market may well be dominated by a small number of large energy businesses.

These changes — vertical integration and multi-fuel supply companies — are at least as significant as privatisation itself (which facilitated the process). The energy market at the end of the century will be very different from what it was at privatisation. Such developments call for an imaginative and innovative response from government and regulators. New regulatory tools will be needed. It is time to merge OFGAS and OFFER together to ensure that the convergence of the gas and electricity industry is matched by regulatory consistency. In addition, the move towards a more complex structure will necessitate a shift away from structural regulation towards more sophisticated conduct regulation.

Unfortunately, there is little evidence that regulatory reform or the long-term energy needs carry much weight with the DTI or the regulators at present. With excess supply, they seem to believe that they can afford the luxury of short termism. However, such myopia is not necessarily in the public interest. Let's hope the MMC at least takes a more enlightened approach.

Dieter Helm
Fellow of New College, Oxford

Dr Dieter Helm is a Director of Oxford Economic Research Associates Ltd and a Fellow in Economics at New College, Oxford. He is a research associate of the Institute for Fiscal Studies, associate editor of the *Oxford Review of Economic Policy* and editor of *Energy Utilities*. He is a member of the Energy Advisory Panel of the DTI and the Department of the Environment's Academic Panel.

IFC pulls out of Nigeria LNG

THE International Finance Corporation (IFC) announced in November that it would not present a proposed investment in a liquefied natural gas (LNG) project in Nigeria to its board of directors for approval.

IFC vice president Jannik Lindbaek explained: "The merits of this project and its structure are sound. However, in discussions with the Nigerian government we have consistently made it clear that we could only proceed if there was sufficient progress in certain critical areas of macroeconomic reform and if we felt we had the support of our member country shareholders. While there has been progress on the fiscal and monetary side, key policy decisions have yet to be implemented. In this situation, IFC is unable to proceed."

The proposed project, amounting to more than $3 billion, would develop an LNG field in south east Nigeria. IFC had been considering providing a loan of $100 million as well as taking a 2% equity share in Nigeria LNG. The project would have been the first time that the Nigerian government's ownership stake would be reduced below a majority position in a hydrocarbon project within their own county.

Devastation caused by Hurricane Luis on the Carribean island of Antigua required emergency repairs to its electricity supply system. Assistance came in the form of a Northern Ireland Electricity 'powerteam'. The 12-man team arrived in September, and spent the next eight weeks restoring electricity supplies to the island's 70 000 population All of the five feeders from the island's power station were damaged, and the majority of distribution lines were damaged in some way. NIE International, the company's consultancy wing, holds the government's Overseas Development Administration contract to coordinate and provide emergency power sector repair work to the Caribbean. Midlands Electricity were placed on stand by to provide an additional repair team should one be required for the neighbouring islands of St Kitts, Nevis and St Martins.

Major study suggests dilemma for oil industry

THE INTERNATIONAL petroleum industry faces a dilemma: an increasing number of worldwide investment opportunities, but few that could provide the scale and return required to replace reserves, production and earnings.

This is a key finding in a major new study on the changing demand for capital in the global oil and gas industry, and the sources of supply to fill demand over the next decade.

The capital requirements of the industry during the next ten years are significant, with estimates ranging from at least $800 billion up to $1.4 trillion. Of these amounts the upstream business will need between $572 billion and $1 trillion depending on the pace of change in the emerging markets and the future level of oil and gas prices.

Downstream spending requirements will be equally robust, given the continued impact of environmental regulations and product demand growth in the Far East, ranging from $173 billion to £230 billion.

In addition, major new demands will come from greenfield liquefied natural gas (LNG) projects and the continued pace of energy asset provatisation, adding a further $55 billion to $175 billion.

The study, *Competition for capital in the international oil and gas industry*, looks at changes in capital demand, including an analysis of new and increased areas of demand, and changes in capital supply, both internal and external, based on data received from 75 international countries.

The study includes five sections that follow a progression from demand for capital, through supply and allocation of capital, to financial strategies employed by industry players and a number of special case studies illustrating the successful use of financial strategy by a number of international oil and gas companies.

While the industry trend in recent years has been to pursue opportunities outside the mature areas of the US and North Sea, the bulk of spending remains in these areas. In 1989 an average of 70% of capital expenditures was made in these two areas; by 1994 this had fallen slightly to 68%. In fact there has been a renewal of interest (and spending) during 1995 in the long-term prospects in the US, especially the Gulf of Mexico and Alaska.

Copies of the study are available, price US$795, via the Circulation Department of the Petroleum Intelligence Weekly in New York, tel: 00 1 212 941 5500; fax: 00 1 212 941 5509.

Greece announces licensing round for petroleum acreage

THE Public Petroleum Corporation of Greece, Exploration and Exploitation SA (DEP-EKY) has released information pertaining to its eagerly awaited first licensing round.

Following the enactment of a new Petroleum Law in February 1995, DEP-EKY will offer six contract areas in the first round, all located in western Greece, with three onshore and a further three offshore. Names and outlines have been identified, and will shortly be approved by ministerial decree. Paxi-Parga covers an area of approximately 2000km^2; the Gulf of Patraikos, 2100; Offshore Katakolon, 1900; N W Peloponnesos, 2000; Aitoloakarnania, 3700; and Ioannina, 4200.

Western Greece has an oil and gas discovery at West Katakolon, awaiting development, and widespread hydrocarbon occurances in wells and seeps throughout the area are to be licensed. Exploration to date has focused on carbonate reservoirs beneath the basal Neogene uncomformity and on Oligocene clastics in structures within the Hellinide fold and thrust belt.

Decline predicted for UK environmental industry

THE DEMAND for environmental technologies is set to fall substantially over the next 12 months, as German and US competitors are winning a larger share of the British market from UK companies.

Air pollution monitoring, water monitoring, waste treatment and water pollution treatment technology companies all face in excess of 10% falls in demand over the next year. And the number of companies expecting to increase their investment over the next five years has also fallen, by 15%.

These are key findings of the second annual survey of industrial purchasers of environmental technolgies, published at the ET '96 exhibition, held in November.

The survey found all sectors of the environmental industry face lower sales over the coming year — notably a 17% decline for air monitoring and water monitoring companies, a 14% fall for waste treatment, a 12% fall for water treatment, a fall of 11% for energy management, and falls of 8% for waste disposal and 4% for air pollution treatment technologies.

Only 72%, as against 87% in a similar survey last year, of respondent companies expect to increase their purchases of environmental technologies over the next five years, most notably automotive, chemical, energy and water companies.

A substantial 45% of mainstream UK companies have increased their expenditure by over 25% over the past five years.

The British share of the UK market has fallen in every sector, except water monitoring.

Legislation drives the market, according to 84% of respondents, and they predict that environmental regulation is going to get tougher. 29% of the responsdent companies complained about the lack of government grants for investment in environmetnal technologies.

The world market for environmental products and services is currently worth $200 billion, and is set to grow to $600 billion by 2000, with the UK market alone being worth in the region of £28 billion.

'Take or pay' — not whether but when

IT is not a question of *whether* some North Sea gas 'take or pay' contracts are renegotiated, but *when* and *how*, according to Energy Minister Tim Eggar.

Mr Eggar was speaking to the Association of British Independent Exploration Companies (BRINDEX) at the end of November. He said: "It must be in everybody's interests that discussions and negotiations among the involved parties are open and realistic.

"At the moment I get the impression that there is a fair amont of generalised posturing, and not enough detailed discussion. There is rumour, suspicion and even the occasional outrageous claim about the Government's position.

"The Government has neither the power nor the desire to impose a solution; we believe strongly that sensible commercial renegotiation among the interested parties will result in a far better outcome for all.

"I have listened to many views, and we are looking carefully at the issues involved. I do understand the points about Morecambe production."

NEA's week of action

IT MAY have escaped your notice, but the week from 27 November to 1 December, was national Conservenergy Week.

Labour leader Tony Blair, deputy prime minister, Michael Heseltine and Liberal Democrat leader, Paddy Ashdown, all joined the charity National Energy Action (NEA), to promote the benefits of energy efficiency for low-income households.

During the week of action, sponsored by Esso UK plc, NEA members insulated and draughtproofed the homes of 12 000 households, using grant aid from the Government's Home Energy Efficiency Scheme (HEES).

On the Wednesday, 200 elderly people from all over the UK — all of whom have had the energy efficiency of their homes improved by NEA — travelled to the Banqueting House in London to mark the nation's biggest housewarming: two million homes improved by NEA since its establishment in 1981.

The reception was one of the highlights of Conservenergy Week, which included visits by nearly 50 MPs to their constituencies to spread the message.

MMC referral

THE President of the Board of Trade announced his decision, in November, to refer National Power's proposed acquistion of Southern Eletric to the Monopolies and Mergers Commission (MMC). Under the terms of the £2.8 billion offer, sent to all Southern Eletric shareholders, the offer automatically lapses.

National Power's chief executive, Keith Henry, commented: "The decision to refer National Power's acquistion of Southern Electric to the MMC has created considrable uncertainty about the future shape and structure pf the electricity industry in England and Wales. As a result of the competition issues in relation to generation and supply, National Power is concerned whether the proposed sale of 4000 MW of plant can be completed as anticipated.

Concern has been expressed regarding the degree of vertical integration arising from this merger, but National Power believes that all reasonable concerns of the Regulator and the Office of Fair Trading could have been met through the agreement of an appropriate regulatory framework.

Boost for Scottish renewables

THE Scottish Office has announced that a second order under the Scottish Renewables Obligation (SRO) would be made in 1996, in response to a Parliamentary Question in November.

Mr George Kynock MP, Minister for Industry at the Scottish Office, informed the House that the proposed second order would oblige ScottishPower and Hydro-Electric to secure more — about 70-80 MW — of their output from renewable sources. A consultation exercise about the first Order, earlier this year, showed broad support for this approach to developing renewable energy usage.

The first Order led to 30 renewable projects with a combined capacity of 76 MW, and the Minister hopes to receive a similar response to the proposed second Order.

The Scottish Office will issue further guidance shortly for prospective applicants. The two Scottish electricity supply companies are currently assembling information and guidelines for parties interested in submitting schemes into SRO2. Potential applicants should make contact now with the relevant Scottish company — the one in whose area the development is proposed — to discuss any aspect of the process. As with SRO1, each successful renewables generator will be awarded a contract of up to 15 years duration, with up to five years to commission.

The second Order is expected to be 70-80 MW in size, made up of four bands, comprising wind, hydro, waste-to-energy and biomass. No individual project will be over 15 MWh, and each will have to prove that it is both technically and economically viable, meeting the statutory 'will secure' test.

● *On pages 15-16 of this issue of Energy World, R G Loram looks at the aanouncement of the fourth renewables Order in England and Wales.*

Energy savings for Liverpool FC at Anfield

LIVERPOOL Football Club are now achieving savings of around £43 000 a year on their electricity, gas and water charges. These savings have been made through working closely with the Stockport regional office of specialist energy cost-saving consultants, McKinnon and Clarke.

The club have the stadium and associated buildings at Anfield, and also a training complex at Melwood. There are a wide variety of uses for electricity, including floodlighting, lighting the significant number of offices and suites, and for heating. Gas is used for catering purposes and undersoil pitch heating, which requires the negotiation of the site specific contract to cover the maximum requirement for gas on a daily basis.

Water is used for pitch watering and general domestic purposes.

Accountant, Arthur Lowe, commented: "We have been pleased with the savings and also the excellent cooperation we have received from McKinnon and Clarke who respond immediately to any query."

Renumeration for the cost analysis and investigation operations is through sharing savings actually achieved, the onus being on the consultancy to find the best supply contracts for the clients' needs. Opportunities to control and reduce costs in these utilities exist, but in ever increasingly complex markets, this demands a deep specialist knowledge with sophisticated computer systems to process and analyse information. The role of the specialist energy cost analysts to interpret and use this information to negotiate the best supply contract is vital, particularly as the supply markets for electricity and gas get more complicated. Close examination of a client's needs, and the knowledge to negotiate with a variety of potential suppliers is the key which enables McKinnon and Clarke to considerably reduce the energy bills of their clients.

The company does not charge a fee as such, all the work undertaken in analysis, site visits, data processing, and report writing by the analysts and engineers is free to the client. If no savings are found, no fee is charged

It is evident that working with dedicated, professional energy cost and engineering consultants allows substantial savings on electricity, fuel and water bills, and the continued analysis of the clients' energy needs ensures that savings are achieved.

'Blue chip' contract

CELTIC Energy Ltd has secured a three-year contract for its coal worth up to £15 million with a blue chip British company.

Blue Circle Industries, a top FTSE 100 company, will purchase around 150 000 tonnes a year of bituminous coal from two existing opencast operations, starting from January 1996.

The contract represents Celtic Energy's fifth major piece of business since formation in January 1995. The company is pleased, as they say it demonstrates the confidence of a major UK manufacturer in placing orders with them.

Celtic Energy's commercial director, Chris Banks, points out that although the former British Coal Opencast held a contract with Blue Circle, it had been on an annual renewal basis.

The coal will be mined from the Llanillid operation initially, and subsequently from Parc Slip West, Bridgend, and then transported to Blue Circle's Westbury and Plymstock works.

Celtic Energy Ltd is the £130 million turnover company formed as a result of the management buy-out of the assets of British Coal Opencast in South Wales, and directly employs 1500 people across its operations in South and West Wales.

West Burton power station, Retford, has significantly improved the quality control procedure involved in determining the price of coal from outside contractors, by installing a new purpose-built coal sampling system (pictured above). Designed by materials handling specialists, Butterley Engineering, in a £0.5 million contract, the system enables coal to be randomly selected from the rail delivery and transferred for quality tests without contamination.

Peter Barlow, divisional director at Butterley Engineering, commented: "The benefit of our coal sampling system is twofold. Firstly, it complies with the British Code of Practice in terms of the weight and purity of coal selected for testing. Secondly, the design of the system ensures the coal for sampling cannot be predetermined. As both supplier and West Burton sample and quality test the coal, both parties are satisfied that the price is commensurate with the quality."

Butterley Engineering has replaced one of the eight hoppers below each of the two rail delivery tracks and the installed the system beneath them. The hoppers' stainless steel coating means coal falls from each wagon through to the main conveyor with minimal contact with the hopper sides; avoiding contamination from previous deliveries.

The random selection of wagons is controlled by computer. Infrared beams at the entrance and exit of the delivery point count the wagons as each beam is broken. The one selected for sampling automatically discharges over the new hopper, emptying the coal onto a conveyor.

Combating lightning with MIST

THE electricity industry can now strike back at lightning, thanks to the latest computerised planning weapon from the Met Office.

Until now the industry has been vulnerable to thunderstorms which can wreak havoc and cost millions of £s. But now an on-line PC computerised system will give a colour graphical display of forecast lightning risk, as well as actual lightning strikes.

The secret lies in a development of the Met Office: MIST on-line weather PC system, which indicates the risk county-by-county.

The MIST software can be loaded onto any modern PC, and is designed for the operational nerve centres and control rooms of major organisations. These include the regional electricity and power distribution companies, where lightning strikes can cause considerable disruption to the loading of the national and regional grids.

Lightning-risk forecasts are produced at weather centres around the UK and collated at Manchester Weather Centre, then sent direct to the Met Office centre at Bracknell via modem links. The resulting map of the British Isles is colour coded by risk of lightning. The forecasts, for up to nine hours ahead are updated every six hours, available 24 hours a day. Further information from Colin Hord, MIST manager, tel: 01344 856284.

As aerial photography specialists Hunting Aerofilms celebrate the second birthday of their digital orthophoto capability, the company reports that a wide range of UK concerns are becoming increasingly enthused by the innovative process, which makes possible the production of maps with highly accurate contours, among them the utilities, civil engineers, local authorities, surveyors and developers.

The company have been appointed a 'value added reseller' by Ordnance Survey. This means that Aerofilms can create orthophotomaps incorporating OS information, making a far wider range of features available to the end user.

The orthophoto technique when applied to survey photographs 'flattens' the countryside, removes distortions caused by ground relief to create a scale-corrected image from which an orthophoto map can be produced. This scalar correct image can have contours and vector information added, as in the above example, to provide a valuable data source. The orthophoto map can be used as a layer in GIS and can be produced in hard copy form, combined with line and text information.

New ceramic reduces energy consumption

AN inexpensive new ceramic that could significantly reduce energy consumption and costs in the oil and gas industry is being developed through joint research by Amoco Corporation and the US Department of Energy's Argonne National Laboratory.

The new ceramic, which selectively removes oxygen from air during high-temperature processing, could also help conserve fossil energy reserves and provide a lower cost of converting natural gas to synthesis gas, a mixture of hydrogen and carbon monoxide used as building blocks for many chemicals and alternative fuels. Synthesis gas is an important starting material for producing transportable alternative fuels, pollution-reducing fuel additives and many industrial chemicals.

The new ceramic could also help the environment by reducing the burning of fossil fuels required to convert natural gas into synthesis gas.

A simple device using the new ceramic to produce oxygen could also help to make utility boilers, diesel and other engines more efficient and cleaner burning with new alternative fuels and additives derived from natural gas.

Amoco and Argonne have achieved high conversion efficiencies using the new ceramic to demonstrate processes for converting natural gas to synthesis gas. During the process, the new ceramic performed without failure for more than 1000 hours at temperatures as high as 850oC.

Development of the ceramic was carried out under a three-year $2.5 million cooperative research programme between Amoco and Argonne, and was jointly funded by Amoco and the US Department of Energy's Office of Fossil Energy and Office of Energy Research/Laboratory Technology Transfer Programme.

Orimulsion supply contract for Italy

ITALY's state-owned power utility — ENEL — signed in November a supply contract with Bitor Europe for 500 000 tonnes of Orimulsion, to be used at the new Brindisi South power station, in Southern Italy.

Brindisi South is ENEL's most modern power station, with advanced abatement equipment to comply with EU environmental regulations. It has four 660 MWe generating units, with desulphisation (FGD) plant currently being constructed.

Bitor Europe hope to negotiate a long-term supply of 2 million tonnes a year, starting in 1997, with the possible prospect of additional supplies by the end of the century to other ENEL power stations.

Orimulsion will be used initially in one of the generating units during a six-month period, starting in October 1996. Shipments in 80 000 tonne tankers, direct to Brindisi South own Adriatic terminal, will start in the second half of 1996.

Successful trials of Orimulsion took place at ENEL's Sulcis power station in Sardinia in 1993. It is currently being used in Canada, Denmark, Japan and the UK.

Sofia '95 — tackling the environment

The Sofia ministerial conference was held in October in Bulgaria, and marked the beginning of a new era of cooperation in the field of the environment between the European Union and its partner countries in central and eastern Europe. The conference was financed under the EU's Phare, Tacis and Life programmes. Energy World looks at achievements so far in this area.

THE Sofia environmental conference, held in October at the National Palace of Culture, Sofia in Bulgaria, marked the beginning of a new era in environmental cooperation between the countries of the EU and central and eastern Europe (CEE). Ministers attending the conference from the newly independent states saw the meeting as having an important dual role: to improve environmental standards, and to pave their countries' path to membership of the European Union. The latter would not, of course, be possible without the former.

The European Commission's Phare, Tacis and Life programmes have all made considerable contributions to cleaning up the environmental problems found in the wake of the collapse of the Soviet bloc. Funding by the Phare and Tacis programmes is mainly directed at projects of technical assistance, and has amounted to over ECU340 million towards environmental projects since 1990. Their combined contribution is the largest amount of grant aid to the region of central and eastern European countries (CEEC).

The primary goal of the EC's DGXI Life programme is to fund research projects which foster improved environmental conditions. Life has committed over ECU10 million to fund projects in the region.

A distinguishing aspect of the Sofia conference from earlier European environmental summits is that the approximation of environmental legislation is now part of the requirement for the accession to the EU. Nine countries have signed association agreements, these are Poland, Hungary, the Czech Republic, Slovakia, Bulgaria, Romania, Estonia, Latvia and Lithuania.

A European Council meeting in Essen last December defined the pre-accession strategy as the partner countries' path to EC membership. The goal of the strategy is to provide a route plan, which has three parts: intensive, high-level dialogue, preparing the countries to cope with the rigours of the internal market, and financial help to develop their infrastructures.

While there is no specific 'environmental criteria' for EU membership, Eric Beaume, a Phare programme task manager, explained that this factor is covered through the approximation of legislation process: candidates for membership will eventually have to adopt the full body of European environmental law. "Bringing their legislation in line with that of the EU is one of the most complex tasks they face. In the environmental area, they will have to implement a vast range of laws and enforcement tools that cover all aspects of environmental protection — from air and water pollution through waste treatment to nature protection."

This isn't to say that all CEECs lack a tradition of environmental protection or suitable legislation. Many precise and elaborate laws were defined in the Communist past, but were never enforced. Ivan Vest, a Slovak engineer who has worked for years in the US, summed up the environmental paradox: "How could we protect the environment when the people responsible for setting industrial production quotas were also those supposed to enforcing the environmental laws?" Much legislation of that era had the opposite effect to that intended, sometimes actually encouraging industry to pollute. It was always cheaper to pay hypothetical fines than to deal with the pollution source.

Environmental experts say that economic decline across CEE during the last five years has helped to clean up the environment to a degree. This is borne out by the Dobris Assessment, published shortly before the Sofia conference by the European Environment Agency. The 676 page inventory of the state of Europe's environment points to lower levels of air and water pollution, concluding that economic transition has led to regulatory changes and more energy-conscious investments. As these economies begin to grow again, it is essential to tackle the roots of the problem. It is important that the legislative basis is in place to support new sustainable economic development. Therefore both legislators and experts agree on the urgent need to have a suitable legal framework in place.

The debate at Sofia was set against this backdrop of issues and opportunities, with the emphasis on the conference being a forum for dialogue rather than a place to push EU policy.

Environmental projects currently being financed through the EC's Phare, Tacis and Life programmes provide excellent examples of what can be achieved through cooperation between the EU and CEECs. A geothermal energy project in Poland receives financial support through the Phare programme, as well as the EBRD, the World Bank and the National Fund for Environmental Protection.

Dealing with air pollution has been identified as one of the major objectives of Poland's environmental strategy. The problem is acute in the southern Podhale region, where ambient air quality is now considerably worse than national or European standards permit.

The first phase of an usual and innovative project which will reduce emissions of particulates by 93% to 100% has recently been completed. By the turn of the century around 70% of the region's total heat supply will be from geothermal energy, with a complementary contribution from natural gas.

The US$130 million project is being carried out by Geothermia Podhalanska, a company established in 1993. It is consistent with the EU's Environmental Action Programme (EAP), in that it addresses the problems of

air-borne health risks and natural protection. As well as reducing emissions, geothermal reduces other environmental costs of the use of coal, such as pollution from transportation and ash disposal (often at present dumped into waterways, threatening drinking water quality). The Podhale project will displace about 300 000 tonnes of coal annually, eliminating emissions of SO_x, NO_x and CO_2, as well as particulates.

Coal has been Poland's traditional energy resource for many years, with nearly 80% of the energy used in district heating generated from coal and coke-fired plants. Homes not connected to district heating schemes also use coal. The resulting air pollution is so bad that during the winter months it blocks the view of nearby mountains. Concentrations of particulate matter and SO_x average around 150 micrograms per cubic metre, causing significant damage to health, as well as to the unique vegetation in the area, which has four national parks.

The region has low to medium temperature geothermal resources. The closed loop system uses well 'doublets' and extracts hot water from a reservoir well and channels it through plate heat exchangers. The extracted heat is fed into a secondary network. Once the water has cooled to a temperature of about 45°C, the fluid is reinjected into the same reservoir at a second well.

The entire project involves drilling up to six new well doublets to extract low-enthalpy (86°C) water, building a new base load district heating plant, as well as a new peak load natural gas plant, constructing a main pipeline network, supplying 15 000 connections. The district heating plant will have a capacity of 204 MW, of which 1949 TJ of energy will be supplied from geothermal sources. The geothermal plant is expected to supply heat and water for a minimum of 25 years.

The first phase, now complete, was to develop and operate the plant. Currently 250 homes, a greenhouse and a fish pond are heated by geothermal energy. The second phase will increase capacity, including boiler conversion from coal to gas. The flow capacity of the geothermal system will be expanded to serve a further 1000 connections by adding one doublet. And a new geothermal base load district heating plant will be built.

The third phase is to develop the geothermal heating system, when four new doublets will be drilled. Transmission lines to Zakopane will be laid and the distribution network expanded to 7000 consumers. The peak load plant for the geothermal system will be completed. Phase four will include further developments of the system with the drilling of four more doublets. Transmission lines will be laid to Nowy Targ and the distribution network extended to a further 7000 customers. A second natural gas peak load plant will be built in Nowy Targ. The concluding phase will see the system expand to the eastern and western valleys of Podhale.

Improving energy efficiency in Hungary is a high priority. The country has a highly inefficient infrastructure dating back to the Soviet period, when energy was supplied cheaply and abundantly. This encouraged the development of energy intensive industries, such as steel, and no investment was made in the development of energy efficient industrial equipment. The result for Hungary is an energy intensity two to three times higher than the western European average.

Because of scare and depleting domestic fossil energy sources, and the end of cheap Soviet energy supply, Hungary is now importing half its current energy requirement. This is a serious drain on the national budget, and inevitably means political and economic dependence on the supplying countries.

Funds from the Phare programme are being used to cut back energy use on the demand side, enabling Hungary's citizens to save both energy and money. The low energy awareness is a residue of Soviet rule. Cheap (almost free) energy did nothing to teach citizens to conserve energy, or to use it more efficiently. Now that prices are rapidly rising towards market level, they are confronted with the true costs of this attitude.

To date most energy efficiency programmes have focused on the supply side — less than 3% of the EBRD and 5% of the World Bank's energy lending has been invested in demand side energy efficiency. But studies have shown that the potential energy saving on the demand side is enormous, with possible savings of 20% to 25% of current usage, with a payback time of less than two years. If capital were to be invested in equipment, energy savings of 30 to 40% are possible.

Striving for economic self-sufficiency, Hungary, as in other CEECs, has relied heavily on domestic energy sources, such as brown coal and lignite. These are far from ideal fuels, with high combustion inefficiency, and serious emission problems. A 1993 survey showed that half the trees in the CEEC were over 25% defoliated.

To realise the goal of a healthy energy sector as the engine for the development to a full market economy, restructuring is essential. National governments throughout the CEEC are splitting up their former energy monopolies into independent enterprises. However, decision-makers, central and local, have little or no expertise in setting up an energy policy. In additional problem is short-term problem solving over the establishment of long-term planning.

This winter, the tenants of a residential building in Budapest will be able to regulate the temperature in their dwellings, according to their needs and budgets. Under the Phare programme, the heating system of the building at 'Dugonics utca no 38' in the northern district of Ujpest has been modernised. The building was selected in cooperation with the urban district heating company and tenants, and is one of four local energy saving projects initiated by Phare. The tender for a technical proposal was won by a local contracting and engineering company, EGI/EGA.

District heating schemes are common in Hungary, a hangover from the past. Residential buildings are connected to heating plant by often leaking hot water pipes, temperatures are not adjustable, and tenants pay a fixed price, regardless of how much energy they use.

During the course of the Phare project, the existing substation of Dugonics 38 was demolished and replaced by a new, compact one. The flow and temperature of heated water can now be controlled on the basis of weather conditions, which means a considerable energy saving. Within the dwellings, the radiators are now equipped with thermostatic valves, specially developed by Budapest University, and cost allocation meters, enabling and encouraging tenants to save energy and money.

The nearby town of Pápa has modernised its public lighting system, in an example of a locally initiated urban energy efficiency project. Hungary's former regime gave the town no priority in development, and it was left with an obsolete energy system. It is now setting up an urban energy management plan.

The project is one of 18 in the first round of the Urban and Regional Energy Efficiency Programme. This pilot programme is a joint initiative of the EU directorates ECOS, Ouverture and Phare. It is aimed at improving energy efficiency at local level within the CEEC, through the establishment of long-term relationships between east and west. A local approach seemed the most appropriate, ensuring tailor-made projects, based on the needs and suggestions of the local partners, thus strengthening the position of local governments in the democratisation process. Following the principle of 'twinning', one eastern European city or region is allied with two western European partner cities. The development of personal relationships enables officials in local and regional authorities to benefit from the experience and knowledge of their European partners.

The Phare, Tacis and Life programmes all contribute to the EC's role as a prime mover in helping the CEEC to implement environmental policies to help ensure those countries' environmental situations are not a barrier to their future membership of the European Union. ❑

Biofuels: France takes the initiative

by Philippe Bourdon

The following article by French journalist Philippe Bourdon first appeared in the March/April issue of *Energies*, the international magazine of Total, and is reprinted here by kind permission of the editor.

OVER recent months, the Total Group's commitment to biofuel development has entered an important new phase, with the signing of formal agreements with agro-industrial companies and primary producers to produce ETBE (ethyl tertio butyl ether), a biofuel derived from ethanol and intended to be added to unleaded super petrol.

Last November, this financial partnership between a petroleum company and a cross-section of players from the agricultural sector — the first of its kind in the world — led to the setting up of a new company called Nord-ETBE, which is to build and operate an ETBE production facility at the Flaunders refinery plant near Dunkirk.

The construction of a plant exclusively devoted to the production of ETBE (or gasohol) is another first for the world oil industry. Until now, this type of biofuel has always been produced in converted MTBE plants (MTBE is a closely-related compound manufactured from the methanol recovered from oilfields). Construction of the plant, which should come on stream during the first half of 1996, is expected to cost about 150 million francs. With a design capacity of 60 000 tonnes per year, the plant is expected to rapidly reach an output of 50 000 tonnes of ETBE per year. When compared with the 1.4 million tonnes of petrol produced each year by the Dunkirk refinery alone, this may seem a small figure. But much significance comes from the fact that the ETBE plant will be using as its raw material 300 000 hectolitres of agricultural ethanol produced on farmland that would otherwise have to be left lying fallow.

The setting up of Nord-ETBE is further evidence of Total's ongoing commitment to research into developing new biomass energy sources. As far back as the early 1980s, the Group was forging ahead with biofuel research in the United States, and by 1985 Total was participating actively in a programme of biofuel testing initiated by the French government. But it was only in 1992, when France introduced tax relief for biofuels, that biofuel research really began to yield concrete results.

The reasons for the Group's commitment to biofuels as an energy source for the future were outlined in October 1994 by Total's chairman and CEO, Serge Tchuruk at the international Wheat Challenge for 94 colloquium. According to World Energy Council figures, global energy consumption should climb by some 45% over the next thirty years. Our planet's fossil fuel reserves are considerable, but they are not inexhaustible, so renewable energies are destined to play an increasingly important role in satisfying world energy demand. As a renewable energy, biofuels have numerous advantages, such as stability of supply, conservation of both the environment and the rural landscape. Provided research in this area is given wholehearted financial support by government, biofuels should become increasingly attractive economically over the long term. The cost of fossil energy is expected to rise, while more intensive research and development on biofuels should steadily bring down their production costs.

At present, biofuels can be produced either from a vegetable oil base or a plant-alcohol (ethanol) base.

In the manufacture of biofuels from oil-producing plants, esterification of rape-seed oil yields RME or rape-seed methyl ester which can be used as a direct additive in diesel motor fuel. RME is produced by oleochemists and sold to oil companies who blend it with diesel fuel and then handle the marketing. Total markets a rape-seed diesel blend containing between 5% and 30% RME. All blends with more than 5% RME are governed by a number of government regulations and can only be sold to fleet operators with their own storage facilities. With its lower solid particle content in the exhaust, this 30% rape-seed diesel is proving increasingly popular, especially with local government fleet operators.

The ethanol or alcohol used as biofuel additive is obtained by distilling any form of plant containing sugar or starch. The usual source crop for ethanol is sugar beet or wheat. The resulting bio-ethanol in its pure form poses serious problems because it is extremely volatile and also forms a homogenous mixture with water. On the other hand, ETBE obtained by combining this ethanol with isobutylene (a 'cut' produced by the catalytic crackers used in oil refining), a process perfected by the French Petroleum Institute (IFP), can be quite satisfactorily blended (up to 15% ETBE content) with super-grade petrols, and is particularly effective with unleaded petrols. ETBE is less volatile than ethanol and impossible to mix with water. Furthermore, this oxygenated compound has a high octane rating and gives off relatively 'clean' exhaust (ie, with lower carbon dioxide levels and fewer particles left by incomplete combustion). All these properties make ETBE a popular choice with enginemakers and fuel marketing operators alike. And as ETBE can only be produced on a refinery site, Total now finds itself playing the dual role of both producer and marketer of biofuel. The only cloud on the horizon at this stage is that the production volume of ETBE is still limited by the finite amount of isobutylene gas available in the refineries.

The setting up of Nord-ETBE is a major watershed in biofuel development, marking the transition from the experimental phase to the production stage. However, as Michel Girard, in charge of Total's agriculture-related projects points out, "We could only push ahead with ETBE development so long as all players with an interest in biofuels were firmly committed, both financially and legally. It was imperative to ensure a stable long-

A ground-breaking partnership

Share capital of Nord-ETBE, which will operate the ETBE plant in Dunkirk, is divided as follows:

- *40% Total*
- *23% Eridania Beguin-Say*
- *17% Bio-Ethanol-Nord-Picardie*
- *10% General Federation of Wheat and Cereal Growers (AGPB)*
- *10% General Federation of Sugar-Beet Growers (CGB)*

term working environment and to define clearly the rules of the game, so as to guarantee that each of the players got the maximum benefit from the operation. I think a project based on a straight supplier-customer relationship would have been doomed from the outset. This is the first time anywhere in the world that a petroleum company has joined forces with the foodstuffs industries and the farming community to develop a new product jointly."

This formal partnership between Total and France's agriculture sector may break new ground, but in many ways it is cementing ties that were established more than half a century ago. Over the years, Total has built up an extremely strong presence across rural France. Firstly, more than 1500 of the service stations operated by the Group are located in towns and villages with fewer than 10 000 inhabitants. Then there is the network of Point Agri dealers specialising in farm-machinery lubricants and totalling more than 600 sales outlets. The Group has six heating and fuel-oil marketing subsidiaries in France, with 300 agencies and 1700 delivery vehicles. To say nothing of the nationwide Totalgaz network, with its 40 000 sales outlets for bottled butane and propane.

This extremely efficient logistic infrastructure enables Total to provide a comprehensive locally-based service to all segments of the farming community, supplying a wide variety of products designed to meet specific farming needs, ranging from lubricants and agro-chemical treatments to premier heating oil and LPG like butane and propane. Total is also taking an active part in the Thousand Villages programme, launched by the French government in 1994, and intended to give a new lease of life to economic and social life in sparsely-populated rural areas, mainly through setting up a series of local multi-service sales outlets.

And lastly, Total was one of the founder-members of the scientific interest group called AGRICE (Agriculture for Chemistry and Energy) which was set up to improve the competitiveness of biofuels, to promote the use of plant-based motor fuels and to develop non-food applications for agricultural produce, particularly in the manufacturing of chemicals.

"The farming community has always represented a major market for Total products," says Michel Girard, "as both animal breeders and crop farmers use above average quantities of both fuels and lubricants. Overall, Total supplies about 20% of the petroleum products used by France's agricultural community, with yearly sales in this sector coming to nearly a billion francs. All of this means that Total is directly concerned by the upheavals caused by the reform of the Common Agricultural Policy (CAP) in 1992. The close working relationship that we have formed over the years with the farming community, added to our shares economic interests, have led us to join forces in trying to find ways to combat the widespread slowdown in farming activity that will inevitably follow the introduction of compulsory fallowing."

As tax relief for biofuels is linked to obligation to cultivate fallow farming land, the setting up of Nord-ETBE means that 10 000 hectares of farmland which would otherwise have remained a frozen asset will now be brought back into circulation. A considerable acreage of additional farmland (250 000 hectares were sown in autumn 1994) will also be brought back under cultivation to produce RME.

The construction of the new ETBE plant, an ongoing commitment to rape-seed diesel marketing and Total's active participation in AGRICE are concrete manifestations of four of the Group's top priorities: the pursuit of technological innovation, the conservation of the environment through development of low-pollution motor fuels and by combating the desertification of the rural landscape, the search for new and economically viable renewable energy sources, and of course the Group's ongoing partnership with the farming community. ❑

Energy for our common world, what will the future ask of us?

*by Ian Fells**

THE 16th Congress of the World Energy Council was opened on 8 October 1995 by His Imperial Highness the Crown Prince of Japan and the Prime Minister. 5000 participants from 84 countries spent a week in the austere, electronically impressive Nippon Conference Centre on the outskirts of Tokyo looking ahead as far as 2050 and beyond, speculating on where the energy is to come from to supply a population which will be at least double that of today and will have high expectations.

The fact that 40% of the present population of five billion has no commercial energy supply points to the enormity of the task. To achieve it without damaging both the local and global environment adds a further dimension of difficulty which is compounded by the condition that the energy use must be sustainable.

A pretty tall order! A joint study on *Global Energy Perspectives to 2050 and Beyond* by the World Energy Council (WEC) and the International Institute for Applied Systems Analysis (IIASA) makes clear the scale of the task. Using the technique of scenario planning the report shows that energy use will rise by two to two-and-a-half times by 2050 and between three-and-a-half and four-and-a-half times by 2100.

Most of the increased demand will come from the developing countries of the southern hemisphere with a possible shift in world geopolitical balance. Fossil fuels will continue to provide the bulk of commercial energy up to 2050 and from then on nuclear and renewables could provide around 12% and 25% respectively but nuclear could drop to as little as 4% percent if its growth is stunted. Post 2050 tensions in fossil fuel supplies will be extreme unless nuclear power and renewables have strongly penetrated the supply market. Analysis of resource implication is enormously helped by the publication of *Survey of (World) Energy Resources 1995* by the WEC, which must be the most authoritative compilation of energy resource data there is.

It is here that an important conclusion of the conference draws attention to the serious lack of long term research and development which should start now if nuclear power and renewables are to make a strong contribution and sustainability is to be achieved post 2050. This is a clear failure of the market-led, competitive philosophy which is sweeping the world. Professor Y Kaya of Keio University in Japan, in his concluding remarks said, "The market is not almighty and to deregulate too fast is not appropriate"; he also drew attention to the difficulty in providing finance for energy development in poor countries which will require new partnerships between government, the private sector and end consumers. Investment of some \$30 x 10^{12} will be required by the energy sector worldwide between 1990 and 2020; it may not be achievable!

Improving energy efficiency of energy use has been highlighted at every energy conference since 1973, but as long as energy prices are low, energy will be wasted and it is here that fiscal incentives seem to be the way ahead. Energy intensities are worsening world wide, including in Japan. Perhaps the most conspicuous waste of fuel occurs in cars in the United States, where gasoline prices are absurdly low. The conference did try to focus its mind on transport, but only in the technical fix sense rather than a complete change of social attitude. They were given plenty of evidence of the problem by the continuous traffic jams in which the delegates' coaches were trapped; on one trip supper boxes were provided for the 40 km trip to the Suntory Concert hall, which took almost two hours. It was worse for the delegates who visited a shrine some 60 km away; the return journey took eight hours! Transport, and specifically cars are now the biggest single source of anthropogenic carbon dioxide, the main greenhouse gas. It must be said that the concert was superb and worth the journey, although in a sense it was ironic to listen to a polished Japanese orchestra playing Mozart and Beethoven to an audience containing British, French and Germans.

The question of long-term, transboundary pollution was addressed in many of the papers. The universal move to natural gas wherever possible, especially by the electricity supply industry, alleviates the effect, but natural gas is not a 'benign fuel', as one gas speaker proclaimed; it just produces less carbon dioxide per unit of heat than coal or oil. Many countries, particularly in East Asia, rely on, usually indigenous, coal to generate electricity. Chinese Minister Y E Qing drew attention to the annual growth of the coal sector in China of 30 million tonnes, giving a national output of 1.4 billion tonnes by the year 2000. China is now five years ahead of its schedule of tripling gross domestic product (GDP) by 2000 from the base year of 1980, with an annual growth in GDP of 11% for the past five years.

The socialist market economy with a completely liberalised coal price has clearly been effective in China, which makes Daniel Yergin's observations in his keynote address, that the socialist model has failed, an over-simplification; Adam Smith's 'invisible hand' is not the only way ahead. Another curiosity in the same presentation, which was in the section entitled *Managing Energy Issues for the 21st Century* was his complete omission of any reference to nuclear power. Here is a keynote speech at variance with the findings in the technical papers of the conference. Indeed, some of the keynote speakers, those that were both distinguished industrialists and market enthusiasts, found it difficult to step outside their own industry and take an objective view.

This problem of short-termism was encountered in a number of presentations. It gives particular problems for the builders of nuclear power stations and large dams such as the Three Gorges project in China (18 000 MW) where long lead times require strategic rather than market-led decisions and environmental protection and security of supply are taken into account. For these reasons nuclear power is doing well in Eastern Asia, with Korea 40% nuclear and Japan 31% nuclear and growing. Both countries are short of indigenous fuel supplies.

A post-2050 analysis by the Mitre Corporation concluded that new nuclear technology would be required urgently by the middle of the next century. Closure of the UK Fast Reactor facility at Dounreay was seen by some delegates as an example of the short termism that leads to insufficient input in long term research and development. The Congress went on to say that the public must be better informed as to the risks and benefits of nuclear power and its role in reducing greenhouse gas emissions. Public and politi-

cal reactions to nuclear power are more emotionally than factually driven.

It was entirely appropriate that this year's WEC congress was held in Japan: the first time the congress has been held in the Pacific Rim. Economies are growing rapidly; the average for South East Asian nations is 7% and by 2010 energy demand in Asia is projected to be double that of 1992; the region will also produce 25% of the world's total carbon dioxide discharge by 2010. This rapid growth in Eastern Asia might lead to regional discontinuities in energy supply and illustrates another of the conference's conclusions that inter-regional cooperation with restructuring of both industries and society will be essential in developing countries. The private sector will play an increasingly important role here with its improvement of efficiency through competition. The Congress emphasised that the subsidy of energy prices should be phased out. Price transparency is essential if the market is to exert its powerful influence on improving efficiency, although fiscal instruments may be needed to achieve the desired results.

Integrated resource planning, stimulated by technology transfer and dictated by environmental protection, will come to be the order of the day. Action on the environment will also be required of developing countries as well as developed countries. It is here that individual private companies are unlikely to provide the long term investment in research and development required to achieve reductions in atmospheric pollution. Dr G M Sfligiotti of Italy suggests governments must act and make available the intellectual property from R&D programmes free to those who require it. Without such philanthropy the goal of sustainable energy supply will not be achieved. Public awareness and understanding of what is required to achieve sustainability is lacking; indeed, the media encourages confusion by its confrontational approach with those for and against nuclear power or wind power arguing their corner persuasively or otherwise rather than presenting a balanced view. The WEC needs to examine its role and effectiveness in getting over the messages it wishes to proclaim.

A World Energy Fair coincided with the Congress and it was there that some of the more imaginative solutions to world energy problems were displayed. Photovoltaic cells with a capital cost of 25 cents (Australian) would be very interesting if really available but the construction of a tower, by the Israelis, one kilometre high and 40m in diameter with a water spray to cool air which falls out of the bottom and drives wind turbines is altogether more problematical.

For the first time a Youth Energy Symposium was held concurrently with the WEC Congress. Some 123 young people from 39 countries took part and their spokesperson, Philip Moody from Australia, presented the findings. They saw personal responsibility for energy conservation as essential. Education by information transfer on the Internet and via E-Mail will increase among the computer literate, mostly the young. They also took a long-term view, believing that further development of renewable energy was inevitable, not an option, and that improvements in technology of fuel utilisation of coal and nuclear (which they see as a "conventional fuel" as essential. Commitment to environmental protection, international cooperation and recycling was strong.

It was refreshing and very heartening to have this youthful and thoughtful input to the discussion. All in all the messages came through loud and clear; the enemies are dogma and short-termism, both products of an overtly market-led energy policy. Deregulation and competition can lead to great improvements in the efficiency of energy supply and use, but their enthusiastic adoption as policy must be tempered with caution. ❑

The author

Professor Ian Fells has published over 2000 papers on the subjects of fuel cells, energy economics, combustion, rocket propulsion and energy policy. In 1993 he received the Royal Society's Michael Faraday Award for his contributions to science through his work as a journalist and broadcaster.

Professor of Energy Conversion at University of Newcastle since 1975, Ian is well known as a television presenter of popular science programmes, such as QED.

He was President of the Institute of Energy in 1978-79.

SUPPLEMENT

Research and development in the Australian coal industry

by R L Graham
Director Coal Research
Australian Coal Association

Over the last seven years the research infrastructure of Australia has gone through a period of major change in response to a series of Commonwealth government initiatives designed to make government funded research more responsive to industry needs and to stimulate private sector research from a very low base.

Instead of a Coal Research Corporation, to be funded from a levy on black coal production, the Australian Coal Association persuaded the Commonwealth to allow industry to collect the levy and to manage the research itself, on a trial basis. This programme, known as ACARP, distributes about A$9 million a year of levy funds and plays a pivotal role in co-ordinating a significant part of total black coal related research in Australia, amounting to about $80 million a year.

This programme co-operates closely with the CSIRO Division of Coal and Energy Technology, and with the BHP Australia Coal Special Research programme, and has close liaison with the Centre for Mining Technology and Equipment and the recently set up Black Coal Co-operative Research Centre. Highlights of work being done in these programmes, as well as under ACARP, are reviewed here, in a full transcript of BCURA's 1995 Robens Coal Science Lecture, given by Ross Graham at The Royal Institution on 30 October.

IN 1994 Australia produced 184 million tonnes of saleable coal from 228 million tonnes of raw coal. Of the 132 tonnes which was exported, 74 million was metallurgical coal and 58 million was steaming coal. The value of these exports was over A$7 billion, making coal Australia's more important export. Apart from the foreign exchange benefits, domestically consumed coal also provides Australia with some of the world's cheapest electricity. While exports of metallurgical coal are not expected to show much growth, steaming coal exports are forecast to grow steadily, perhaps even doubling in the next 15 years, so that coal is likely to remain very important to Australia for the foreseeable future.

The future is however, by no means certain. Pits are aging and getting deeper. Competition for sales is intense. Coking coal is threatened by PCI, direct reduction technologies and the difficulty of building new coke plants. Deregulated electricity markets and the privatisation of government-owned electricity generation and distribution will certainly shake coal's domestic market, and of course, over everything hangs the fear of global warming. As well as these looming problems Australia's research infrastructure has been drastically revised with considerable ramifications for coal research. Here I will attempt to describe how all this change has affected coal research in Australia.

In December 1992 the Australian Coal Association took over on a trial basis, a programme of coal-related research from the Federal Government, which had been run under the National Energy Research Development and Demonstration Programme (NERDDP). Under the former programme approximately A$167 million was spent from 1978 to 1992, with expenditure largely funded from a levy of 5c/tonne on black coal production. The Australian Coal Association now fully directs the research programme, called ACARP and since June 1993 has taken over voluntary collection of the coal research levy. The levy is currently generating about A$65 million per year.

Just prior to the formation of ACARP, the Commonwealth also ended a special levy payable by a BHP managed group of open cut mines in central Queensland. One of the conditions attached to forgoing this levy, was that the mines would put A$65 million into a five-year programme of research called the BHP Special Research Programme. Although not entirely spelled out, it was

understood that the benefits of this research would largely be available to the rest of the coal industry. My observation is that the operation of this programme has had a significant effect on BHP Australia Coal's attitude to, and organisation of research at every level.

In the same period the Commonwealth has conducted uncountable reviews and assessments of the way research generally is done in Australia, including several major reviews of the CSIRO. It has also heavily funded the formation of Cooperative Research Centres, which are institutions designed to make the CSIRO and universities cooperate more closely and become more involved with industry and commercial research. The CSIRO must now draw at least 30% of its funding from external sources and to assist this and industry cooperation, generous tax incentives for research, have been implemented.

All these changes have had a quite profound effect on the way coal-related research is done and have entirely changed the pattern of funding. Researchers who had learned to milk the old system effectively suddenly found not only that the cow had moved, but also that its udder had been redesigned and previously accepted buckets were now less welcome. So while the changes have been welcomed by most, there have been the inevitable critics.

Coal industry research in Australia

Approximately A$80 million is spent on black coal research each year in Australia . The CSIRO, universities, CRCs and other tertiary research bodies probably account for about $20 million of coal research each year. Coal companies (excluding the BHP Special Research Programme{SRP}) spend about $15 million, with another $30 million being provided through various cooperative channels, of which ACARP is one. Much of the BHP SRP effort is also cooperative in nature. Mining manufacturers and service providers such as mine planning consultants, explosive manufacturers, software providers and so on probably spend about $15 million. This is a rank guess, however, and could be out by a factor of two.

Although ACARP is responsible for only about 12% of this expenditure directly, because of the cooperative effort mentioned above, it actually manages or is directly associated with about 35% of total coal-related research. This picture will however change a little with the advent of the Cooperative Research Centre for Black Coal Utilisation, which was opened on 25 September 1995.

This is an important new initiative in coal utilisation involving the CSIRO, the University of Newcastle, the University of New South Wales and the University of Queensland. The CRC expects to spend about A$40 million on coal utilisation research over the next seven years, and the work it plans to do, having been closely directed by industry, is closely attuned to the research priorities of ACARP in coal utilisation. Although ACARP is not directly involved in this programme, it is expected that the two initiatives will have close links and ACARP expects to be involved cooperatively in projects developed through this CRC as it is with projects developed by the CRC for Mining Technology and Equipment in Brisbane.

Table 1: Mining and Energy Cooperative Research Centres

Name of cooperative research centre	Steady rate C'wealth funding per year (year 3-7)	Total C'wealth grant	Grant period (years)
CRC for Mining Technology & Equipment (inc extension)	3.24 m (against total annual	18.66m	7
CRC for Black Coal Utilisation	1.80m (against total budget of approx 5.5m	11.66m	7
G K Williams CRC Extractive Metallurgy	1.98m	12.60m	7
Australian Petroleum CRC (inc extraction)	2.93m	17.26m	7
A J Parker CRC for Hydrometallurgy	1.82m	11.30m	7
CRC for Australian Mineral Exploration Technologies	1.60m	9.97m	7
CRC for New Technologies for Power Generation from low-rank coal	2.08m	13.46m	7
Australian Geodynamics CRC	2.49m	17.04m	7
CRC for Landscape Evolution and Mineral Exploitation	2.5m	16.20m	7
TOTAL	**20.44m**	**128.15m**	

Cooperative research centres

ACARP has close links with all sectors through joint membership of various advisory councils. Contact with service providers and manufacturers is also good, but can be uneasy on occasion because of individual concern about perceived (and usually mythical!) commercial advantage in secrecy.

Table 1 shows the cooperative research centres in Australia which relate to mining. Only the first three have a significant impact on black coal. The funding shown is only the direct Commonwealth grant. In-kind contributions from the CSIRO and the Universities (mainly staff costs) plus industry grants and contract research could be expected to double or triple the Commonwealth input. The networking is well conceived in most cases and it is likely that they will achieve substantially above what their budgets may suggest.

Black coal research strategy

The CRC's research and education programmes cover three areas of technological development:

- pulverised fuel (PF) combustion);
- advanced power generation, particularly integrated gasification combined cycle (IGCC) and pressurised fluidised bed combustion (PFBC);
- pulverised coal injection (PCI) into blast furnaces.

The five linked research programmes and educational activities are outlined in the following sections:

Advanced characterisation: to develop rapid techniques for characterisation of coal quality for a wide variety of applications in production and utilisation processes.

Coal matter reactions: to determine the reaction rates of coal under the high intensity reaction conditions (elevated temperatures and pressures) typical of new technologies under development.

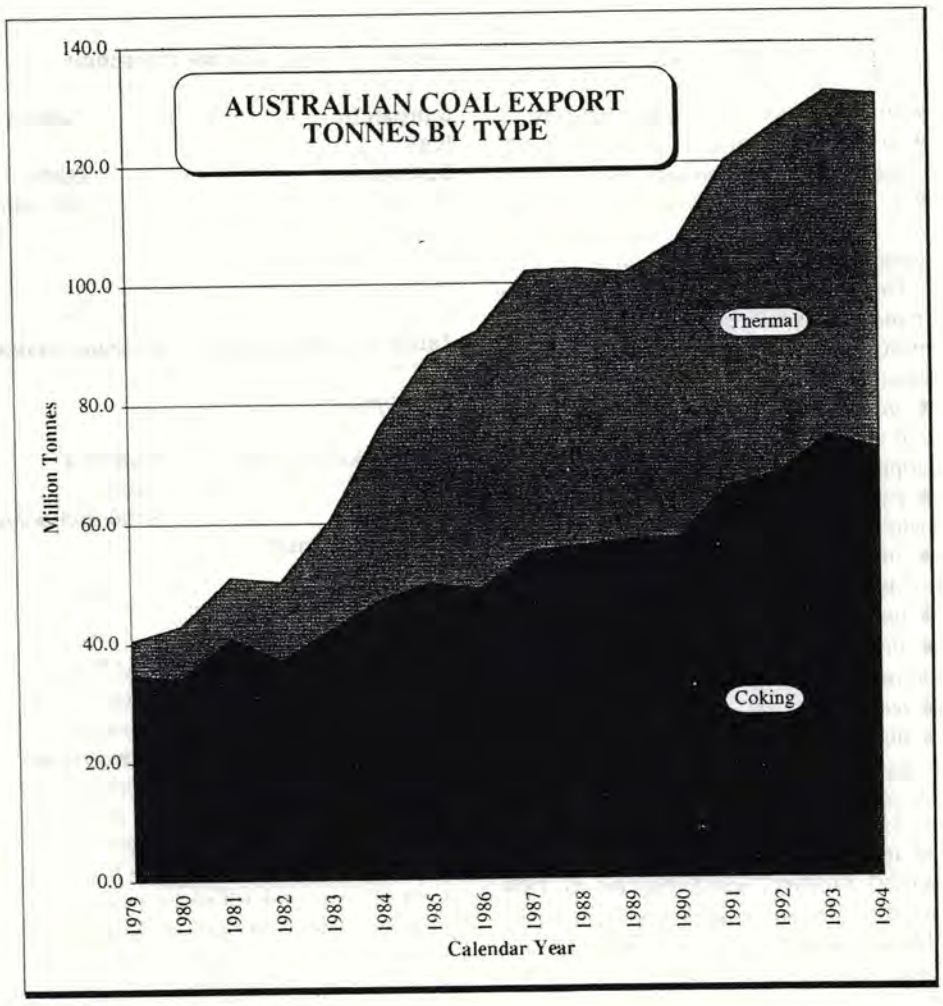
Mineral matter reactions: to develop a comprehensive understanding of the transformation of inorganic matter in coal to ash and slag during combustion and gasification.

Environmental issues: to develop predictive techniques and control strategies for emissions of gaseous and particulate pollutants from utilisation of Australian coals in both pulversied fuel combustion and new technologies for power generation.

Technology assessment: to develop robust analytical tools and methodologies which will enable the prediction of the performance of Australian coals in coal utilisation technologies and to support the selection of technologies for use in Australia.

Education and training: this programme recognises that there is not an adequate resource of new graduates and postgraduates who are appropriately trained in advanced methods of characterising and evaluating coals for their use in current and new technologies to support coal, power and metallurgical industries.

The low-rank (or brown coal) CRC also has an excellent programme of research, but unfortunately there isn't time to go into it here. I will just mention that separate to this initiative, the Herman Research Laboratories of the State Energy Commission of Victoria has been privatised and will continue to operate as a commercial entity. It will be underpinned for a number of years by a +$100 million research project based on privately-raised capital using Commonwealth Government taxation incentives.



ACARP research

An initial handicap which ACARP suffered from, and to a degree still labours under, was that its predecessor NERDDP was seen to do work which was largely irrelevant tot he enterprises which actually paid the levy. The levy is paid for by coal miners yet the research was heavily biased towards coal utilisation. The miners tended to see the levy as just another tax which the Commonwealth used in a fairly arbitrary way to do what it saw as national interest research.

This perception is despite the fact that in the latter stages of NERDDP, it did respond quite strongly to the industry's technical problems and with industry input, instituted a well-funded, focussed programme of mining research, which has borne very successful fruit in a number of important developments. The most important of these is the part that was played in helping set the design specifications for the Voest Alpine ABM 20 road header and the design and development of the Joy Sump Shearer. The success of these initiatives is really what led to ACARP because the industry saw what could be done if it could permanently take charge of the research agenda.

However in spite of these successes, it has been necessary to constantly iterate the dollar value of the work ACARP is doing, in order to dispel the impression of doing esoteric research of little practical value, which is the industry's memory of NERDDP.

It costs Australia's coal miners well in excess of $5 billion to produce their product each year. By examining the areas of greatest cost and seeing what could be done to improve productivity in these, it has been possible to choose project areas where ACARP should be able to improve the industry's earnings by about $480 million a year, if it is successful. I will give some examples of how this number is arrived at in the body of this lecture, and show why I believe ACARP is already adding about $38 million a year to the bottom line.

Table 2: Open cut, overburden removal

12 projects **$1.6 million ACARP** **$2 million Total**	**TARGET** **GAIN** **$40 million/year**	**AIM: 10% improvement =** **$200 million/year for industry 2%** **attributable to ACARP =** **$40 million/year**

Open cut

Australia produced 130 million tonnes of saleable coal by open cut mining in 1994.

There has been considerable success recently in Australia, in open cut R&D. Industry concern in the open cut area has been growing steadily as pits have been get-

ting deeper and approaching the design limits of conventional thought as to how the technology could be improved:

- so as to reduce present operating costs;
- to extend the depths at which current technology will remain economic, and
- to look at technology options for winning coal when the economic limit of current technology is eventually reached.

The major gains to date are coming from improved blasting practices and improvements in bucket design and rigging. Future gains will come from:

- improved mine planning packages, which will allow accurate computer simulation of stripping alternatives to minimise rehandle;
- partial automation of dragline operation to reduce cycle time;
- improved monitoring and bench marking to lift performance of weaker operators;
- further bucket and rigging improvements;
- improved maintenance leading to reduced down time;
- reduced coal loss;
- highwall mining.

As a result of these improvements, there are reported increases in dragline efficiency of 5% or greater in Bowen Basin pits. ACIRL reports that 19 pits have used the ADPC facility, achieving up to 18% improvement in bucket carrying capacity. The total attributable to ACARP is in the order of $15 million a year.

Table 3: Open cut: coal extraction

5 projects	**TARGET**	**AIM: 5% reduction in coal loss**
$1.2 million ACARP	**GAIN**	
	$24 million/year	**+$24 million/year industry gain**
$1.5 million Total		

Table 4: Underground — roadway development

16 projects		**AIM: increase average roadway development rate to +15m/shift**
$2.6 million ACARP	**TARGET**	**Target industry gain (savings+prod) = 300 million/year**
	GAIN	
	$100 million/year	
$8.1 million total		**If a third of this attributable to ACARP= $100 million/year**

Draglines

Improved blasting techniques, which among other beneficial effects improves digability. This research is largely being done by explosives manufacturers in conjunction with individual pits, often closely linked to the Julius Kruttschnitt Minerals Research Institute (JKMRC), which has a history of research in this field.

Improved bucket design, and bucket rigging, to improve carrying capacity. Nearly all recent work in this field in Australia has been done at ACIRL's Australian Dragline Performance Centre at Ipswich, with assistance from a number of bucket manufacturers. Their success has led to some competitors entering the field lately. Much of the research component of ACIRL's work has had ACARP support.

Improved instrumentation of draglines. Almost every dragline in Australia is now instrumented to a degree, with at least a Tritonics monitor. BHP has also experimented with load cells and more sophisticated instrumentation. The result is a much better appreciation of boom loads (and as a by product, sources of possible inefficiency, such as maintenance people derating motors or adding excessive wear packages to buckets). The importance of the man-machine interface has also been emphasised, There is a need to be able to better interpret and use the vast amount of data from the monitors.

Better mine planning to decrease rehandle. There has been a general improvement in mine planning but the advent of 3D Dig appears to have been a step improvement. However the package will have to have been in use of some time before its value can be accurately gauged. Already researchers are looking beyond it to fully interactive planning and simulation modules.

Automation of draglines. CSIRO has made considerable progress using machine vision to control the swing to dump cycle with successful trials on the mini dragline at the ADPC. They plan to try this out on an operating dragline at the Tarong pit shortly. The aim is to develop a 'cruise control' system which will mimic the most efficient swing of the most efficient operator, time after time.

Man-machine interface. There is a need for better training of dragline operators. It can be demonstrated that lifting the performance of the lesser operators to the level of the very best on a consistent basis has a major benefit in productivity.

In looking to produce a simulator based on virtual reality, it was realised that several goals could be achieved at once and that much recent research was capable of contributing to the grand picture. The information from the dragline monitoring project, the

'Big Geordie' dragline excavator at work on an opencast mine in the UK.

computer code for 3D Dig which mimics the operation of a dragline cycle and the control information from the dragline automation project, should together provide a very sound basis for developing a dragline simulator. Depending on price, this would be a major benefit in operator training. In combination with 3D Dig type code and each mine's terrain model from its mine planning package, such a system would in theory allow operators to be trained in a virtual environment closely resembling each individual mine. A scoping study for this ambitious project is being carried out by the University of Queensland.

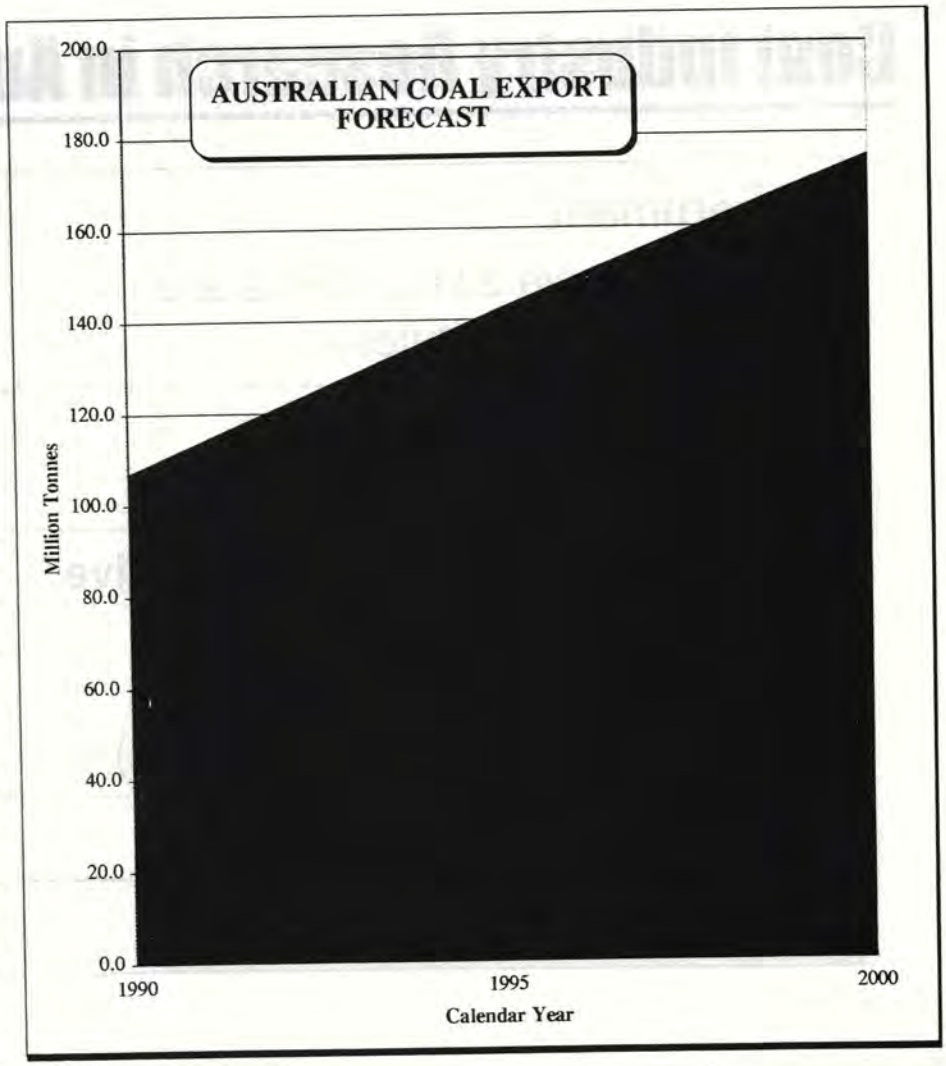
Coal extraction

A recent ACARP study has demonstrated that $480 million worth of coal is thrown away each year in Australian open cuts. An excellent report from the JKMRC has detailed the sources of loss. The report will be issued with computer disks which graphically illustrate loss situations and control remedies.

A ground radar unit for recognising the top of coal has been successfully developed by Georadar Pty Ltd. It was originally developed for use on a Wirtgen surface miner but it should have a number of other applications. It is now a tool in search of a use.

A portable coal face ash analyser has also been successfully developed by the CSIRO. The unit is small and light and uses a source so low in radioactivity as to be legally non-radioactive. It is designed so that it can be passed over a coal face to give an immediate readout of ash content. The unit is in the process of being made commercially available..

The resulting coal loss study was completed, and the industry loss estimated at $480 million/year.



Loading unit — truck operations

BHPAC large truck project. The most important Australian project on trucks is the one being carried out under the BHP Special Research Programme. They have developed a design for large trucks (up to 300 tons) which should increase their efficiency by around 15% if successful. They have reached agreement with a truck manufacturer and a prototype is expected to be completed in 1996.

Birrana front suspension project. Testing under an ACARP grant has demonstrated that for most commonly configured coal trucks, the front shock absorbing struts are almost totally locked up and rigid when the truck is fully laden and that suspension is basically just the tyre elasticity. This explains the loping motion of laden trucks and related back problems, tyre damage on cornering and truck body stress. A research project is underway to assess ways of rectifying the problem.

GPS systems. Considerable interest is being shown in GPS based truck monitoring systems for control of trucks to improve both truck utilisation and also coal quality through more precise plant feed. This is obviously most important in multi-seam mines. An ACARP project was completed recently to assess the state of the art in GPS and its applications to open pit mining. Ultimately this technology should lead to driverless trucks.

Highwall mining

Many people believe that it is critical for Australia to develop the ability to mine from the highwalls to bridge the gap from the end of open cut mining to underground mining. BHPAC have taken up this challenge and is in the process of developing a highwall mining system based on the Joy-Addington Add Car system. They appear to have reached agreement with all the necessary technology owners regarding Australian rights. Their aim is to get the technology to operate in steeper dips than the current units, to develop an improved guidance system and to develop cost effective inertisation techniques. The project is well advanced but the estimated completion date is not known.

ACARP's role has been peripheral to the BHPAC work, with projects on the geotechnical problems involved in highwall and punch mining and a study on likely backfill options and costs.

Rehabilitation

Australia is also developing considerable expertise in mine rehabilitation since it has become an important social issue. ACARP currently has nine projects underway, many of which are substantial collaborative projects.

The largest project is one involving the University of Queensland and several divisions of the CSIRO entitled Postmining Landscape Parameters. This project is look-

Coal Industry Research in Australia

Government (CSIRO, Universities, CRCs and other Tertiary Institutes)	**$20,000,000**
Coal Company Proprietary Research	**$15,000,000**
Company Sponsored Co-operative Research (ACARP, BHP Special Research Program, AMIRA, JCB, ESAA, etc)	**$30,000,000**
Mining Manufacturers R&D	**$15,000,000**
Total	**$80,000,000**

ing at the problem of recontouring mined surfaces in the Bowen Basin to stable landforms and includes engineering, hydrology, soil formation and plant establishment amongst other parameters. The project has been running for four years and has been recently extended.

The Dozertrak project was technically successful. This project was based on accurately locating the cutting edge of a piece of earthmoving equipment in real time, using either a laser scanning theodolite or GPS and relating this to a design surface, which was developed as a simple terrain model on a screen in the driver's cab. Operators quickly learned to cut to the design surface without the aid of other survey data. Commercialisation is proceeding, but more slowly than desired.

Underground

Underground mining is the largest category of ACARP research, attracting about 37% of funds in the last round. This may look excessive considering the importance of open cut mining in Australia, but arises from the greater problems of mining underground, and also a strategic decision on the part of open cut miners, who see that inevitably many open cuts will be forced to extend into underground operations. Underground research therefore represents a long-term investment in their future.

Roadway development

The research programme is too complex to describe in detail, but I will cover a few projects of particular interest.

Roadway development is the most pressing issue facing underground coal miners in Australia. Slow roadway development is the reflection of multiple problems, which must be solved in different combinations from mine to mine. It is therefore a very difficult problem to solve generically, since solutions must be found to specific problem areas and then the solutions combined on a case by case basis. The main problem areas are:

- outbursting;
- strata control;
- rib control;
- machine availability and productivity;
- emission monitoring and control;
- face to conveyor coal clearance;
- systems integration and harmonisation;

Table 5: Underground — in-seam drilling/outbursting

20 projects	TARGET GAIN	AIM: Improve certainty of outburst prediction to reduce time spent in driving under outburst conditions plus improve efficiency of in-seam drilling by 20%
$1.8 million ACARP	$100 million/year	Industry target: $100 m/y production gain plus $4m/y saving on drilling costs
$4.2 million		

- communications;
- panel and services advancement.

A recent study for ACARP by Dr Michael Kelly of the CSIRO has recognised four main regimes:

i) high gas — high lateral stress — old mine
ii) weak roof and floor (or generally good, but with structurally controlled bad zones)
iii) mines with few significant technical issues, driveage rate essentially systems dependent
iv) thick seam, new mine environment.

There are of course local variations. The mines in each regime have a different set of systems development and machinery development research priorities, so that it has not been possible to settle on a single unified approach. However some priorities are being met..

The results of underground roadway development are that average drivage rates are now over 10 million/shift, up from 7.8 million/shift in 1989. Eight out of 26 longwalls now near or over 15 million/shift are partly due to NERDDP/ACARP efforts — worth approximately $50 million/year in savings and production. Of this $15 million/year is attributable to ACARP.

A trial of the first production model Joy Sump Shearer is underway at the Capricorn colliery in Queensland, fully integrated with a flexible conveyor train, monorail, etc. This project, which has ACARP support, uses state of the art equipment and is the most completely integrated underground roadway driveage system that we know of. The Australian and international coal mining industry is watching the progress of this trial with considerable interest.

A consortium is being formed to trail a tunnel boring machine for roadway driveage. The basis for the project is that everything the Capricorn project is attempting to achieve has already been achieved by tunnel borers, which are fully integrated systems carrying forward spoil clearance, ventilation, bolting, services and so on. At the time of writing a favourable feasibility study has been completed and there seemed to be widespread industry support, however realisation of the project depended on substantial additional financing, which had not been absolutely secured.

A Fletcher roof bolter in action in a UK pit.

The Flexibolt roof bolt was developed by Barrett Fuller and Partners, under a grant from our predecessor, NERDDP, and we have been responsible for assisting with field trials. This is a high strength bolt based on a 23mm diameter multiwire steel strand, with a tensile strength of 55 to 60 tonnes. It is demonstrating remarkable success in high stress areas, and particularly where there is high horizontal stress. Interestingly, as can be seen in these examples, not only did the use of these bolts in the trial improve the roof, but also the ribs. We believe the use of these bolts is going to have a profound effect in mines which suffer from very high stress.

Kembla Coal and Coke have developed an improved system of monitoring and remote control of mining equipment under outburst conditions. This system has many advanced features, including monitoring and control via the trailing power cable, high definition video cameras with microwave link, and a positive pressure, flameproof, mobile control room. The development of a safe underground control room is a significant step to remote operation of a variety of mining equipment, including longwall and possibly even highwall systems. It will allow the use of non-flameproof monitoring and control equipment underground.

A key operation in efficient roadway driveage is roofbolting. An ACARP project last year finally produced a compact semi-automatic roofbolter. However during the demonstration of the prototype it was decided that what was really required was a fully automatic unit and that it should be less complicated than the prototype to avoid maintenance problems. A revised design was produced and Ausminco expects to build a prototype of the new unit in 1996.

The Australian Coal Association in a parallel initiative to ACARP has arranged finance for development of a new lightweight roofbolter with several very innovative features which should have a major impact if successful. This project through Cram Engineering should take about two years to complete.

Rib bolting is also an important issue. ACARP is developing a new innovative rib bolter with Cram Australia Pty Ltd, which is due for completion this year. ANI Arnall have also been commissioned to adapt recent advances in coal pillar yield modelling, developed at the UNSW, to quantify the mechanics of rib behaviour under a range of conditions, with the aim of developing better rib support systems.

The Cable Bolt Inserter is partly an offshoot of the successful Flexibolt development, Powercoal's Angus Place colliery, Gordonstone colliery and Cram have developed new techniques and devices for cable bolt emplacement which look like having significant savings in time and money, plus being considerably safer.

Table 6: Underground — maintenance

7 projects	TARGET	AIM: Improve maintenance Reduce current U?G
	GAIN	industry costs of $450 million/year and improve up time of key machinery
$0.86 ACARP	$100 million/Year	A 10% increase in production rate for Australian longwalls
$1 million total		would increase revenue by $120 m

Table 7: Coal preparation

Category	No of projects	ACARP commitment $millions	total $millions	Target gain $millions/year	Results
Fine coal	8	1.03	2.25	20	First stage of all projects successful. Industry target gain looks very conservative
Dewatering	9	1.56	4.36	20	Coarse coal centrifuging project stage 1 successful. Air purged centrifuge stage 1 successful.
Dense medium	6	0.72	1.52	15	Research at early stage
Process control	4	0.68	1.28	20	Research at early stage
Sub-Total	**27**	**3.99**	**9.41**	**75**	**Major gains are possible through improved coal preparation, but may take time to be realised because of the capital investment required.**

Gas drainage

For mines with high gas, particularly where there is a history of outbursting, the mines inspectorate requires that driving be done in outburst mode, wherever there is any risk. This requirement has severe economic penalties. For outburst mode not to be invoked it is necessary to be able to thoroughly redrain development blocks and then to be able to prove that the drainage has been totally effective.

ACARP has 20 projects related to in-seam drilling for gas drainage and outburst control. Most of the projects are small in dollar terms because the problems have been broken into small elements.

Gas drainage would be cheaper and more effective if drainage holes could be drilled straight and operators knew exactly where the holes had finished. Currently up to twice as many holes as are theoretically needed, are drilled to cover the uncertainty. Even so the inspectorate will still not accept certainty of drainage. Projects are concentrating on hole surveying and on downhole geophysical techniques to both guide the drill and to extract the maximum information after drilling.

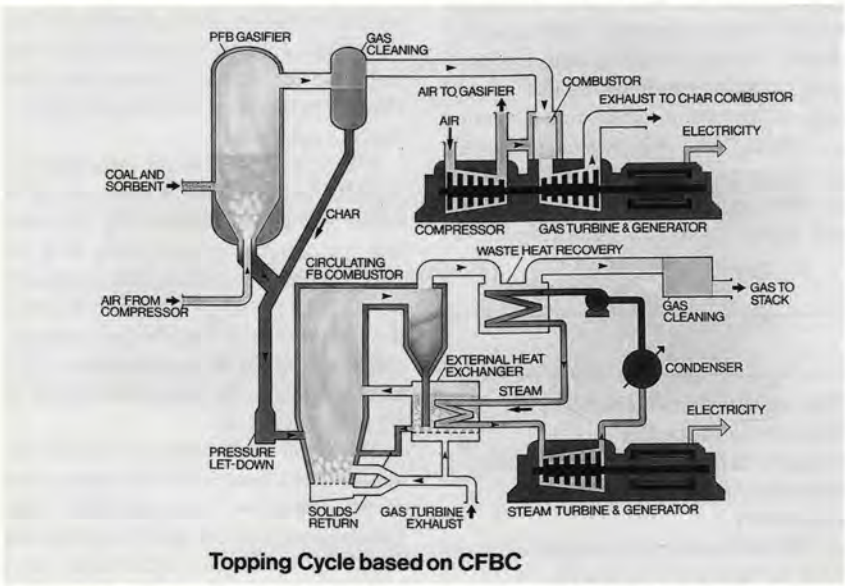
Development of radar and radiometric borehole guidance systems are under way at the Centre for Mining Technology and Equipment in Brisbane. This is part of a larger cooperative project which includes the ongoing development of water jet drilling techniques. Technology is being developed by AGA/Sigra to enable steering of downhole motors and monitoring of drilling parameters behind the bit thus facilitating future detection of potential outburst zones while drilling.

Technology for detecting in real time, zones of increased gas flow in drill holes, has been developed by Lunagas Pty Ltd and is undergoing mine trials. The system is based on oil field tyre sampling of the drilling fluid.

Sigra has developed a borehole pressurisation system to facilitate future geophysical logging of holes while drilling. This device, which will allow collection of rock samples under pressure while drilling and an analysis of their degassing rates, has great potential for outburst detection. Trials of the prototype will begin shortly.

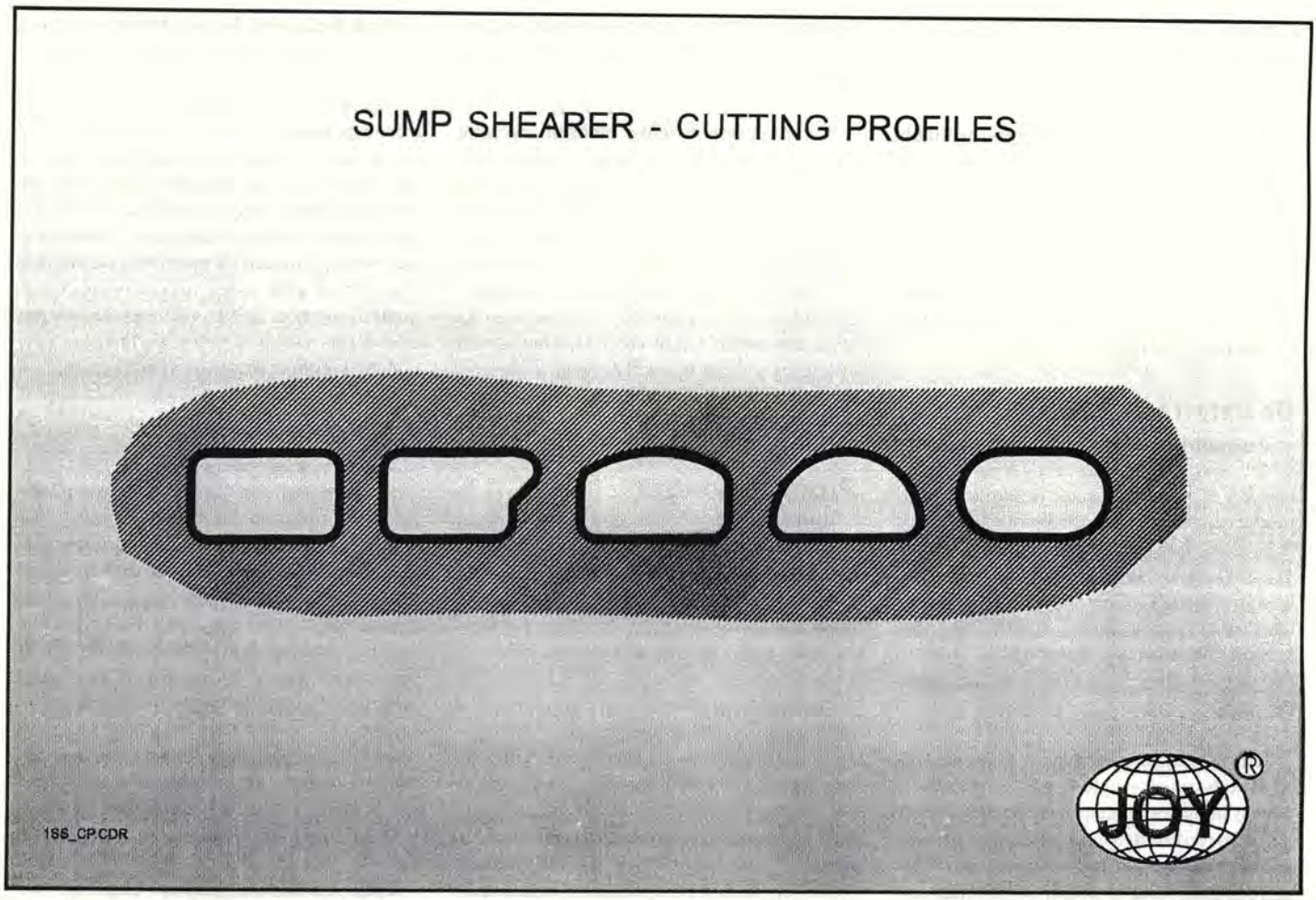
Geogas is developing a remotely interrogated, real time return gas monitoring system to monitor gas drainage effectiveness. It is undergoing mine trials at present.

As a result of the underground in-seam drilling and outbursting projects, efficiency



Topping Cycle based on CFBC

The world famous British Coal topping cycle, which was developed at the Coal Research Establishment (CRE). CRE is currently working with ACARP to test Australian coals under gasification conditions, using an air-blown gasifier.



The sump shearer's range of cutting profiles.

has risen. This is largely due to the solution sharing and coordination between the various players. Manufacturer liaison has led to improved AMT survey tool and IS rating for Surtron Scout. There will also be savings in reduced down time as a result.

Maintenance

Condition monitoring is a key area for R&D. ACARP is attempting to provide better tools so that faults are recognised sooner to prevent breakdown of critical components.

Stoppages in trunk conveyors are serious causes of production loss. One of the main causes of stoppages and also a serious fire hazard, is failed idler bearings. A project is underway to take underground, existing technology from a surface application. Vipac developed a mobile acoustic bearing monitor for long overland conveyors in the iron ore industry and have proposed that it be reduced in size, made intrinsically safe and adapted to different signal responses to do the same task in the underground situation. The project is well advanced and it is hoped that underground trials will begin by the end of the 1995. As a long-term goal they have also proposed the development of in-belt monitors, which monitor not only the idlers but also belt tension, tracking and so on, with each revolution of the belt. Early results towards proving the proof of concept are encouraging.

Australian Conveyor Engineering have recently completed an ACARP project which has advanced fundamental, understanding of the lagging shear characteristics of conveyor belting in relation to drive drum slip.

BHP Engineering are undertaking a project with ACARP support, to carry out remote condition monitoring of key components of mobile underground equipment and to transmit this data link to the mine communication network.

Two of these studies are now completed, following a strong response from industry. As a result changes to maintenance practice are occurring, but the full benefits are as yet unquantifiable. Condition monitoring has been targeted for further work.

Coal preparation

Coal preparation is the vital link between what is dug out of the ground and what the customer actually receives. The ACARP priorities reflect this need for customer satisfaction through product improvement and consistency. At the same time however, it is necessary to improve yields wherever possible and to maximise operational efficiency.

Fine coal. A key area for coal preparation is in the separation and treatment of fine coal. In the drive to achieve higher and higher yields, increasing attention has been paid to recovering fine coal, however a higher percentage of fines in the product can lead to moisture, transport and environmental problems, so these areas have also become high priority.

Several of the dewatering projects listed below are to do with fine coal. In addition there are a number of projects under way to improve the recovery of fine coal.

Two cyclofloatation projects are being funded by ACARP. Both have shown initial promise. The unit being developed by the CSIRO Division of Coal & Energy has demonstrated a capacity to produce a 7% to 9% ash product from a feed slurry with 23% ash content. The main advantages of the process is the very high capacity per unit volume achieved by the very short residence time compared to conventional technology. This next stage requires design modifications and tests to improve coal yields beyond the 50% to 80% achieved to date and to optimise the total system for differing feed coal composition. The other project by Professor

Jamieson at the University of Newcastle is undergoing small-scale pilot stage testing.

The CMTE is conducting a project to define the capability of currently available and new size classification technologies. It will investigate the mode of operation and efficiency of size classification at a number of plants, estimate the economic impact of the inefficiencies on the subsequent cleaning units, consider the use of recently developed equipment and develop strategies for optimal economic classification.

Dewatering

Dewatering continues to be a major priority for coal preparation because of the cost benefits of removing water from the shipped product. It has been estimated that reducing the moisture by one percent in a 100 000 tonne product coal shipment will lead to a freight saving of up to $20 000; an increase in specific energy of 70 kcal/kg; and a saving in make-up water of the order of one million litres for a typical coal preparation plant.

The air-purged centrifuge has demonstrated in laboratory-scale trials a capacity to reduce moisture content by a further 20% to that achieved from a conventional centrifuge. ACARP is funding construction to a commercial plant and establish design and economic parameters to evaluate commercial opportunities.

Three projects are investigating agglomeration or shear coagulation of fine particles as a means of reducing moisture content. One, at the University of Newcastle, will investigate the potential for removing fines and ultrafines using a polymer coagulating agent and subsequent moisture removal by filtration. Two others are examining agglomeration by various binding agents.

Another project is to overcome problems associated with screenbowl centrifuges and vacuum filters by using scroll-type centrifuges required to capture fine coal particles and recovery of solid concentrates from the modified scrolls.

Dense watering

Dense medium is still the most important cleaning technique used and there are a number of projects in hand which attempt to improve the efficiency of this method.

BHP Research are evaluating the feasibility of on-line measurement of dense medium cyclone efficiency through monitoring , cyclone differentials, cyclone cut point (D_{50}) and cyclone yield and examining their relationships to efficiency measurements including Ep. The project should proceed to on-site plant trials shortly.

A conventional dense medium cyclone effects a separation at a density significantly higher than the feed medium density, thereby lowering plant yield by a minimum 1%. A Tri-Flo Separator which has zero offset capability will be tested against a conventional cyclone in an operating plant environment. By switching between the two processes an accurate comparison of yield, throughput and efficiency will be made. The work to be carried out by CRA should begin by the end of the year.

Process control

An important area for achieving improved coal products is through improved process control. A commissioned study by ACARP identified some needs in this area and led to process control projects for dense medium cyclones and hydraulic distributors.

Another important project is to improve the efficiency of on-line gauges. There has been some industry dissatisfaction with current installations and manufacturers such as MCI have responded, with ever more accurate and sophisticated instruments for ash, moisture and general washability control. However, many of the problems which operators have with their on-line gauges are not the fault of the instruments, but of the way they are used and maintained. Poor calibration procedures are known in particular to be a significant problem.

Because each pit has its own peculiar set of problems in regard to such parameters as:

- coal variability, both intra-seam and multi-seam;
- varying mineral matter, such as iron oxides and carbonates;
- different degrees of plant sophistication, and
- different standards of operating excellence and maintenance,

it has proved very difficult to quantify how gauges should be improved or to quantify their operational limits or to devise strategies for minimising errors.

The indications are that through project 3090, a significant improvement in the operation of on-line gauges will be achieved, which should flow through to improved product control and particularly, lower ash levels.

Uniform feed distribution

It has been estimated that plant throughput could be conservatively increased by 10% if uniform feed could be distributed to parallel process modules in a coal preparation plant.

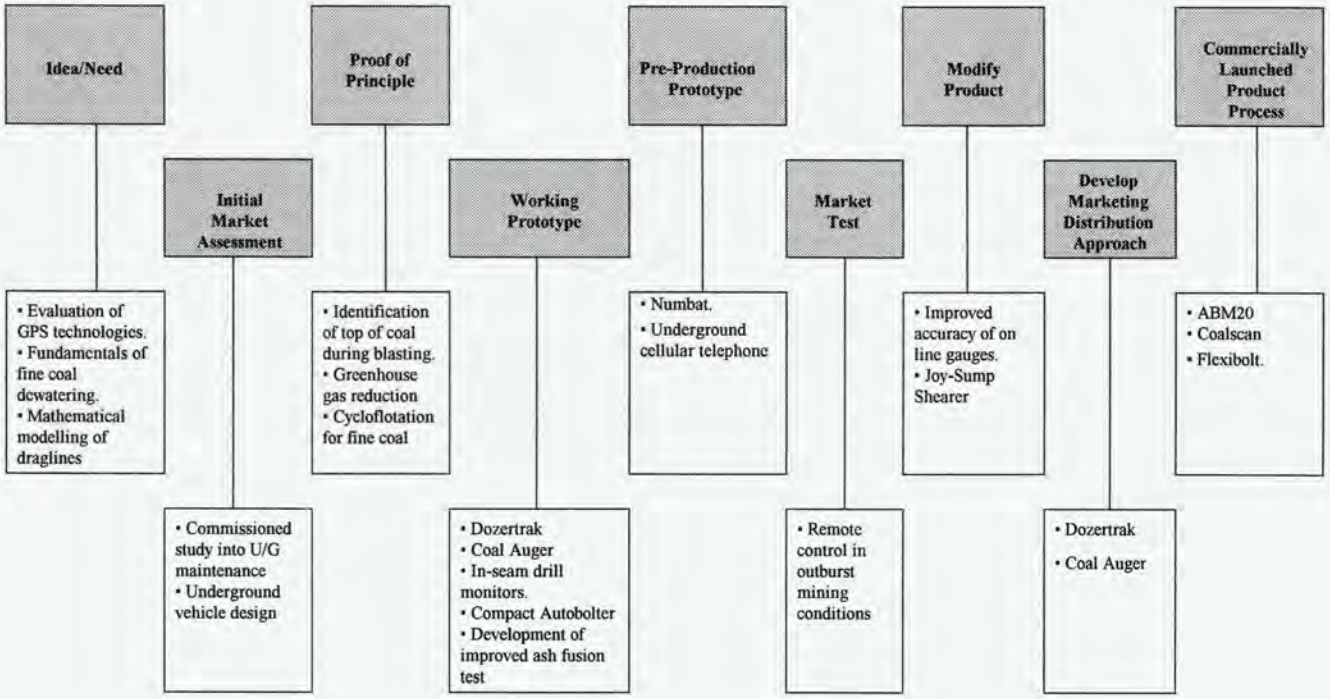
A project at the JKMRC is planned to test a concept based on breather pipe air flow rate as a means of controlling slurry flow rates. A successful outcome could lead to a low cost retrofit module which would have a significant impact on plant output rate. Distributor bias will be inferred by measuring de-sliming screen bed level using inexpensive instrumentation such as tilt switches and angle transducers which can be retrofitted to existing plant without extensive modification.

Coal utilisation

Thermal coal categorisation. This category represents the largest segment of the ACARP utilisation research programme and has two main strands. The first is to be able to predict the behaviour of Australian coals in the new advanced technologies for power generation so that they will be able to be suitably fitted to these new technologies. If there are likely to be problems, then Australian producers will want to know well in advance so that solutions can be developed. The second is to better define the distinctive features of Australian coals so that the positives can be advertised and the negatives (if any) minimised.

CRE Air Blown Gasifier. There are two substantial projects under way to test Australian coals under gasification conditions. One of these will evaluate Australian coals on the air blown gasification cycle pilot plant operated by the Coal Research Establishment (CRE) in the UK. The plant consists of an atmospheric pressurised fluidised bed gasifier and a ceramic candle filter test facility. Six Australian coals will be selected for reactivity tests at high pressure and temperature. From these tests two coals will be selected for performance testing in the pilot plant. The results will be compared with a database of numerous internationally traded coals.

CSIRO Entrained Flow Gasifier Project. Another project is predicted on building an experimental high temperature slagging gasifier at the CSIRO laboratories in Sydney. Funding for this has been upset by the pending break-up/privatisation of the NSW electricity industry, but hopefully can still be reinstated. The project is to define the slagging behaviour and fluxing requirements of Australian coal ashes. These generally have high ash fusion temperatures which may effect the economic use of some Australian thermal coals in slagging gasifiers. The resulting data will be used by producers to evaluate the suitability of particular coals for use in IGCC processes.



ACARP priorities

CQIM Project. Use of Australian coals in conventional power generating plants is still expanding so improved characterisation for this market is also needed. Many plants world wide use the EPRI Coal Quality Impact Model to evaluate coals for their use in their installations. As this was developed for North American coals however it was felt that it may not be entirely satisfactory for Australian coals. An arrangement has been entered into with EPRI for evaluation of CQIM on Australian coals with the object of seeing what adjustments, if any, are needed. This is proceeding with the cooperation of Pacific Power's Eraring power station.

New Improved Ash Fusion Test. The current standard ash fusion test has been widely criticised because of its subjectivity and poor repeatability and reproducibility. ACIRL, CSIRO and the University of Newcastle have been working on improved test procedures. Work to date has produced new insights and techniques for understanding the fundamentals of ash fusion behaviour in boilers and work at a fundamental level will continue, to explain the responses observed in terms of mineralogical phase changes.

Laser fluorescence microprobe. The CSIRO has been working for some time on the provision of an objective, accurate rapid and inexpensive standard test based on microfluorescence that assesses the fusible maceral content of a single coal or coal blend. Substantial progress has been made using a scanning laser fluorescence microprobe to measure the proportion of fusible components and the degree of fusibility of components of individual coals and blends.

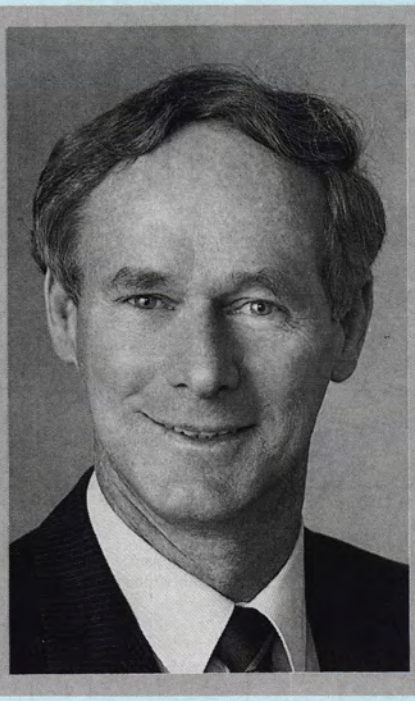
The University of Sydney is working on improved techniques for predicting NO_x formation from char nitrogen. The project will improve understanding of the role of the char nitrogen in emissions of NO_x from coal combustion, with a view to explaining why, in practice, high nitrogen content coals do not necessarily produce high NO_x emissions. The major resulting benefit will be to address any negative marketing impact of the high N-content of some Australian coals by providing reliable documented data on Australian and internationally traded coals to demonstrate that NO_x production from Australian coals is no worse than international counterparts.

The largest producer and by far the largest consumer of both coking coal and coke in Australia is BHP. They have a substantial research programme of their own into characterisation of coking coal and into coke making, which is for the most part confidential. They have built a fully instrumented movable wall coke oven in Newcastle and are having considerable success in understanding the factors which lead to increased oven wall pressures in coke ovens.

The ACARP programme is practically based and seeks to deliver commercially viable outcomes. We have projects in all stages of the innovation process from the initial concept to the launched product. This is where the non-coal research portion of the NERDDP programme continues.

We are very conscious that there are various stages that good ideas have to be nurtured through and that we are not just doing research for its own sake, but to get something tangible and workable at the end. ❑

The author



A false start in teaching, which resulted in a BA, was corrected by a university vacation job in the underground, silver-lead-zinc mines at Broken Hill in 1965, leading immediately into a traineeship in geology, a BSc in 1967, and an MSc in 1975.

Ross Graham joined Esso Australia Ltd in 1967, as a petroleum geologist, transferring to the minerals department in 1972. He was appointed Minerals Exploration Manager in 1981.

Leaving Esso in 1986 he joined Boulder Gold NL to manage the exploration effort for a number of recently floated junior exploration companies with interests in North America, Australasia, the Solomon Islands, Swaziland, Philippines and Greenland. He was appointed General Manager of Boulder Gold in 1989. In addition to gold and platinum, Boulder also had interests in ferrochrome and conducted research, largely funded by a levy on black coal production. Under a trial scheme, called ACARP, the levy is now paid to a newly set up company called Australian Coal Research Ltd, of which Mr Graham is the Executive Director.

Projects with a contract value of about A$60 million were inherited from the old scheme and subsequently contracts with a further similar value have been written. The levy generates only about A$9 million per year, but the scheme achieves considerable leverage through cooperation with other funding bodies and additional coal industry support.

ACARP is only one initiative in the recent general reorganisation of research in Australia and Mr Graham will explain how this reorganisation has affected the coal industry.

Energy for the future

an environmentally resilient strategy

by Hans DuMoulin

ETE 21, an international non-government organisation (NGO), was established in 1990 by two European alumni of the MIT-based workshop on alternative strategies (WAES). The emphasis of the project was on the environmental implications of meeting global energy requirements, in contrast to the WAES concern about the future availability of energy. The networking approach was chosen in order to harness the vast wealth of information available world wide without duplicating work done elsewhere. Representatives were sought from academia, environmental research groups, professional bodies and industry, covering the widest possible range of disciplines and nationalities.

The main participating organisations in the USA were the MITRE Corporation and MIT, both of which organised think tanks on behalf of ETE 21. 14 think-tank sessions were held in all. The objective was to identify rational responses to close the energy loop in an environmentally responsible and economically viable manner.

The main conclusions are set out below. They are basically addressed to policy formulators and decision makers at all levels of government, as well as interested members of the public. These can be sub-divided into general observations and technological opportunities and policy issues.

General observations and technological opportunities

- It is predetermined that demand for energy will grow, less so in industrialised, more so in developing countries, where 95% of population growth will have taken place when world population reaches some eight billion by 2025. By then the developing countries will consume some two-thirds of global energy, as opposed to less than one-third today.
- Whilst there is still considerable energy saving potential, this will be overwhelmed by the growth in demand in the developing countries. Rapid transfer of modern technology can help stem the demand explosion in these countries.
- The climatological damage the additional greenhouse gases, in particular CO_2 from fossil fuels, may cause is still uncertain. *The Economist* in their June 1994 Survey on Energy put it thus ... 'the paradox of climate change: it is too serious to panic about.'
- Pollution (noxious and harmful chemicals and particulates) needs to be abated under all scenarios. The demand for comfort, mobility and power is only just taking off in some very large developing and ex-Communist countries which hold large fuel reserves of fossil fuels, in particular coal. In cities all over the world traffic congestion has become acute.
- A strategy which reduces the rate of increase of energy demand relative to economic growth is desirable in every respect. Energy saved does not need cleaning up! Energy efficiency opportunities with existing technologies offer scope for considerable surprise. There is no reason why, additionally, new technologies should not emerge. Also demand side management measures, which reward utilities for lower billings ('negawatts') rather than high sales, are already beginning to make an impact. Further improvement in energy management in offices and homes can be expected as well as better traffic, freight and electricity distribution management. Future energy demand could be as much as a third less than many conventional projections indicate today. Predictability is a thing of the past.
- Where pollution abatement measures aggravate CO_2 and other greenhouse gas emissions (eg, sulphur removal, catalytic converters) fighting pollutants should be given the greater weight, at least until such time that the climate issue is fully understood, in view of the proven adverse effects of pollution.
- Future growth in energy demand will be increasingly in electricity and transport. To replace fossil fuels in these sectors is mainly hampered by the storage problem. The energy stored over aeons in coal, oil and gas provides an — ultimately depleting — wealth of solid, liquid and gaseous fuels. This accumulated resource base and its vast supporting infrastructure needs to be utilised efficiently in the interest of the environment.
- The precautionary principle dictates that non-depleting and clean alternatives to fossil fuels continue to be developed. They should be subjected to equally rigorous environmental impact analysis.
- Renewables based on solar energy and its main immediate derivatives wind, waves and tides suffer mainly from their intermittent nature. A break-through in electricity storage technology would benefit these renewables immensely.
- Biomass (fuel crops) and waste provide non-intermittent renewables. These frequently require vast tracts of land with associated biodiversity, soil depletion, fresh water and collection problems. Under certain favourable climatological and geographical conditions these problems can be overcome economically and ecologically.
- Hydropower and geothermal energy are neither totally renewable, nor entirely benign. They can make considerable contributions to electric/heat supplies if the environmental repercussions are fully taken into account.
- If the CO_2 problem does not become acute the world could quite possibly get by without additional nuclear capacity. This is pernicious because nuclear energy, arguably the greatest technological development of the second half of the 20th century, could begin to atrophy. If it were to be allowed to whither away, there would be no other source to generate electricity of sufficient substance if the CO_2 adverse climatic impact effect were to become real. There might be an opportunity to develop a near total recycle system (eg, an accelerator driven sub-critical reactor) or a 'fast burner' instead of a fast breeder, in plain terms, a waste-burning reactor. This could help to reduce fears related to radioactive waste and pollution proliferation. An

ETE 21 is an international network created to examine issues relating to energy, technology and the environment, and to help promote rational action in this field for the 21st century. ETE 21 recommendations aim to achieve sustainable energy consumption, based on environmental costing and life-cycle analysis.

absolute 'nil-risk' solution does not exist in the field of energy supply.

- The Chinese symbol for danger is a juxtaposition of the characters for 'threat' and 'opportunity'. With rapidly increasing concern about the pollutants caused by traffic congestion and normal consumption of energy the scope for technical fixes is increasing. A few of the obvious ones are:

In power generation and industry: combined cycle and CHP technologies, together with integrated gasification for coal (and even large-scale biomass where appropriate). Also fluidised bed and alternative sulphur removal methods.

In dwellings and commercial buildings the opportunities are too numerous to list, varying from total 'smart' houses, including active and passive solar systems to advanced windows to heat pumps, super-efficient lighting etc. Conflicting interests between builders, owners and many other parties can and should be reconciled.

In the transport and communication sector opportunities range from further technical improvements to internal combustion engines to totally new ultra-light weight hybrid vehicles (including flywheels) to intelligent highway systems/road transport informatics, telemantics (as a substitute for mobility) to sophisticated sensors and smart cards (for road/congestion pricing systems).

Policy issues

- Intervention with the free market (Adam Smith's invisible hand) should be avoided except in the event of demonstrable market failure.
- Traditionally clean air, water: 'nature's peace and quiet' were treated as 'free goods', without legal property rights or monetary value.
- Market failure can be demonstrated in relation to three environmental criteria, namely health, climate and congestion. Preservation of health and avoidance of congestion are predetermined problem areas and thus tangible objectives. Climate issues are, as yet, less tangible and should be considered a scenario variable.
- Public policy options to achieve some form of sustainable growth (definitions proliferate) range from education/persuasion (including voluntary industrial targets/agreements) to command and control (mandatory government intervention).
- Intervention in the market via the price mechanism ('greening' the invisible hand) provides a more flexible solution which fits in between the foregoing extremes. Such greening requires the introduction of environmental/social costing, a quantification of disbenefits or negative external impact (externalities) of, for example, pollutants. This is a radical departure from traditional accounting and brings environmental costs into the boardroom. Externalities can be made effective via fiscal instruments (green taxes) or tradeable permits, based on the polluter-pays principle, and are generally referred to as 'market instruments'. Willingness to pay may impose ultimate upper limits.
- Green taxes can be very target-orientated provided they do not destroy international competition; are fiscally neutral (eg, accelerated scrapping 'fee-bates', fee on old, rebate on new, more efficient vehicles); and show clear environmental/social benefits.
- An important environmental benefit is that externalities expressed as green taxes will level the playing field between fuels (eg, renewables versus nuclear) or technologies (eg, electric battery versus fuel cell cars or hybrid vehicles). They will need to be properly quantified (eg, to include all materials and energy flows) and handled on a cradle-to-grave basis (called full product life cycle analysis, or LCA). As externalities are in the eyes of the beholder, ie, are very much a matter of subjective judgement, it is unlikely that national political, let alone international agreement will be reached.
- A resilient strategy can still be achieved by using sensible qualitative judgement, instead of fully quantified externalities, when testing alternative strategies against environmental objectives. This allows trade offs to be compared and helps to prevent arbitrary decisions being taken, eg, that 'flavour of the month' technologies get locked in irreversibly. It also allows for moving the goal posts if the environmental objective changes, eg, if the scenario on climate change were to alter. It is better to be roughly right than exactly wrong.
- In conclusion, intervention, even via the market, should be used only when the environment can not be improved more efficiently by other means — and then only if it raises money that can be used to compensate for the disbenefits caused.

An Australian 'down under' juxtaposition of sayings goes as follows: you don't see the writing on the wall 'til you have your back against it. As most of us experience daily: the wall is not showing much give when it comes to congestion and pollution! Let us hope it will with regard to the CO_2 effect. ❑

The author

Born in The Netherlands in 1932, Hans DuMoulin has spent most of his career abroad, about half of it in the UK, where he is currently resident.

He obtained his doctoral degree in economic sciences and business administration with honours from Erasmus University in Rotterdam in 1956. Since then he has spent 34 years in the energy business, alternating between planning/advisory (staff) and executive (line) jobs.

Dr DuMoulin started with Esso (Imperial Oil) in the exploration and production function in Western Canada. He joined the Royal Dutch/Shell Group in the planning and economics division in London in 1959, and worked in various executive capacities in supply, trading, refining and petrochemical functions in Venezuela and Malaysia.

He was one of the seven founding members of Shell's think tank which devised the multi-scenario approach to energy planning in the early 1970s. This technique is still successfully employed in many private and state corporations and has also been adopted by Government departments, electricity boards and international institutions.

After the 1973 oil crisis, Dr DuMoulin was placed in charge of the energy economics division of the Shell Group planning coordination in London, concerned with oil/gas/coal and secondary energy economics globally. In 1981 he became senior planning adviser for the Asia Pacific region based in Singapore with Shell Eastern.

In 1984 he was invited to become a director of Petroleum Economics Ltd in London, and in 1986 was appointed chairman of the newly established PEL Pacific.

He is a member of the Strategic Planning Society, the Institute of Petroleum and the International and British Institutes of Energy Economics. He lectures to post-graduate students and business managers on strategic planning in the energy and related industries. And was appointed visiting professor at the University of Grenoble in 1990. He is also joint coordinator of ETE 21.

Dr Hans DuMoulin

Renewables update

*by R G Loram**

Geoff Loram is a member of both the Institute of Waste Management and the Institute of Energy. He has made regular contributions to *Energy World* on the subject of the NFFO scheme and energy from waste. Here he looks at the latest developments in waste incineration, following the announcement of the fourth renewables order.

THE LIFE of the would-be renewable energy developer tends to be somewhat erratic, due to the influence of the Government's method of operating the Non-Fossil Fuel Obligation (NFFO) scheme. A year ago the third renewables order was published, and the successful bidders should now be well into making their schemes a reality. To those who were not successful, together with newcomers and those with a continuing development programme, have been twiddling their thumbs since then, waiting for the Minister to announce the advent of the fourth renewables order — NFFO 4 — for England and Wales, which he did on 2 November.

The Minister proposes to make the order 'early in 1997', so developers are about to embark on a bout of furious activity to get their schemes designed and costed in detail over the next nine months or so, in order to be able to bid to supply electricity at a price they are willing to maintain (subject to indexing for inflation) for 15 years. There will be a further wait of about five months before the results of the bidding process are announced. It is assumed that this will coincide with the announcement of the fifth and final NFFO tranche. But slippage in timetables on the first four tranches deters one from being too optimistic.

For NFFO 4 there are some significant changes in the technology bands, which the orders are split into for bidding purposes. Wind power and small hydro are much as before, but the latter is defined as being below 5MW. Landfill gas projects are limited to those where tipping was being carried out prior to 22 July 1993 (does this presage the exclusion of LFG from NFFO 5?); and the energy crops/forestry waste band is now confined to gasification or pyrolysis plants. Agricultural wastes are out, unless they are used to produce a gas by anaerobic digestion, in which case they are allowed to include up to 20% of food processing waste, calculated on a dry basis.

Probably the most significant change has been made to the municipal and industrial waste band, which was by far the largest in NFFO 3 (39% of the total). This has now been split into two new bands: the first for projects using fluidised bed combustion (FBC) and the second is confined to CHP schemes. Both bands' projects can include up to 10% (on a dry solids basis) of sewage sludge. This would seem to indicate that conventional mass-burn type waste-fired plants generating electricity are only now considered to be well enough established for them to make their own way in the market place — not an unreasonable conclusion, seeing that the technology is some 25 years old. I am assured by those 'in the know' that when details are revealed in the DTI's Renewable Energy Bulletin (no 6) it will be seen that they are not, in fact, excluded.

It will be interesting to see if, in the event, any new, large CHP projects — as opposed to adding a heat element to existing plants, such as SELCHP and Nottingham — are proposed in this tranche. Large waste burning plants produce a large quantity of heat, and it is often difficult to find adequate outlets within an economic distance from the plant. Apart from some cases where there are some conveniently sited users of process heat, the infrastructure needed tends to be both extensive and expensive and, even if there was a favourable situation to hand, it seems doubtful whether the considerable amount of planning and negotiations involved could be completed in the NFFO timescale. There may be some smaller scale CHP schemes based on industrial wastes, as at least one manufacturer is interested in funding, installing and operating such schemes.

The introduction of a separate band for plants using FBCs is rather curious, as proposers have always been at liberty to use this technology, indeed, some have done so. Since they are inherently more efficient than mass-burn incinerators, they should easily compete in the marketplace once the timid, conservative British establishment plucks up the courage to use a technology that has been in successful use in other countries for more than a decade.

Back in 1991 the scientific and technical committee of the Institute of Waste Management (IWM) set up a working party to consider the use of FBC for burning municipal wastes, and after four years of deliberation the Institute published a report on the subject earlier this year. That the report is positive in its conclusions demonstrates that FBCs have a number of significant advantages over mass-burn incinerators. That the four years spent examining the wealth of information that is available on FBC — including its application to wastes — did not result in a better document is unfortunate. For instance, the major advantage of increased boiler efficiency is not mentioned at all, even though the reasons for that increase are listed. The current UK energy from waste (EfW) plants at SELCHP and Tyseley reckon to generate 0.5MWe from a tonne of MSW, but an FBC plant would expect 0.7MW, and hope to achieve 0.75MW. Assuming similar capacity and operating costs (the report offers no comparison) a potential 40% - 50% increase in income could have a dramatic effect on generating costs.

The IWM incinerator special interest group, which it was suggested should change its name to special interest group on waste to energy, held its fifth workshop at Dunchurch, near Rugby on 1 November, and attracted more than 40 delegates. The menu consisted of a series of short presentations of papers of varying length and complexity, some of which were of considerable interest. Lars Fritz of L Fritz Technology gave a paper on 'Computers as an aid to combustion optimisation' which included a short section on IR scanning of grates for the better control of

*Energy from waste & waste disposal consultant

combustion. This is a technology which has been developed slowly since early trials at Essen-Karnap in Germany in 1988, but which seems to be arousing more interest recently.

Another interesting paper was an account by Mr N Stacey of the retro-fitting of up-to-date flue gas cleaning and combustion control equipment at the Coventry waste-to-energy plant. After a careful evaluation and tendering process, a fairly simple dry lime injection and fabric filter process was chosen. This entailed fitting a finned-tube economiser to bring the flue gas temperature down to 140°C, which yields a bonus of increasing the energy output.

Prof Andrew Porteous gave those who did not get to the IWM's annual conference in Torbay another chance to read his 'Overview of selected topics on waste to energy' and to hear his usual pithy and ebullient comments. The first part of his paper demonstrated why recycling and energy recovery, far from being rivals, are compatible technologies, and that recycling combustible material will only be out of the waste stream for one or, at the most, two cycles. The second part presented valuable data demonstrating what a very small proportion of total emissions to air those from incinerators represented in 1991 and how he estimated that they would be negligible by the year 2000.

The Professor's positive and commonsense approach was in stark contrast to an earlier presentation by Frank Farell of HMIP. His theme was to warn of yet stricter emission controls, without apparent scientific justification. He put forward the view that if emissions from plant burning hazardous waste could be held to even tighter limits than MSW-burning plant, that should be considered BATNEEC for the latter and those limits enforced instead of those laid down in IPR 5/3. There is a sort of logic in that, but it is totally illogical not to say that those limits should also represent BATNEEC for all combustion plant, however fired. That would raise some howls of dismay from the coal and oil lobbies, but what price level playing fields when it comes to renewable energy trying to compete in the market as the Government expects it to?

Clean up the environment — burn waste

This rather tongue-in-cheek sub-heading does not refer to the comments on emissions limits made above — though it might well do — but to a planning application by Warwick International, a chemical manufacturer at Mostyn, Clwyd, to build a waste incinerator. This caused a deal of uniformed and emotional protests where I live, five miles away across the Dee estuary. Investigating the matter for a local conservation society, I discovered that the waste consisted of tank-bottom residues from the company's process (it makes special additives for soap powders and detergents) and that it was a mixture of uncontaminated hydrocarbons. This is currently landfilled, but the company looked at the CV of 24MJ/kg and sought out a means of burning it, so as not to waste that energy. Their process steam is raised in heavy fuel oil fired boilers and the new plant, which will burn 24 tpd of the waste, will replace about 10% of the oil-fired capacity. HMIP informed me that they would prefer it to be burned rather than landfilled, and pointed out that the flue gases would be very clean, apart from a modest amount of NOx and a considerable improvement on the flue gas from the heavy fuel oil with its sulphur and heavy metals.

I hope, with the company's assurance, to present a more detailed report on this interesting scheme when it is a bit further advanced. ❑

Key stage for Windscale AGR

PROJECT WAGR, to decommission Windscale's advanced gas-cooled reactor (AGR), became visible across the Cumbrian skyline recently, as the first of four heat exchangers was lifted clear of the 'golf ball' sphere.

The operation to lift out the first of the components which acted as massive water boilers marked a significant success for the engineers and experts who had meticulously planned the exercise.

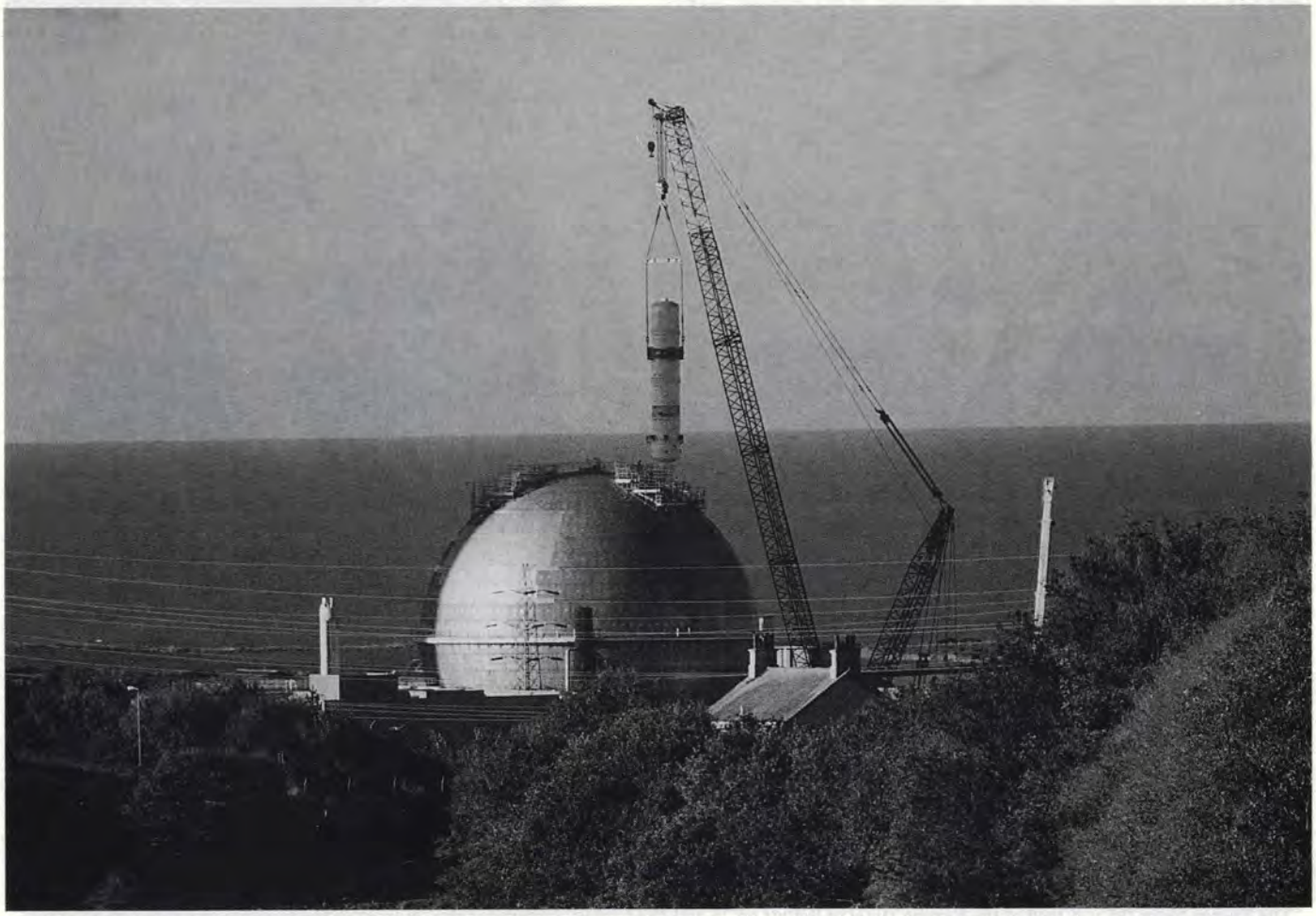
One of the largest cranes in Europe, with a lifting capacity of 1000 tonnes an an 84 metre boom, slowly removed the 190-tonne heat exchanger from the silver dome as press and TV cameras trained their lenses on the landmark stage of decommissioning.

The 20.4 metre-long heat exchanger was loaded onto a special transporter, having been cleaned, swabbed and sprayed with special weatherproof coating. Later, it was secured and covered ready for transport to the BNFL low-level waste store at Drigg, ten miles away.

The three remaining heat exchangers will also be removed via holes cut in the spherical roof of the reactor and laid horizontally on the transporter with the help of a second crane and transported separately by the same route, via the villages of Calderbridge, Gosforth, Holmbrook and Drigg.

The planning and preparation work for Project WAGR included the design of the two 13.2 tonne lifting attachments; preparation of the heat exchangers for the lift, including the removal of exterior pipework, sealing of residual openings and the spraying of the heat exchangers to 'fix' any loose contamination. Planning, risk assessment, management of subcontractors and procurement also had to be carried out, along with testing and strengthening of the ground and road surfaces, including identification of underground services, to ensure that they would be capable of holding the crane and the transporter. The final piece of preparation was the cutting of access holes in the roof of the reactor. To ensure the highest degree of safety during the lift, AEA Technology, responsible for Project WAGR also oversaw the construction of flexible membranes connecting the bioshields on top of the heat exchangers to the underside of the WAGR roof. This means that lifting is carried out in an enclosed environment.

The cost of decommissioning WAGR, from shutdown in 1981 until the current phase is completed, with the removal of the core and heat exchangers, is projected to be about £80 million. Funding is from the DTI, Nuclear Electric, Scottish Nuclear and the EC. ❑



Lifting out the first heat exchanger from Windscale's advanced gas-cooled reactor, as part of the decommissioning programme being managed by UKAEA Government Division.

Entries invited for new waste award

VILNIS VESMA (Member) and his company is launching a new ongoing competition, in association with *The Resource:* the National Waste Avoidance Awards.

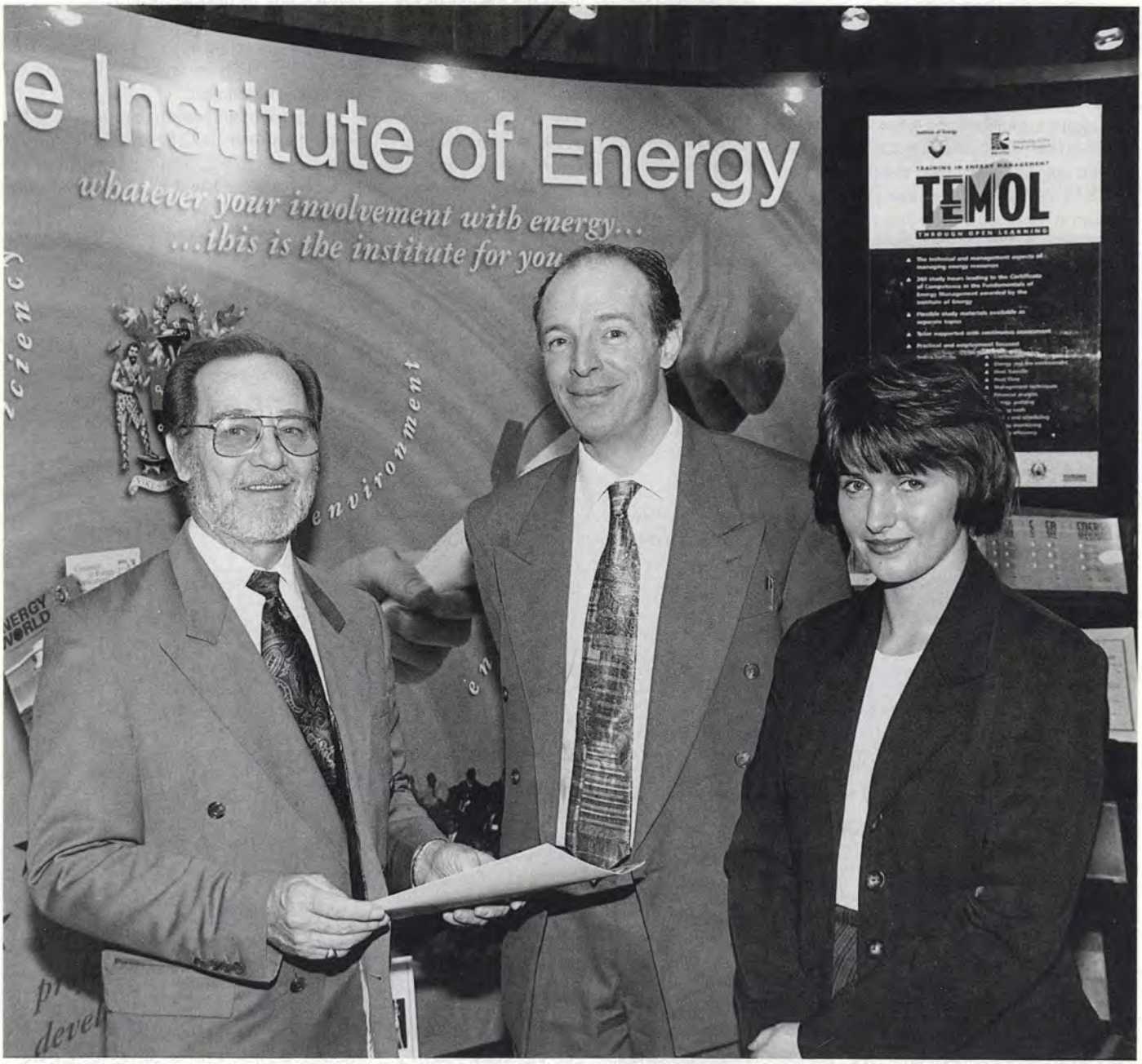
The object of the awards is to recognise the efforts of those who reduce the consumption of resources at little or no cost, by detecting and eliminating avoidable waste. Avoidable waste is defined as 'any excessive consumption of resources arising from a cause which is quickly rectified at little or no cost, without disruption and with no loss of service in terms of production output, comfort, quality or safety.'

Entries are invited from all those responsible for the management of consumable resources and awards will be assessed in two classes: employees of end user organisations; and specialist advisers. The awards will then be made to those entries showing ingenuity in methods of detection; effort in organising a formal regime of waste avoidance; and the best object lesson for others. Further information available from Donna Petherick, fax: 0171 354 8106

Calling Sheffield alumni

THE University of Sheffield's Chemical Engineering and Fuel Technology Society organises both social and sporting events within and outside the University.

The CEFT Society annual dinner dance will be held on 24 February at Novotel in Sheffield, and readers who are graduates of Sheffield University are invited to attend. Further details are available from Sonia Hayes, fax: 0114 2780611.
e-mail: S.Hayes @ Sheffield.ac.uk



The Energy Show '95 was held at the Europa Hotel in Belfast on 25 and 26 October. Pictured above, in front of the Institute of Energy stand at the show, are (from left to right) Jim Leach, Secretary of the Institute of Energy, Andy McCrea, Chairman of the Northern Ireland branch, and Louise Evans, Projects and Marketing Manager for the Institute.

23rd Idris Jones Memorial lecture

THE 23rd Idris Jones Memorial lecture, organised by the South Wales and West of England branch of the Institute of Energy, has been announced.

Sponsored by the National Grid Company plc, the 1996 lecture will be given by its Chairman, and President of the Institute of Energy, David Jefferies CBE FEng.. His subject will be 'The highways of power and their role in the energy markets'.

The lecture is to be held this year, as in several previous years, in the impressive setting of Cardiff Castle, on Friday 22 March at 11 am (coffee and reception at 10.30 am). The lecture will be followed by the branch annual luncheon at 12 for 1 pm.

Admission to the lecture is free, but those wishing to attend should apply for tickets. Tickets to the luncheon should also be applied for, and will cost £8 per head, inclusive of coffee, pre-lunch drinks and wine with the meal. Tickets will be issued in early February. Apply in writing, with cheques made out to The Institute of Energy, to: Mr David Suthers, 2 Danybryn Close, Radyr, Cardiff CF4 8DJ.

David G Jefferies CBE FEng, President of The Institute of Energy will deliver the 23rd Idris Jones Memorial lecture. Previous years' lectures have been given by Keith Nelson (British Gas), John Collier (Nuclear Electric), Dr R J Batterham (CRA, Australia) and Jeremy Attree (Electricity Association Technology, Capenhurst).

Branch events

January 1996

Northern Ireland

6 January

Visit to NIGEN, Kilroot power station. Contact: Dr Patrick Waterfield, tel: 01232 364090

Midland

Thursday, 11 January, from 6.30 pm

'Buying electricity in the contract market' by Mr M Warrander, Utilities Co-ordination Executive, Allied Domecq Ltd. Snr Common Room, Aston University, Birmingham. Light buffet from 6.30 pm, lecture starts at 7 pm. Contact: Mr D E A Evans, tel: 01384 374329.

London and Home Counties

Thursday, 18 January for 6 pm

Presidential address at the Royal Institution, Albermarle Street, London. Contact: Colin Rigg, tel: 01245 493131, ext 3298.

S Wales & W of England

23 January, 6.30 pm for 7 pm

'Energy matters in Sainsbury's' Mr I Williamson, Senior Manager, Building Services Engineering, Sainsbury's. Training room, Sainsbury's, Llewelyn Road, Cwmbran. Contact: Mr Biffin, tel: 01443 480480.

February

East Midlands

Date to be confirmed

International Combustion Derby. Contact: Mr G Thornton, 50 Ontwoods Drive, Loughborough, Leicestershire.

Northern Ireland

Date to be confirmed

PV in buildings dissemination seminar. Contact: Dr Patrick Waterfield, tel: 01232 364090.

Midland

Thursday, 1 February, from 6.30 pm

'The relationship between global warming and energy usage' by Mr J Wright, Birmingham Centre for Climate & Atmospheric Research. Snr Common Room, Aston University, Birmingham. Light buffet from 6.30 pm, lecture starts at 7 pm. Contact: Mr D E A Evans, tel: 01384 3744329.

Scotland

6 February, from 6.30 pm

'Young Engineers Evening' Napier University, Merchiston Campus, 10 Colinton Road, Edinburgh. Contact: Mr Hannah, tel: 01389 765177, ext 348.

Yorkshire

Wednesday, 21 February, from 2 pm

'Hazards of offshore rig operation' by Mr J King, held at Leeds University. Contact: Mr Mallalieu, tel: 0113 2768888.

S Wales & W of England

21 February, 11 am - 4 pm

Visit to Spirax, Cheltenham (buffet included). Numbers are limited, so reserve places by contacting Mr Biffin, tel: 01443 482231 at the University of Glamorgan.

March

East Midlands

Date to be confirmed

British Oxygen, Scunthorpe. A tour of the works. Contact: Mr M Allen, tel: 0115 9815879.

Yorkshire

Date to be confirmed

A visit to PowerGen's Killingholme gas-fired power station. Contact Mr Mallalieu, tel: 0113 27768888.

Midland

Thursday, 7 March, 7 pm

Branch visit to Messrs Smith, Stone and Knight Paper Mills, Birmingham. Contact: Mr D E A Evans, tel: 01384 374329.

Yorkshire

12 March from 7.30 pm

Held at Cedar Court Hotel, Wakefield. Joint meeting with the Institute of Petroleum. Topic to be advised. Contact: Mr Mallalieu, tel: 0113 2768888.

S Wales & W of England

Wednesday, 13 March from 5.30 pm

Young Members' Technical Papers Evening. Graduates and students compete for prizes by presenting an energy-related project. Held at SWEB HQ, Almondsbury, Bristol. Prospective candidates should contact Mr Simon Wilce by 1 January with a proposal. Contact: Mr Biffin, tel: 01443 482231.

Yorkshire

Wednesday, 20 March from 2.30 pm

'Industrial explosions' given by Jeff Lund, HSE, Buxton. Swallow Hotel, Rotherham. Contact: Mr Mallalieu, tel: 0113 2768888.

Restricted appeal

'Steam Plant Calculations Manual' by V Ganapathy, second and enlarged edition. Published by Marcel Dekker Inc, New York, 440pp, $69.75.

THIS book is one of a series of about 90 volumes covering many practical engineering topics, including several on energy-related subjects. They are targeted on students and non-specialist engineers.

The text takes the form of questions and answers. Some of the questions are simple, requiring just a formula, while others are complicated, requiring an assumed answer and a check that the answer fits, eg, a boiler circulation estimate.

In these days of computers the temptation, particularly when time is pressing, is to feed numbers into the machine and accept, without adequate checking, the answer provided. Little understanding of the engineering behind the calculation can be acquired in this way.

So this book, and, presumably, some of the others in the series, at least partially fill the gap. If the problem the engineer has to solve is one covered by the book, he/she can turn to that section and quickly check the computer answer. However, the level of background information behind the formulae given differs greatly from problem to problem, often just a formula with no explanation is given, but in many cases there is a useful summary of the technical issues associated with that problem. As is only too prevelant in the academic approach, there are generally no indications of the level of accuracy associated with the calculations. Some arithmetic in engineering has an accuracy of ± five or 10%, while others (two-phase pressure drop, for example) may be, at best, no better than ± 20 or 30%.

The calculations used are standard form, for example, Grimison (strangely called Grimson in this volume) for cross-flow pressure loss and heat transfer. Here I would draw the author's attention to the excellent and comprehensive work on both bare and finned tubes, of Zukanskis in Lithuania, published in two volumes. On two-phase pressure loss the correlation derived from the careful work of John Thom at Cambridge is used and the 'burn-out' correlation is that of Macbeth who worked at Winfrith.

For users outside the US the main drawback to this book is that only the American form of British units (although the 'long' ton rather than the more usual 'short' 2000lb ton is used) are employed. With the rest of the world wedded to SI units this must restrict the potential appeal of this book, as well as making many of the examples more complicated than they need be.

N G Worley

A healthier future

'Environmental Management — Issues and Solutions' edited by Michael Atchia and Shawna Tropp. Published by Wiley, 241 pp.

THE contents of this book have stemmed from a series of seminars on environmental management, organised by the United Nations Environmental Programme (UNEP), bringing together input from experts in 25 developing countries. Some 50 authors have contributed and so the contents provide the reader with an update in the following main areas:

- intellectual foundations of sustainable development;
- basic principles and processes in ecosystems;
- basic environmental tools, including programme prototypes and funding possibilities;
- specialised themes and strategies for environmental management.

The book admits one failure and that is, like all subjects dealing with scientific concepts and activities, it will like many before it succumb to the passage of time. Nevertheless, the book does contain much that is very relevant to the present time and the foreseeable future by the presentation of a number of fundamental propositions.

Environmental concern is said to have become manifest in the 1950s, although with a few exceptions, voices of alarm were not paramount until much later, and certainly the governments of the western democracies paid only lip service to these concerns.

It is only now that the rich countries of the world are beginning to focus more on the deterioration of the environment which the poorer nations perceive only as aesthetic. The Stockholm conference of 1972 began to examine actively what needed to be done, while the Rio Summit of 1992 was the first to which many nations ascribed to with the adoption of an agenda for a better and healthier future.

Eur Ing F John L Bindon

Differing outlooks

'Energy from inertial fusion' edited by W J Hogan. Published by the International Atomic Energy Agency, Vienna, Austria, 1995, 450 pp.

WORK on nuclear fusion commenced in the 1960s and has proceeded cautiously to the state where before long, a modest $30 billion is needed for the demonstration power plant. Fusion is not a chain reaction, like the present use of nuclear fission. If successful, this will lead to safer and more efficient generation of nuclear power because there will be much less inherent production of radioactive substances, and hence of discharges. It will be a major chance to cut down on the use of fossil fuels with their effluent of ash and carbon dioxide, required by OECD to be cut by the year 2010, with major global reduction by 2050.

There are chapters on the physics of inertial confinement fusion (ICF); inertial fusion energy (IFE) power plant design, so large as to be divided into four main components: driver, reactor, target factory and ROP (remainder of the plant NOT Russian Oil Petroleum). The smaller moiety has chapters on special design issues, the development strategy, safety and environmental impact, economics and figures of merit, other uses of inertial fusion, concluding with a short chapter on international activities. Conclusions are presented after major sections which will enable the reader to grasp the drift of the discussion. Like all new technology it could have been enhanced by a glossary of the abbreviations and acronyms that have already been generated. The editorial effort to put this into a cohesive whole has been a mammoth task in itself.

The book is financially supported by IAEA and UNESCO. It has a wonderful example of an editorial disclaimer, probably because the 122 member states supporting IAEA may have differing outlooks. There are 83 authors from 10 countries, with 560 references, 126 figures and 31 tables. It is intended for the engineer, policy maker, scientist, student and technologist, and is thoroughly recommended to members of the Institute of Energy as a document for continuing professional development.

Nigel Gwyther

Recently published

'Financial evaluation of environmental investments' by Tuula Moilanen and Christopher Martin. Published by the IChemE, October 1995, 180 pp, £38.00. Available from IChemE, Books Sales, 165-189 Railway Terrace, Rugby CV21 3HQ. Tel: 01788 578214; fax: 017788 547262.

'The EARA Register of Environmental Auditors' edited by David R Thomson, Ruth A Bacon, Julie P Tarling and Suzie J Baverstock. Published by Earthscan, May 1995, £50.00. Available from Earthscan, 120 Pentonville Road, London N1 9BR. Tel: 0171 278 0433; fax: 0171 278 1142.

Reporting of clean coal technologies

John Hunter argues for development of his idea for a rotary coal gasifier (RCG) system for clean, coal-fired electricity generation (*Energy World*, October 1995). He compares his idea to the air-blown gasification combined cycle (ABGC) system which was once called British Coal's topping cycle, and is now nearing the commercial demonstration stage of its development. But he makes some critical errors concerning ABGC.

ABGC utilises fluidised beds, and sorbents (eg, limestone) can be added to them with the coal. This reduces the output of sulphur oxides (SOx). The residence time of the SOx in the beds provides sufficient time for the sorbents to capture the sulphur for removal with the coal ash. But the RCG system cannot use sorbents in this way because the residence time of the SOx and the sorbent would be too short. Hence, RCG would require expensive flue gas desulphurisation (FGD) equipment.

FGD adds about 20% to the capital cost of a conventional pulversied fuel (PF) coal-fired power station, and it adds about 10% to the cost of electricity from a PF plant. John Hunter claims the RCG system would have lower capital costs and be more efficient than PF. If this is true then the relative costs of FGD would be higher for RCG than for PF.

The RCG system also needs to use crushed coal. Mr Hunter claims this affords an advantage over ABGC. But htis is simply not so. Crushing and grinding coal costs money. ABGC can use large size coal which reduces costs of coal preparation; and ABGC can accept coal with very high ash content which further reduces coal preparation costs in some circumstances. Indeed, ABGC can use 'run-of-mine' coal as a fuel which would afford substantial benefits to an ABGC plant situated at a coal mine.

He also claims that RCG has an 'expected carbon efficiency of 0.90 thus eliminating the need for a separate char burner as is required in the (ABGC) system'. But ABGC has a conversion efficiency of between 0.8 and 0.9, and its char is the 0.1 to 0.2 of the coal which it does not convert. The burning of this char provides a substantial benefit to the ABGC system which uses a unique combined cycle.

A turbine cycle converts energy of a fluid to mechanical work. A gas turbine cycle uses gas turbines, and a steam turbine cycle uses steam turbines. Some energy remains as heat in the exhaust fluid (ie, gas or steam) from a turbine. A combined cycle uses the heat exhausted from a gas turbine to boil water into steam for supply to a steam turbine.

A turbine operates at maximum efficiency when it removes as much heat from its working fluid as possible, and this means that the fluid's temperature must be lowered as much as possible when it passes through the turbine. Materials exist which allow gas turbines to accept much high temperatures than steam turbines. For this reason, gas turbines can lower the temperature of their gas more than steam turbines can lower the temperature of their steam, so gas can be more efficient than steam turbines.

The potential efficiencies of gas and steam turbines are not as greatly different as could be thought. This is because steam has higher thermal capacity than gas, and the turbine output temperature can be cooler for steam than for gas. These facts enable combined cycles.

The minimum output temperature of a gas turbine is less than the maximum input temperature of a steam turbine. And the exhausted gas from a gas turbine cannot heat steam to a temperature higher than it has itself. Hence, in a conventional combined cycle either the gas turbine output temperature must be higher than it could be (and so the gas turbine efficiency is less than is possible). In practice, a balance is struck. The gas turbine and the steam turbine both operate at less than maximum possible efficiency, but they each work at the optimum efficiency to maximise the efficiency of their combination. This conventional combined cycle is more efficient than a gas turbine cycle or a steam turbine cycle.

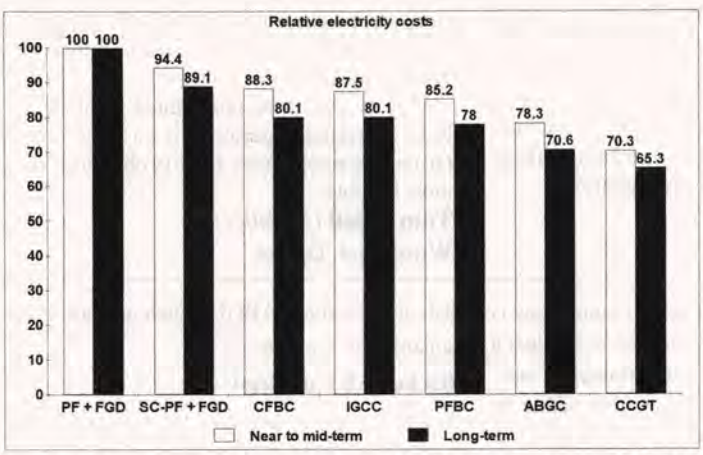
ABGC also uses a combined cycle but not a conventional one. Uniquely, ABGC operates both its gas and steam turbines at maximum efficiency.

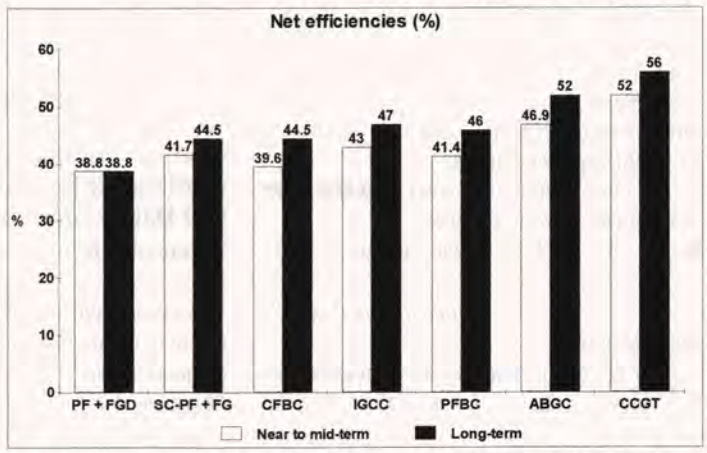
ABGC uses a spouted fluidised bed gasifier which is supplied with air to convert over 80% of its coal feed to a combustible gas. The unconverted coal becomes a char which is burnt in a fluidised bed combustor. The combustible gas is burned and used to power a gas turbine which operates at its maximum possible efficiency. Exhaust heat from the gas turbine is used to boil water, and the resulting steam is superheated by the fluidised bed combustor. This superheated steam then operates the steam turbine at its maximum possible efficiency. This provides ABGC with higher efficiency than any other proposed clean coal technology.

There are several novel clean coal technologies for power generation which are being demonstrated at commercial scale or are nearing this stage of development. These are: supercritical pulversied fuel (SC-PF); integrated gasification combined cycle (IGCC); circulating fluidised bed combustion (PFBC); and air-blown gasification combined cycle (ABGC). These new technologies for coal-fired generation will have to compete with each other and — importantly — they will have to compete with combined cycle gas turbine (CCGT) power stations burning natural gas.

A study by the UK DTI has determined that the existing design for ABGC has significant cost advantages over other coal-fired power generation systems, is the only generation system capable of competing economically with gas-fired CCGTs in the foreseeable future, and is capable of several generations of developmental improvement. A recent independent assessment by Stone and

(continued on page 22)





Left:Relative costs of electricity from clean coal technology and CCGT power stations now and in the future, assuming no change to the relative costs of coal and natural gas. Right: Net efficiencies of clean coal technology and CCGT power stations now and in the future.

Windy words

FOR the past year we have been treated to an interesting debate in these pages about the future of various forms of fuel and power generation. At times it has been more entertaining than illuminating, when some contributors to the debate have felt compelled to become a bit overly ardent in their advocacy of their favourite technology. The metaphorical playing field seems to slope both ways at once, depending on who is looking at it!

Members of this Institute are mainly scientists or engineers, and as such we must be seekers after the truth: scientists because that is the very purpose of science; and engineers because if we don't we can get things wrong, and our sins will be visited upon us. We need, therefore, to resist the temptation to let our commercial interests or personal enthusiasms influence our arguments. Whether someone once said, a long time ago, that nuclear power could become too cheap to be worth metering is as irrelevant to the debate as comparing the 'apple' of the energy density of a windfarm with the 'pear' of the energy density of a conventional power station. The use of irrelevant arguments merely indicates to the unbiased reader the probable lack of sound, logical arguments that are relevant.

Examine the pleadings of the Coalfield Communities Campaign in November's Viewpoint, coal might provide the cheapest power on an historic cost accounting basis, but would that be true with current cost accounting? Very doubtful. They say Orimulsion should be banned, but why? Why not just impose emission limits on the SO_2 and heavy metals?

In this spirit of true scientific enquiry, let me ask Prof Swift-Hook some specific questions. How much wind energy capacity does he consider can be installed before it is necessary to make provision for alternative generating capacity to be available specifically to replace the wind-farm capacity when the wind does not blow, or blows too strongly? Obviously, whilst wind-energy remains a fringe generating activity, the normal reserve capacity can probably cope, but the Professor has much greater ambitions for it, and it is incumbent upon him to answer this question. I have in mind particularly the winter of early 1991, when there were three very cold weeks, due to a big area of high pressure sitting over the country, during which time no wind-powered electricity would have been generated at all. Going further, who would be responsible for ensuring that such capacity was, in fact, available? What would be the likely cost of such stand-by power, and would he not agree that any extra cost ought to be aggregated to the cost of wind-energy? I await his reply in these columns with interest.

R G Loram *(Member)*

Renewables versus fossil fuels: the debate continues

I WOULD be pleased to know that safe and affordable energy will be available for future generations, in what will still be a green and pleasant land. However, I have yet to be convinced from what I have read in *Energy World* that wind turbines will be economically viable.

We have been told a price for wind turbines, but not whether this is an ex-works price or the total installed cost, with all associated equipment and including any government subsidy. If it is the latter, then the advocates of wind turbines would surely have made this clear.

We have been told the rated outputs of wind turbines. It is not made clear that the rated output is produced only at the maximum acceptable wind speed above which the output must be restricted to prevent damage, and below which the output reduces rapidly as wind speed reduces, according to a cube-law relationship.

There is I imagine, enough experience available by now for the advocates of wind turbines to clearly show that they are viable by producing such data as:

- the rated outputs and total installed costs of a number of wind turbines;
- the total metered annual outputs of those turbines over, say, three successive annual periods;
- the sums paid for those outputs assuming the rates paid to be the same as those paid to a power station;
- the total annual running costs, including interest (without government assistance), insurance, depreciation, maintenance, labour and administration.

If by some miracle wind speeds were high enough to produce the rated outputs at all times, it would require 8000 wind turbines of 250 kW rated output to replace one typical power station. At a quarter of that wind speed, about 6.5 mph, described on the international scale as a 'light breeze', a wind turbine would continue to run after using a starter motor and would generate 1/64th of the rated output. Allowing for transmission losses there would be just enough to boil a kettle and make a pot of tea!

One might wonder would the impact of thousands of wind turbines, scattered over the countryside, be justified by the relatively small and unpredictable contribution these would make to the electricity supply?

G D Daniel *(Member)*
Sevenoaks, Kent

LPG versus CNG

With reference to the article in *Energy World,* October 1995 'On the road with natural gas', it is unfortunate that the article was restricted to compressed natural gas (CNG) only, as liquefied petroleum gas (LPG) has almost identical environmental benefits, without the disadvantages associated with CNG.

The problem with CNG is that it does not liquefy under pressure and therefore very large and heavy storage tanks are required and the range of operation is substantially limited. On the other hand LPG liquifies under very modest pressure and therefore a large amount of energy can be stored within a small space. For a given range the storage space required for LPG tanks is less than one third of those for CNG and, being at a substantially lower pressure, the weight of the storage tank is many times less than that for CNG.

An extensive research programme was recently undertaken by TNO in Holland to compare the alternative motor fuels of petrol, diesel, LPG and CNG. The conclusion reached by TNO is as follows:

'The results of the programme point clearly to a general superiority if gaseous fuels. Of these gaseous fuels LPG is obviously the most feasible.'

Tom Fidell *(Member)*
Wimborne, Dorset

(continued from page 21)

Webster agrees.

John Hunter is working to popularise his RCG system, and it is sensible for him to compare his system to the existing best clean coal technology. But the comparison should be fair, accurate and reasonable.

A consortium of commercial companies is trying to obtain the funds needed to conduct a demonstration of ABGC at commercial size. Obtaining funds to develop a clean coal technology is difficult, especially in the UK. In these circumstances, prestigious journals have a responsibility to ensure they only publish articles about ABGC which are fair, reasonable and accurate.

Richard S Courtney
Science and Technology Spokesman
British Association of Colliery Management

Engineering for life

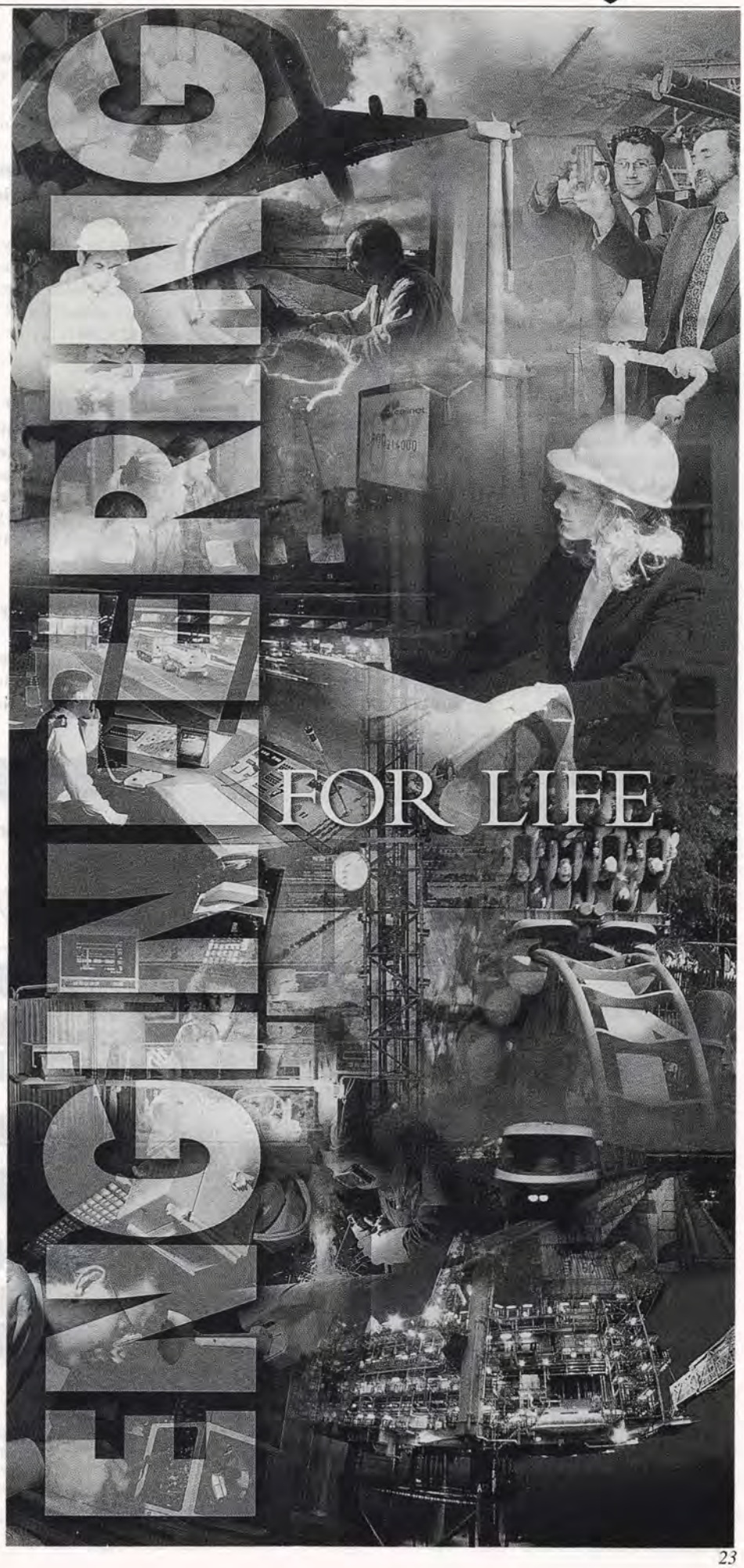
THE contribution that engineering makes to the quality of life is the key message of a brochure *Engineering for life* (pictured right) produced by the engineering profession to support a special BBC 2 television season celebrating engineers and their achievements.

The brochure challenges popular misconceptions about the role of engineers, highlighting in a straightforward manner the effect that professional engineers have on our day-to-day lives.

The brochure describes the many fascinating ways engineers shape our surroundings. Their influence on the environment, on our work and home, in communications, leisure and entertainment, health and transport are explained and there are many photographs of exciting engineering projects, including the Thames Barrier and a wind farm, and of engineers in action. Its conclusion is followed by a comprehensive list of contact addresses, including all the engineering institutions under the aegis of the Engineering Council.

The brochure has been produced by the engineering profession in conjunction with BBC Education with sponsorship from the Department of Trade and Industry, the Engineering Council, the Institution of Electrical Engineers and Nuclear Electric plc. It is endorsed by Action for Engineering — the Government initiative to harness engineering skills to improve the understanding of engineering's contribution to wealth creation.

A free copy of *Engineering for life* can be obtained via a phone line: 0891 221122. Calls are charged at 39p per minute cheap rate, 49p at other times.



18th Young Woman Engineer sought

YOUNG Woman Engineer of the Year award is in its 18th year. Since its inauguration in 1978, the IEEIE and The Caroline Haslett Memorial Trust, who jointly sponsor the award, have been delighted by the high calibre of entrants.

The 18th award will be made to a young woman, under the age of 30, who is able to prove her ability to hold a responsible position in the electronic, electrical or allied engineering field at Incorporated Engineer level. Contenders must also have successfully completed all the required technical education and training.

Nomination forms are available from The Secretary, IEEIE, Savoy Hill House, Savoy Hill, London WC2R 0BS, tel: 0171 836 3357. The award will be made at a special ceremony in January 1996.

January 1996

Electricity: gearing up for 1998
Conference, 9-10 January, London. Details from AIC Conferences Ltd, 2nd Floor, 100 Hatton Garden, London EC1N 8NX. Tel: 0171 242 2324; fax: 0171 242 2320.

Switchgear technology for power systems
A two-day course, 10-11 January, Capenhurst, Chester. Details from Ms Del Bennett, Course Administrator, E A Technology, Capenhurst, Chester CH1 6ES. Tel: 0151 347 2557; fax: 0151 347 2178. (Places are limited, the next course is set for 14-15 May)

Middle East Electricity '96
Exhibition, 14-17 January, Dubai. Details from IIR Exhibitions, Market Towers, 1 Nine Elms Lane, London SW8 5NQ. Tel: 0171 344 3888; fax: 0171 344 3829.

Economically Exploring and Developing the Atlantic Frontier
Conference, 15-16 January, Aberdeen, Scotland. Details from Claudia Stokes, EuroForum, 45 Beech Street, London EC2Y 8AD. Tel: 0171 878 6886; fax: 0171 878 6887.

Teach-in on the new CIBSE Code for Interior Lighting
Seminar, 24 January, London. Details from the Courses Secretary, Mid Career College, P O Box 20, Cambridge CB1 5DG. Tel: 01223 880016; fax: 01223 881604.

Power generation and supply (PGS '96)
Conference, 24-25 January, London. Details from IIR Ltd, 6th Floor, 29 Bressenden Place, London SW1E 5D. Tel: 0171 915 5055; fax: 0171 915 5056

The future for a European gas company
Annual conference, 26 January, London. Details from The Economist Conferences, 15 Regent Street, London SW1Y 4LR. Tel: 0171 830 1000; fax: 0171 409 3296.

CRINE '96: Learning to survive
A two-day interactive conference, 31 January - 1 February, London. Details from Conference Registrar, CRINE 1996 Conference, Conference Associates and Services International Ltd, 4 Cavendish Square, London W1M 0BX. Tel: 0171 499 0900; fax: 0171 629 3233.

Safety and environmental management in abandonment
Two-day international forum, 31 January - 1 February, Aberdeen, Scotland. Details from Claudia Stokes, EuroForum, 45 Beech Street, London EC2Y 8AD. Tel: 0171 878 6886; fax: 0171 878 6887.

Integrated Metering & Billing Systems in the Utilities Industries
Workshop, 31 January, London. Details from Eve Lawrence, SMi Ltd, 1 New Concordia Wharf, Mill Street, London SE1 2BB. Tel: 0171 252 2222; fax: 0171 252 2272.

February

Integrated Utilities
Two-day conference, 1-2 February, London. Details from Eve Lawrence, SMi Ltd, 1 New Concordia Wharf, Mill Street, London SE1 2BB. Tel: 0171 252 2222; fax: 0171 252 2272.

Canadian Energy Research Institute (CERI) North American Crude Oils and Liquids
Conference, 5-6 February, Calgary, Alberta, Canada. Details from CERI Conference Division, tel: + 403 282 1231; fax: + 403 289 2344.

Design and Manufacture
Short course, 5-9 February, Guildford, Surrey. Details from Mrs Margaret Morgan, Short Course Organiser, Department of Materials Science & Engineering, University of Surrey, Guildford, Surrey GU2 5XH. Tel: 01483 259378; fax: 01483 259508. e-mail: M.Morgan@surrey.ac.uk

Stack emissions: monitoring, modelling and impact assessment
Conference, 7 February, London. Details from SCI Conference Secretariat, 14/15 Belgrave Square, London SW1X 8PS. Tel: 0171 235 3681; fax: 0171 823 1698

Balancing customer and shareholder interests
Annual electricity conference, 19 February, London. Details from The Economist Conferences, 15 Regent Street, London SW1Y 4LR. Tel: 0171 830 1000; fax: 0171 409 3296.

Piping design, analysis and fabrication
Short course, 19-21 February, The Netherlands. Details from The Center for Professional Advancement, Oudezijds Voorburgwal 316A, 1012 GM Amsterdam, The Netherlands. Tel: +31 20 638 2806; fax: + 31 20 620 2136.

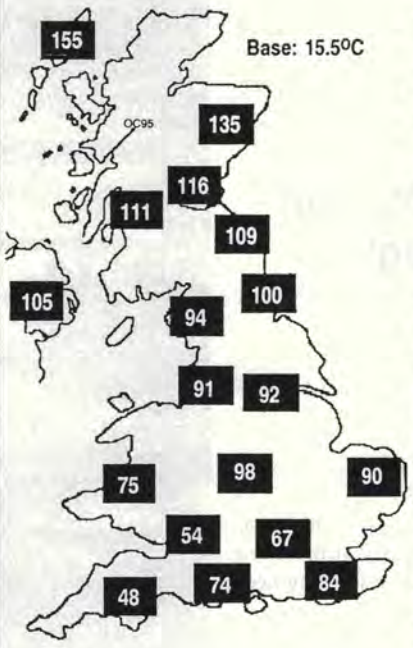
Emergency lighting — design and practice
Seminar, 26 February, London. Details from Courses secretary, Mid Career College, P O Box 20, Cambridge CB1 5DG. Tel: 01223 880016; fax: 01223 881604.

Worldwide deep water technologies
Two-day conferences, 26-27 February, London. Details from Helen Smith, IBC Technical Services, Gilmoora House, 57-61 Mortimer Street, London W1N 8JX. Tel: 0171 637 4383; fax: 0171 631 3214.

Blowers in industrial use
Conference, 28-29 February, Germany. Details from VDI-GET, tel: +49 211 6214 480.

DEGREE DAYS: OCTOBER 1995

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 (01531 821350)

 Note: the figures given here have been calculated to correspond as closely as possible with those published by government sources. However, because of differences in observing stations, close agreement cannot always be guaranteed.

● ADVERTISEMENT FEATURE ●

Steam turbine at heart of environmental power system

A steam turbine from UK manufacturer Peter Brotherhood Ltd is fulfilling a vital role in a new combined heat and power system fuelled by clinical waste.

The safe disposal of hazardous waste is a major problem for its originators. There is particular public concern over the disposal of clinical waste from hospitals and other medical facilities which is perceived as posing a major threat to health.

The Royal Bournemouth and Christchurch Hospital Trust in the UK has responded to new legislative controls on emissions and waste disposal by constructing a new waste incinerator at the Royal Bournemouth Hospital. As well as disposing of clinical waste the new facility will provide both electricity and hot water for the hospital as a by product of the incineration process.

The hospital trust selected White Rose Environmental — the waste management division of Yorkshire Water plc — to develop and run the new £3 million incinerator. White Rose Environmental operates the facility and sells the power, hot water and waste disposal service to the trust.

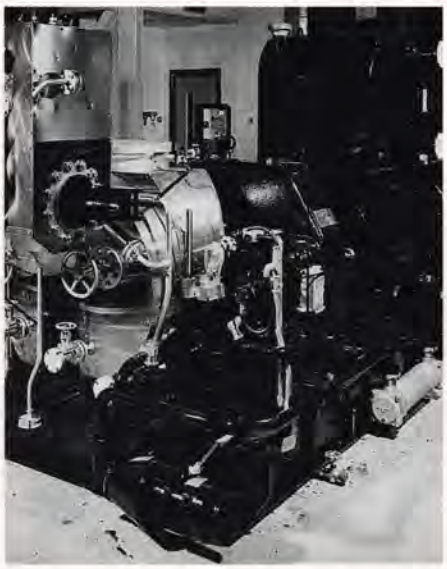
The primary objective of the unit is the safe disposal of clinical waste and a Peter Brotherhood steam turbine was selected because of the proven reliability of the company's equipment and its experience in 'waste to energy' projects.

The waste disposal facility can generate up to 500 kW of electricity by burning clinical waste from the hospital and other health care facilities in the region. Around half the power produced is used within the hospital — helping to cut its power bill — and the other half is used by the waste disposal facility itself.

The waste disposal and power generation plant also provides hot water for heating, washing and other purposes within the hospital, resulting in the hospital trust being able to cut its gas consumption by 13 000 000 kWh per year.

Recovering the heat from the combustion to generate electricity makes the unit 'environmentally friendly' but the decision to adopt this technique was taken purely on financial grounds. To make the project economic, Peter Brotherhood had to supply a turbine which met stringent technical specifications within a very tight budget. Overall the contract value was around £250 000 for the turbine, generator and control system and a separate vacuum condenser which provides hot water at about 80°C.

Reducing emissions was of particular concern to the hospital management and the local planning authorities. White Rose Environmental's new incinerator plant has considerably lower output of major pollutants such as particulate matter, heavy metals and dioxins — a group of chemicals which are regarded as a significant health hazard — than the old incinerator which it replaced. This is despite the fact that it is burning waste from a number of hospitals and health care establishments, whereas the old incinerator dealt only with the Royal Bournemouth Hospital's own waste.



The Peter Brotherhood steam turbine for the Royal Bournemouth Hospital in the company's works prior to shipment.

The incinerator burns the clinical waste at temperatures in excess of 1000°C. The fine ash which remains has less than 14% of the bulk of the original wastes and is disposed of in a specialist landfill site.

The incinerator at the Royal Bournemouth Hospital is just one example of a number of 'waste to energy' projects which have been completed in recent years.

Incineration is a particularly suitable process for the disposal of clinical wastes, because of their hazardous nature, but for non-hazardous materials it can offer the benefit of waste volume reduction.

Sewage is another waste material which is increasingly difficult to dispose of. EC regulations aimed at combating environmental pollution mean that by 1998 all sewage sludge produced in member states will have to be incinerated. Clearly there are economic as well as environmental benefits if the heat from the incineration process is put to productive use.

As part of the process of equipping its Beckton Sewage Treatment Works to meet the new legislative requirements — and to make effective use of the energy produced — Thames Water has built a £10 million combined heat and power system. It incorporates a 2.6 MW Peter Brotherhood steam turbine and two 4.1 MW gas turbines fired with methane gas produced as a by product of sewage treatment.

The steam turbine uses steam raised from the waste heat in the exhaust gases of the gas turbines. Exhaust from the steam turbine is condensed back into water in a multi-pass water-cooled shell and tube condenser, integrated into the turbine baseplate. The relatively hot cooling water is passed through heat exchangers in the sewage sludge digesters to increase the rate of methane production by raising the sewage temperature.

The steam conditions of the turbine have been chosen to be compatible with the need for future expansion of the system to incinerate sewage sludge.

To meet the needs of the waste incineration market for reliable and economic steam turbines, manufacturers such as Peter Brotherhood are developing improved design and manufacturing capabilities. Sophisticated computer modelling techniques such as finite element analysis, piping stress analysis and advanced process simulation programmes are used to test initial concepts, opening up a wider range of design alternatives.

Although each turbine is thus specifically designed to meet the customer's specifications, a modular form of construction enables standard, service-proven components to be assembled in various configurations to meet particular needs. This modular approach allows components to be manufactured for stock, thereby providing shorter delivery times and lower overall costs.

The problem of waste disposal is opening up new opportunities for innovative CHP-style schemes based upon reliable and well-proved steam turbine designs produced specifically to meet the needs of this market.

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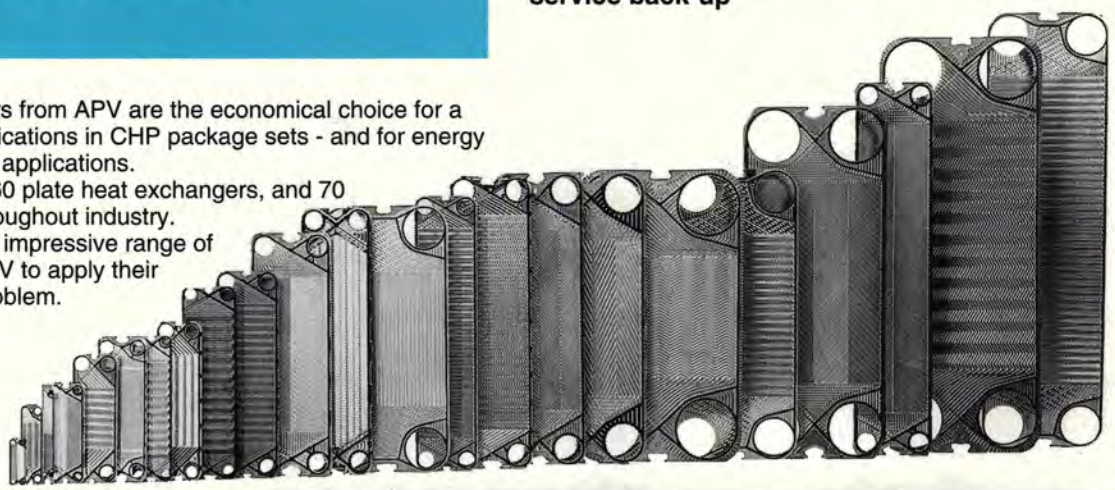

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