ENERGY WORLD

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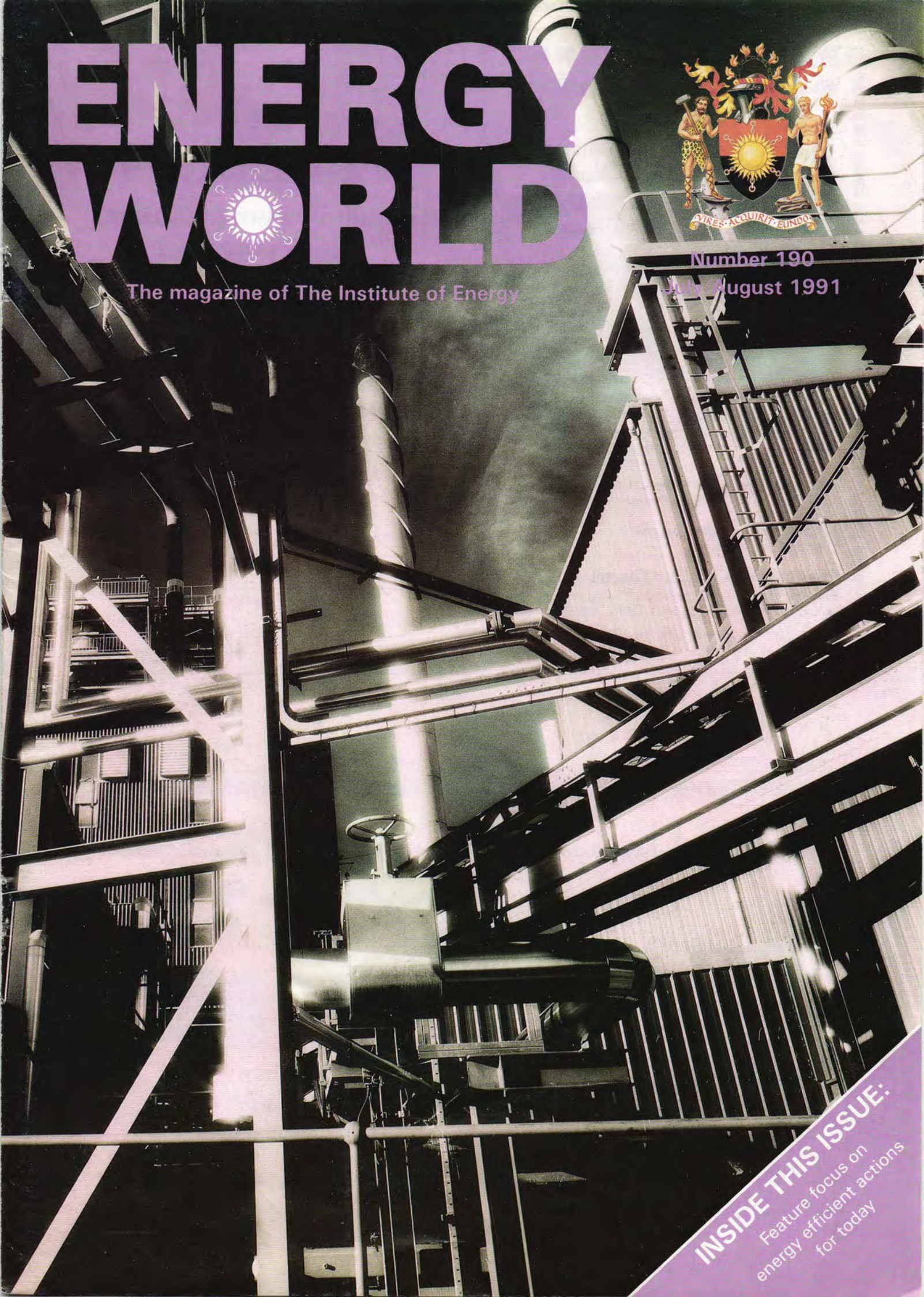

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Feature focus on energy efficient actions for today

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COVER

The combined heat and power (CHP) plant at Tunnel Refineries Ltd adorns the front cover of this month's *Energy World*. When the plant opened, in October 1990, it was part of the largest contract energy management deal to date in the UK. Emstar Ltd engineer, fund and operate the project, which comprises two 6 MW(e) Ruston Tornado gas turbines, two waste heat boilers and a 2.2 MW(e) steam turbine generator. Tunnel's requirements for both electricity and steam in large quantities made CHP the obvious choice at their process plant in Greenwich, where Emstar were able to utilise an existing boiler on the site. Emstar's Managing Director John Ashcroft delivered a paper at this year's Institute of Energy annual conference, a report of which appears in this issue.

The folly of avoidable waste

£4500 A YEAR wasted through unauthorised heating of a vacant building; £5000 a year lost because an access-ramp frost heater was running continuously; heat worth £6000 a year dissipated through idle boilers in a college hostel, simply because a manual isolating valve was not being used correctly; gas costing £10000 a year gone forever because a timeswitch had been bypassed; £20000 a year wasted in an oversized temporary vacuum pump while repairs to the duty pumps were unnecessarily delayed. It makes a dismal catechism, but these real examples of energy waste share one important attribute: they were avoidable. It cost little or nothing to put them right, and the savings — both financial and environmental — were immediate.

Easier said than done, perhaps. It is an inevitable fact of business life that you cannot cover every eventuality. Who has time and resources to check every timeswitch and valve under their jurisdiction? Whose job would it be to check regularly that heated access ramps are not unusually warm? Who knows where they all are, anyway? What if your production process is so big that a temporary vacuum pump with an 80kW rating can go in without the plant management knowing about it? Who knows what other random, unpredictable human or technical failure will strike next and cause another slice of totally unnecessary energy purchases? For that is what my examples represent: energy purchased for no useful end. Wasting money, causing totally needless pollution, wearing out plant and equipment, and giving the energy moguls further excuses for ever-fatter pay cheques.

There is an answer. Thanks to the power of the desktop computer, combined with a few common-sense analysis techniques applied to nothing more than routine meter readings, production figures, and degree-day counts, we can now detect the onset of avoidable waste reliably and promptly. The best available scheme can be operated by a clerk or secretary, and costs less to implement as a once-off charge than any one of my examples of waste would have cost (on a recurring basis every year) if they had been allowed to go on undetected.

I would say the time has come to turn our attention away from our preoccupation with energy-saving equipment — which we cannot afford anyway at current interest rates — and concentrate some effort on eliminating unnecessary purchases by using the new management tools now at our disposal. My five examples came from organisations which have gone down this track, but for every company which has tried it, there are a hundred which are still vulnerable to costly undetected changes in performance. Let's go after that avoidable waste.

*Vilnis Vesma MA CEng MInstE**

** Vilnis Vesma is a former staff member of the Institute who has worked as an energy manager and now specialises in software for energy conservation.*

EERC report boosts US coal and gas

A COMPREHENSIVE study of United States energy policy and technology by the Energy and Environmental Research Center (EERC) recommends increased development of coal and natural gas resources as a key step in breaking US dependence on foreign oil. The recommendation is one of several included in the document, compiled over a 15-month period by EERC researchers.

Data for the report was drawn from energy sources worldwide, including Europe, the Soviet Union, Australia, India, South Africa, and the Americas. It includes a detailed chronology of world energy events since 1969, analysis of energy-related developments, recommendations for future US policy in the coal, oil, and natural gas industries, and the status of emerging technologies.

The report also recommends a revival of nuclear power, accelerated development of renewable energy resources, and mandated conservation, as well as increased reliance on the abundant fossil energy resources of coal and natural gas, to create a broad-based US energy policy.

Go ahead for French PWR

IN JUNE EdeF gave the go ahead to Framatome for the first PWR unit of the new Civaux nuclear power plant in France.

The 1450 MWe 'N4' type Civaux 1 unit is scheduled to be commissioned in 1997.

Czech export treaty

A TREATY on co-operation between Czechoslovakia and Egypt in the area of energy production has been signed in Prague.

The treaty provides for exports of Czechoslovak power equipment, high voltage cables and network distribution frames as well as training for Egyptian personnel in Czechoslovakia. Payment for the plant and equipment will be partly compensaated by a delivery of consumer goods, textile, leather, aluminium, fruit, vegetable and other, mainly semi-finished products.

Towards international cooperation on safety

DR RENE LEVESQUE (left), president of the Atomic Energy Control Board of Canada, and his British counterpart, Mr Edward Ryder (right), chief inspector of nuclear installations for the Health and Safety Executive, signing an arrangement in London in July, continuing the cooperation and exchange of information between them. Looking on (centre) is the Canadian High Commissioner, the Hon Donald Macdonald.

International cooperation on nuclear safety is a vital element in maintaining high standards in the regulatory domain.

Under the arrangement the two sides exchange safety-related information about the regulation of nuclear installations for which they are responsible in regard to siting, construction, operation and decommissioning. The exchanges cover a broad range of issues, including legislation, codes, standards, criteria and guides; technical reports and safety assessments; and reports of incidents and reactions to incidents both by the public and by the authorities.

Aid to efficiency from Israel

Prof Joost Manassen of the Weizmann Institute with his improved zinc-bromine storage battery.

AN IMPROVED zinc-bromide storage battery, designed to provide back-up power for solar, wind and other electricity-generating schemes, has been developed by researchers at the Weizmann Institute in Israel.

Although still in the demonstration stage, this inexpensive battery appears to meet the requirements for large energy-storage banks that could enhance the capabilities of electrical power plants, increase the utilization of home-based solar electricity production, or power practical electric automobiles.

According to Weizmann Institute's Prof Joost Manassen, the researchers have already shown that the best improved zinc-bromide cell compares favourably with the best of other inexpensive water-based storage batteries.

Gas for Portugal

THE PORTUGUESE government has chosen a consortium consisting of French, German and Portuguese companies to implement its proposed introduction of natural gas to the country.

Members of the consortium led by Gaz de France include Total and Ruhrgas, as well as three Portuguese companies: Gas de Portugal, Francisco Antonio Fernandes and Quintas + Quintas.

The proposed plan calls for three major installations, including a natural gas receiving and re-gasification terminal.

Dutch to lift nuclear freeze

THE DUTCH government announced in June that it will lift its freeze on nuclear installations, imposed following the Chernobyl accident.

The freeze, which was to be in force until the end of the century, will now end in 1994, when the present government's term of office finishes, due largely to economic and environmental reasons.

Micro-hydro in the Dales

AN INNOVATIVE water power system designed for use in isolated parts of the Himalayas has found itself an unlikely home in a remote corner of the Yorkshire Dales. Like many Himalayan villages, Tennant Gill farm stands little chance of being connected to the National Grid. But since June, tenant farmer Bill Cowperthaite will have a green and substainable electricity supply at the flick of a switch for the first time.

The micro-hydro system housed on the National Trust Malham Farm Estate differs from existing systems operating in the UK, in that it is designed for production and maintenance within the communities where it is used. Although micro-hydro installations are now widespread in many Asian countries (particularly Nepal), most rely on costly, imported components, which make them prohibitively expensive for most people.

The farm provides a test site for the various components of a package put together by engineers from Nottingham Polytechnic and the charity Intermediate Technology (IT). IT works closely with organisations in a number of countries to develop low-cost technologies which use local resources and skills.

Instead of a high-tech turbine, a simple water pump has been reversed so that it is driven by water, rather than providing the driving force for the water. Instead of attaching this to an expensive generator, an ordinary electric motor has to be adapted for the purpose. A simple, ingenious electronic controller, which ensures a steady and even supply of electricity, completes the package.

As the world struggles to meet its ever-increasing energy requirements, Malham demonstrates the cost-effectiveness of renewable energy, and shows that being 'green' doesn't have to be a luxury that only the rich can afford. According to Adam Harvey of IT's micro-hydro programme, "This is a particularly exciting project for Intermediate Technology because, in addition to offering thousands of people in developing countries improved security and quality of life, it is equally appropriate for this country."

Doubts about coal sell-off

THE MOST radical views to date concerning the privatisation of British Coal to be voiced by a Conservative MP were heard from Dr Michael Clark MP at a conference organised by the right-wing 'think tank' Adam Smith Institute.

Dr Clark warned that privatising British Coal would lead to an industry 'drastically' reduced in size. In addition, the Government proceeds from the sale would be small and would have an adverse effect on the balance of payments.

Dr Clark, chairman of the Commons select committee on energy, went on to say that only 12 to 15 of Britain's 66 pits would be secure from the competition of cheap imported coal, and only these could be sold by conventional trade sales. Instead he suggested that British Coal's profitable open-cast operations be sold off, while the deep mines would be handled by a Government-controlled holding company, free from debts and liabilities.

At the same conference, held in London in June, Malcolm Edwards, commercial director of British Coal, said that without long-term contracts with the generating companies, the industry could not be privatised.

Merchant bankers, N M Rothschild, financial advisers to the Government on the sale are expected to present their plans in September.

National Energy Award launched

John Wakeham (centre) at the launch of the new National Energy Award. He is flanked by Alan Tweedale, chairman of NIFES (far left), Peter Rost of the Parliamentary Group for Energy Studies (left); and Lord Ezra (second from the right), and Howard Metcalfe, managing director of NIFES (far right).

A NEW incentive for British business to save energy and reduce costs and waste was launched at the House of Commons in June, when the Secretary of State for Energy, John Wakeham, announced a major new competition, the National Energy Award.

Entrants, drawn from consumers across the public and private sectors, will be expected to demonstrate significant advances in the purchase and use of energy, and in caring for the environment.

The prestigious new award, sponsored by the NIFES Consulting Group and the Major Energy Users' Council (MEUC), has the full support of the Department of Energy, and is expected to be fiercely contested by organisations of all sizes.

The panel of judges for the competition will include Mr Rickett, director general of the Energy Efficiency Office; Lord Ezra, managing director of the NIFES Consulting Group and Mr A Williams, managing director of Pilkingtons Energy Advisory Division.

The closing date for entries will be 2 September 1991, with nominations being judged by an independent panel. From a shortlist of finalists, a winner will be selected and presented with a trophy carved in Pilkington Glass at a special House of Commons ceremony later in the year.

1075 MW to close

NATIONAL Power announced in June the closure of 1075 MW of capacity.

Two coal-fired generating units at Blyth in Northumberland will be withdrawn from service, reducing the present capacity of 1548 MW by 480 MW.

An oil-fired generating unit of 483 MW will also close at Fawley on Southampton Water. Another oil-fired unit of 112 MW at Padiham, Lancashire is to go. The oil-fired units will be 'mothballed' and may be brought back into service. An estimated 300 jobs will be lost as a result of the closures.

Weather wise

THE MET OFFICE held an informal lunch briefing on 11 July in London, in order to increase awareness in the energy and water industries of how Met Office services can help companies in these industries increase their efficiency, and hence profits.

Weather forecasting has long been used by the gas and electricity industries to help in predicting the demand for these commodities. Recently however there has been increased demand from the renewables sector as the RECs seek to fulfill their responsibilities under the Non Fossil Fuel Obligation.

Past weather records are invaluable in deciding exactly where to site a wind farm, or a wave power station. When the facilities have been built, weather forecasting can aid in protecting the installation from damage in extreme weather, and can help to plan for optimum operating conditions.

Building services engineers also need to be aware of weather when designing and maintaining heating and cooling systems. Also those involved in the building trade are taking an interest, with ideas such as using shelter belts to decrease the energy use in buildings.

In addition to its standard services the Met Office can offer individually tailored contracts to meet the particular needs of a company. They are also seeking sponsorship to help them improve their long-term seasonal forecasting, building on the recent success of forecasting a season in the tropics.

Council report

THE FIRST thing that is noticeable about Council is the change of membership. The President changes every year and others move up the chain of succession or fall off the end if that is not too impolite. This year Ted Pugh was the Past President who completed his stint and Doug Willis passed on the Presidential badge. Both put so much of their time, energy and ideas into the Institute, they will be missed although we hope that we can use their wise counsel when they are fully fit. Ted had an operation on his back and Doug should have had an operation on his hip by the time this note is published.

As President we welcome Bob Evans, Chairman and Chief Executive of British Gas. He has surprised us with the time he has given and the help he has provided in such a busy post. Mike Roberts is in the wings as President-Elect and Jim Harrison from the Coal Research Establishment returns to Council as Vice-President.

The Honorary Secretary and Honorary Treasurer usually have a five-year term of office, but both positions have new occupants now. The former post goes to Fraser Ferguson, recently retired from the Department of Energy and the finances are under the stewardship of Malcolm Pittwood of British Coal and the Yorkshire Branch. Many of the committee chairmen are new:

Publications and Conferences — Dr Nigel Lucas, recently returned from the east

International — Prof Peter Dunn of Reading University

Education and Training — Dr Peter Padley of Swansea University

Executive — Richard Agg of British Gas.

From left to right: Fraser Ferguson (new Honorary Secretary); Jim Harrison (Vice President); Malcolm Pittwood (new Honorary Treasurer); and Bill Evans (Chairman, Yorkshire Branch).

In addition a large number of Branch officers, whose real service to the Institute is in helping to run local activities have changed. We do owe a debt of gratitude for the work of the local committees in keeping the Institute active.

The Institute has just had its status as a nominated body of The Engineering Council, authorised to accredit courses of education for Chartered and Incorporated Engineers, renewed for a further five years. A major factor in the time taken for the renewal was the lack of representation of Incorporated Engineers on Council and the Committees. There are some IEngs who are involved but more could be if they were encouraged by colleagues or could persuade the boss of the value of keeping up to date.

Keeping up to date is a theme of the Education and Training Committee, as The Engineering Council has published its statements on Continuing Professional Development and it is up to the Institute to decide what action it should take and what activities it should provide. Your ideas and needs would be a welcome contribution to the discussion.

Another activity in this field is a study of the education and training requirements for energy managers. The Institute has operated Diplomas in Energy Management and in Energy Technology for some time. However, the number of people taking the courses and the examinations has always been small. A study is being undertaken to establish the content, methods of delivery and of assessment. In these days of National Vocational Qualifications the emphasis is on competence to perform a job rather than to pass an examination.

The Council also agreed in principal that the Institute should provide the secretariat of the European Federation of Energy Management Associations (EFEM). It is hoped that this will give better contact with European colleagues and the Commission for the Economic Community.

There is little to report on the future arrangements of the Institute. Perhaps the one thing to stress is that there is no talk of a merger with any other organisation at the present time. The Past President in his letter to members at Christmas time referred to the sharing of premises and facilities. In this way it is hoped to reduce costs of administration whilst carrying on an independent activity.

The discussions on this subject have raised the issue of access to minutes of our meetings and to their confidentiality. There is a need to discuss and record sensitive issues, some of which relate to the commercial situation of other organisations, for example. It is not the wish of Council, the officers or the staff to be secretive but there must be discretion in these matters. Consequently it was agreed that Council minutes would be available through branch chairmen and secretaries, who sit on the Council. They may be able to explain some of the background that has taken place in the subcommittees from the discussions that were held.

It is intended that *Energy World* should report more of the Council happenings and the work of committees, but sometimes copy deadlines and other pressures intervene and this can be more difficult than at first seems to be the case.

New members

Fellow

Malcolm Douglas Ward, Birwelco Ltd, Halesowen (*transfer*)

Member

Peter John Thornton, Institute of Arable Crops Research, Rothamsted, Harpenden

Wai Keung Yu, Pypun-Howard Humphreys Ltd, Hong Kong

Associate Member

Kevan Hughes, Schlumberger Industries Flow Measurement, Stretford, Manchester

Associate

Stephen Geoffrey Hough, British Airways, London

Group Affiliate

Scottish Nuclear Limited, Glasgow

Student

Aidonis Aris, University of Reading

Babiker Ahmed Badri, University of Reading

Surat Indrijarso, University of Salford

Sokratis Konstantindis, University of Reading

Nicholas James McDonald, University of Liverpool

Inayatullah Memon, University of Leeds

Leloko Mokhutsoane, University of Reading

Adamu Getahun Mulugeta, University of Reading

George Francis Nangale, University of Reading

Kishorsinh Rathod, The Polytechnic of Wales

Carl Robinson, Sheffield City Polytechnic

Willio Njaga Sarre, University of Reading

Joseph Dauda Sormana, University of Reading

Mark Peter White, University of Leeds

A great loss to the Institute

IT IS with deep sadness that we have to report the death of Joan Deakin.

Joan was a loyal member of staff at headquarters for over 30 years. She died on 9 July following a short illness. The funeral took place at Golders Green Crematorium on 16 July.

An appreciation will be published in the next issue of *Energy World.*

Energy efficiency — a worldwide concern

by Richard Shock BSc PhD MRSc

Dr Richard Shock looks at the energy efficiency scene worldwide, but with particular reference to the UK. From schemes such as THERMIE, run by the EC, to CADDET, operating under the aegis of the IEA, Dr Shock goes on to examine the advice and information available to companies in the UK, urging them to 'grasp the advantage'.

INCREASED energy efficiency has long been seen as a major contributing solution to the problems of scarcity and distribution of fossil fuel resources. In recognition of this, many national governments support R&D, demonstration and information dissemination programmes in this area. In recent years, such activities have also been conducted on a transnational basis following the realisation that problems do not stop at international boundaries and that cooperation may accelerate the process of finding solutions, prevent duplication of effort and help in transferring technologies. Recognition of the greenhouse effect and other environmental problems has increased the momentum of international problem identification and collaborative efforts to find technical and other appropriate solutions.

This article discusses the UK national programme in energy efficiency, and two major international activities: THERMIE, run by the Commission of the European Communities and CADDET, carried out through the International Energy Agency.

The author

Dr Richard Shock is based at the Energy Technology Support Unit (ETSU) at Harwell Laboratory in Oxfordshire. Leader of the UK National Team, Richard also represents the UK on the CADDET executive committee and on the THERMIE proposal selection committee for the Rational Use of Energy.

Best practice programme

The UK Department of Energy runs the Best Practice programme to stimulate the adoption of energy efficient technology in the UK. The programme is managed on behalf of the Department of Energy by the Energy Technology Support Unit (ETSU) in industry and by the Building Research Energy Conservation Support Unit (BRECSU) in buildings-related areas. Projects receive financial support, energy savings and performance are monitored by independent experts, and the results are published along with a range of supporting literature. A wide range of supporting activities, including events, visits, seminars etc ensure that the material is brought to the attention of appropriate decision makers.

The programme has four elements:

- **Energy Consumption Guides**, which survey energy use across a particular sector of industry on an unattributable basis. This information enables managers to compare energy use in their own site with other companies in the same business and identifty areas where savings can be made
- **Good Practice**, which highlights energy efficient techniques already in use via Case Study brochures and Good Practice Guides. The guides give detailed information and advice on how to implement proven energy saving measures
- **New Practice**, which supports 'first of a kind' projects where the technology or the application is new. Projects are monitored by an independent consultant. A colour leaflet and a detailed report on the results are published and distributed
- **Future Practice**, which supports joint ventures developing the energy efficient measures of tomorrow. Leaflets and reports on the research are freely available.

THERMIE

THERMIE is a European Community programme which supports demonstration projects in rational use of energy, solid fuels, renewable sources of energy and hydrocarbons. It is a part of the overall energy policy of the Communities with roles which include:

- helping to ensure that Community industry has access to secure and competitive supplies of energy
- improving the quality of the European environment
- strengthening the technological base of European industry by encouraging industrial cooperation.

The total available funds are 350 MECU (approximately £240 million) allotted for the period 1990-1992, and a similar sum indicated as necessary for the following two years. The funding is intended for innovative projects, where the technology or the application is new.

The aim of the scheme is to assist in the demonstration of newly-developed techniques, processes or products whose technical and economic performance for full industrial-scale implementation is not yet proven. It is assumed that the R&D stage is virtually complete; support is not thus given to proposals which involve R&D, feasibility studies or market surveys. In order to qualify for the grant the proposers must state that the demonstration project would not otherwise proceed. To stand the best chance of being accepted it is usually advisable for the proposal to be submitted jointly by the user and the equipment supplier.

In contrast to the Commission's R&D programmes, there is no requirement for the proposers to be from more than one country, although transnationality is always a good

Table 1: Subsectors in which projects can be supported by THERMIE

Rational use of energy	**Solid fuels**
Buildings	Combustion
Industry	Conversion
Energy industries, electricity and heat	Waste
Transport and urban infrastructure	Gasification integrated with combined gas/steam cycle
Renewable Energy Sources	**Hydrocarbons**
Solar Energy	Exploration
Energy from biomass and waste	Production
Geothermal energy	Transport
Hydroelectric energy	Storage
Wind energy	

selling point. The exception is for projects where the total cost is over 6 million ECU in which case it must be submitted by at least two independent promoters established in different member states. As part of general EC policy, some preference is also given to proposals from small and medium enterprises and to those from regions whose development is lagging behind.

Funding of up to 40% of eligible costs is available for 'first of a kind' projects. Eligible costs are those related to the innovatory or risk elements of the project; they generally include final design, purchase/construction, commissioning and monitoring. Where a technology has been demonstrated once but not widely adopted, funding is available up to 35% for projects using the same principle under different technical or geographic conditions.

Proposals can be submitted following a call which is published in the daily *Official Journal of the European Communities*. The Department of Energy and its management agencies assist in the dissemination of calls. The next call for proposals is expected to be issued soon and to have a deadline for submission of 31 October 1991. With very few exceptions projects must be carried out within the EC 12 countries.

There is also strong competition for the available funds and, although it is not essential, experience shows that UK proposers who take advice from ETSU, BRECSU and/or the Offshore Supplies Office on the suitability of their project and on completion of the application documents, greatly increase their chances of success in gaining grants. All projects have to show good energy-saving potential, relevance to a number of EC countries and the clear intention of the proposers to market the technology actively. This is to maximise dissemination of the results and replication of the technology if it is shown to be successful.

THERMIE differs from its predecessor programmes in several ways, one of the more important being the attention given to 'associated measures'. This is a programme of activities, with a budget of 10-15% of the total, designed to encourage the application and market penetration of energy technologies. The associated measures include:

- analysis of the features and potential of the market for the application of energy technologies and their market penetration
- the monitoring and evaluation of projects financed by the Community, ie through THERMIE and its predecessors
- the dissemination of information on the promotion of energy technologies and the results of projects by greater exploitation of databases, the organisation of technical seminars, participation in technical fairs, production and distribution of documentary material.

Much of the work is carried out through a network of OPETs (Organisations for Promotion of Energy Technologies). There are now 35 of these organisations throughout the EC, of which four are in the UK. They are:

- ETSU, for rational use of energy in industry, transport and energy industries, renewable energy sources and solid fuels
- BRECSU, for rational use of energy in buildings
- Petroleum Science and Technology Institute, for hydrocarbons
- Technology Training Partnership (Scotland) Ltd for rational use of energy and renewable energy sources.

CADDET

While THERMIE offers funds for projects, CADDET (Centre for the Analysis and Dissemination of Demonstrated Energy Technologies) offers access to the results of demonstration projects in other countries. Operating under the aegis of the International Energy Agency, CADDET started in 1988 and is a very effective organisation in which 13 countries cooperate.

The International Energy Agency (IEA) is a group of 22 countries based on the Organisation for Economic Cooperation and Development (OECD). Among its other activities it promotes a collaborative programme of research, development, demonstration and dissemination. This programme covers 44 separate areas, each governed by a set of rules agreed by those countries with an interest in that particular topic. CADDET is the subject of one such agreement.

CADDET literature.

CADDET is a jointly-funded activity currently supported by: Australia, Canada, Denmark, Finland, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the UK and the USA, covering buildings, industry, transport and energy industries. The operating agent for CADDET is NOVEM in the Netherlands which has a small team of professionals dedicated to this activity, along with appropriate support staff. In addition to their membership contribution, Sweden supports the CADDET Analysis Support Unit (CASU) which is principally involved through its contribution to the Analysis series. The annual budget for these activities exceeds £600 000.

The purpose of CADDET is to promote international technology transfer by identifying energy efficient technologies which have been successfully demonstrated, and disseminating the information across all participating countries. Each country has a national team which indentifies important projects and passes the information on them to CADDET. The national team also acts as the channel by which output originating from the Centre and general information about CADDET activities are passed to organisations, companies and individuals best placed in their countries to use them. Consultants can play an important role in the uptake of new technologies and CADDET information should be of interest to them.

CADDET carries out four main activities in support of its overall objectives:

- It maintains the register — a central computer database covering projects in the 13 participating countries. The register now contains over 1200 entries and provides the central core of information on which several other activities are based. The database is currently being updated and will be available shortly on diskette.
- It issues brochures of two types. Most are four-page leaflets which describe completed projects and include an economic analysis. One-page leaflets are also available giving outlines of projects which are currently under way. No charge is made for small quantities of brochures.
- It carries out analyses and publishes them as paperback reviews of a particular area, selected with the assistance of the national teams. Analyses draw on the experience of demonstration projects in several member countries to improve the understanding of the international state of the art. They compare technical and economic performance of demonstration projects and set out the background to the reasons for similarities and differences experienced.

These reports offer useful guidance to decision-makers at all levels and provide considerable 'added value' to CADDET. The status of the reports in the series so far is as follows. Five studies have been issued: on small-scale cogeneration, heat transformers in industrial processes, heating and cooling supply in office buildings, thermal storage for managing electrical loads in buildings and CNG vehicles. Several are in preparation, including industrial CHP, demand-side load management in commercial buildings,

industrial drying and curing, process integration and energy efficient lighting.

Some topics in this series will be produced by CASU as 'in-depth analyses', which will present results of detailed modelling and similar studies in areas where such work is necessary to elucidate the lessons from demonstration projects.

A charge is made for analysis reports to cover printing, postage and packaging. It publishes a newsletter — a quarterly bulletin on CADDET and its products, new demonstration projects, technology and policy reviews and national profiles. Subscriptions to the newsletter are currently free within the UK.

In the UK, the national team activity is integrated with the structure that already exists in the Best Practice programme, the ETSU and BRECSU teams who manage it, and with the activities of the other participants. British Gas, the Electricity Association, the CBI, the four building professions and ESTA (Energy Systems Trade Association) are represented on the National Liaison Group which advises the EEO on general aspects of CADDET UK and provides an extra channel of communication.

National teams are constantly in touch with one another through their regular contacts with CADDET and CASU and through the annual meeting of national team leaders. They provide a good route for obtaining rapid information on demonstration projects and related issues in other countries.

CADDET has now become established and the useful output is growing rapidly. The Energy Efficiency Office's Best Practice programme aims to bring to UK energy users the best and latest technology developed within the UK. In dovetailing CADDET output with that of the Best Practice programme there are three main benefits to the UK:

- it can highlight overseas technologies which may be appropriate for UK applications.
- it may lead to possible licensing agreements for the manufacture of such technologies by UK industry
- it can provide a 'shop window' for UK energy technologies, leading to their uptake in other countries.

For example, a museum in Norway recently decided on the basis of the CADDET analysis report *Learning from experiences with small-scale cogeneration* to install a CHP plant. Combined Power Systems Ltd, based in Manchester, have been awarded the contract to supply the engines for the plant through Flonidan, their agent in Denmark. This is advanced, second-generation technology developed with the involvement of the UK Department of Energy.

It is becoming increasingly apparent that companies which take no account of energy costs will find it more and more difficult to remain competitive. There is now a wealth of information available on how to use energy efficiently, from the UK and around the world; the advantage is there to be grasped. □

If you would like further information on either CADDET or THERMIE contact Richard Shock on Tel No: 0235 432621 or Fax No: 0235 432923.

More general information on the Best Practice programme in industry is available from the Energy Efficiency Enquiries Bureau, Energy Technology Support Unit, Harwell Laboratory, Oxon OX11 0RA. Tel No: 0235 436747. Fax No: 0235 432923.

For further information on buildings-related energy topics, contact the Enquiries Bureau, Building Research, Energy Conservation Support Unit, Building Research Establishment, Garston, Watford WD2 7JR. Tel No: 0923 894040. Fax No: 0923 664097.

Regenerating the inner cities: the energy dimension

by Andrew Warren

Recent government interest in putting greater resources into less properous inner city areas has prompted the Association for the Conservation of Energy (ACE) to examine how the interests of energy efficiency might coincide with the ambitions of government. In this study Andrew Warren, Director of ACE, considers how energy efficiency could stimulate new enterprises; increase employment; assist local workforces to acquire new skills; improve both the public and private built environment and reduce social deprivation.

BRITAIN now spends £35 billion annually on its fuel bill. Mrs Thatcher, launching the Business Week of the Milton Keynes Development Corporation's Energy World, said that: "If only we could cut that amount of £35 billion down — we think by as much as 20% — it would release something like £7 billion for purchasing other things. If he has not to spend on energy costs in his house, the householder has money to spend on other things. That in itself could create more jobs."

The groups in society who spend the highest proportion of their income on fuel are the unemployed, the elderly, and single parent families, for whom the need to run expensive (and often inadequate) heating systems all day and all evening imposes a very severe burden on incomes. A disproportionate number of those suffering from fuel poverty are to be found in the inner cities.

This is a problem that is compounded by the condition of the housing stock in inner cities — elderly, poorly insulated, poorly heated and poorly maintained. Heating systems are often inefficient and thus expensive to run, whilst the lack of insulation or adequate controls merely exacerbates this problem. If the homes of the inner city were improved through the installation of cost-effective energy-saving measures, insulation and heating controls for example, this would have two important benefits for the residents of inner city areas.

First, these residents would have more comfortable homes. Second, even though some of the cost savings from energy saving improvements will be taken up through increased comfort levels, there is evidence to show that there would still be energy cost savings, savings which will be available, in the Prime Minister's words, "to spend on other things". If the disposable income of those who live in the inner cities is increased, this extra money would be spent mostly on goods and services in the local areas where such extra spending is most needed.

This argument does not however apply only to the householder. Industry and commerce in the inner cities can equally well benefit from the lower fuel costs which energy saving investments can bring. That there is much potential for energy saving in industry and commerce is not in doubt. The government, acknowledging the poor record of the UK in terms of our energy cost per unit of output, has

publicly stated its aim to make Britain the most energy efficient nation in Europe.

The increase in profitability and international competitiveness which this would bring about would be of much benefit to the industries of the inner cities, which frequently occupy elderly buildings extravagant in their use of energy. Money which local firms are not spending on fuel costs can increase profits, competitiveness and help create jobs, thus aiding directly in the regeneration of the inner cities.

Inner urban businesses are now frequently relatively small-scale, and rarely have available the expertise to assess properly their energy circumstances. In consequence much would be gained if further public initiatives were taken to inform management of the opportunities foregone, and the most effective means of reducing their energy costs.

Reducing waste in inner urban areas would help existing businesses to compete better in their market places, thereby maintaining and ever increasing employment opportunities.

Stimulation of new enterprises

The energy efficiency industry is extraordinarily difficult to define precisely: indeed neither NEDO or the DTI attempt to do so. Even the Government's Energy Efficiency Office — set up with a specific remit to promote the growth of this 'sunrise' industry — still finds difficulty in defining its exact parameters.

This diversity is reflected in the way in which labour is organised. Many different unions have members involved with energy efficiency equipment. These would normally be represented by the mainstream industrial, rather than purely the energy, section of the union; and certainly on the Trade Union Congress' Energy Committee there is no direct energy efficiency representation.

Equally there is no strong geographical area lobby for this industry: its manufacturing bases are diffuse and scattered, and installation work can be found in every part of the country.

For the purpose of this article, the industry has been taken to incorporate all activities including the manufacture, distribution and installation of energy-saving equipment of all types, and the provision of energy efficiency advice and sundry related services.

The installation of energy conservation equipment is well suited to small firms. Indeed this is a classic field where an entrepreneur with limited capital can establish an enterprise. For whilst the manufacture of energy-saving equipment is becoming increasingly capital, rather than labour, intensive and is dominated by a handful of major companies, the theoretical opportunities for the entrepreneurial plumber/heating contractor or insulation installer — particularly if tied in with one or more major manufacturers — are considerable. However, whilst it is not known precisely how many Enterprise Allowance applications have been made on this basis, it is understood to be relatively few.

However, some of the Manpower Services Commission backed Neighbourhood Energy Action projects based as far apart as Glasgow and East London, have succeeded in spawning new cooperative enterprises. These have been able to continue even after the Manpower Services Commission funding has been withdrawn. By entering successful competitive tenders, these enterprises have succeeded in obtaining contracts to undertake further energy efficiency work, albeit normally in municipally-owned property. Admittedly these projects have been the exception rather than the rule, in that most NEA teams have stayed together post-MSC work have only done so in non-energy work.

Some charities have undertaken energy advisory work on a commercial basis: the Energy Conservation and Solar Centre has successfully tendered to undertake many thousands of home energy audits for local authorities in the London area.

Energy information surveys

Sadly a true commercial market for such audits or surveys amongst private homeowners has never been established anywhere in the world. This has meant foregoing many opportunities in this sector so long as householders remain ignorant of the potential energy saving investments which could be applied to their homes.

Aware of this, the EC published in September 1987 a draft directive which could help to provide precisely such information. It requires anyone transferring either the ownership or occupation of a home to provide basic information concerning the energy efficiency of the premises.

Experience with such a scheme in Denmark over the past five years provides convincing evidence that the availability of such a requirement greatly increases energy awareness, and thereby helps increase investment in this area. It is noticeable that even when in the initial years of their survey scheme the Danish government agreed to produce a pump-priming subsidy, the scheme had a multiplier effect, generating £4 of private for every £1 of public money. The scheme is now wholly self-financing, and has already covered approaching half the Danish housing stock.

At present the number of home energy surveyors practicing in Britain is but a handful; the number registered under the Danish scheme is 1200. Given that Denmark's population is less than one-tenth of Britain's, it does provide some inkling of the potential such a scheme could have, so long as the opportunities offered by the EC's Directive are grasped by member governments.

Increasing the number of home energy surveyors practicing should in turn expand the market for those who provide the goods and the skills which such surveyors would recommend. For the past decade Britain's Department of Energy has provided financial assistance for those operating in commerce, industry or in the public sector, to enable them to have professional surveys undertaken to measure the energy efficiency of the premises for which they have responsibility.

The rationale of these surveys is identical: they should provide better information upon which judgements can be made regarding investment in energy efficiency issues. This in turn should lead to an increase in demand for energy conservation goods and services.

The conclusion cannot be escaped that endorsement of the EC's proposed directive by the UK Government would be certain to stimulate the creation of many new enterprises in the energy efficiency field. Combined with other public initiatives geared to the same end, inner urban areas especially could become a seed bed for energy service companies.

Creating new jobs

Sensible investment in energy conservation in the inner cities has merits beyond providing the stimulation of new enterprises and the improvement of the quality of the building stock. Investment in cost-effective energy conservation and cogeneration can generate a substantial number of worthwhile and long-lasting jobs.

Research undertaken for the Association for the Conservation of Energy has shown just how many jobs, and the types of jobs, which can be created from investment in energy efficiency in the inner cities.

The research examined the job-creating potential of energy conservation under a number of different scenarios for expanding the energy saving efforts in the inner cities. The programme of improvements which we propose would result in the creation of up to 110000 new jobs within our cities.

At present around 15000 people are employed nationwide manufacturing, installing and servicing energy saving equipment and materials, and in carrying out energy saving surveys in industry and commerce. If the energy saving programme in the UK's inner cities is expanded, this figure could rise by more than five times in these areas alone, creating up to 67000 direct jobs over ten years.

The total increase in employment would be augmented by up to 42000 additional jobs

The author

Andrew Warren is Director of the Association for the Conservation of Energy (ACE). Born in 1948, he was educated at Rugby School and the University of Exeter. Upon graduation, he worked in advertising for Saatchi and Saatchi Garland-Compton Ltd, before becoming the Secretary to the Movement for London Campaign. Upon foundation of ACE in 1981, he was appointed its first Director. He was the co-author of the TV series *Fancy Saying a Thing Like That*. He is an underwriter at Lloyds. He is married to a solicitor, has two sons and a daughter and lives in Essex.

Since 1982 he has written regular monthly columns for energy magazines, and latterly has contributed a monthly column to the Daily Telegraph. He also writes for many other national newspapers, and is a frequent broadcaster and lecturer. He was Energy Journalist of the Year in 1986.

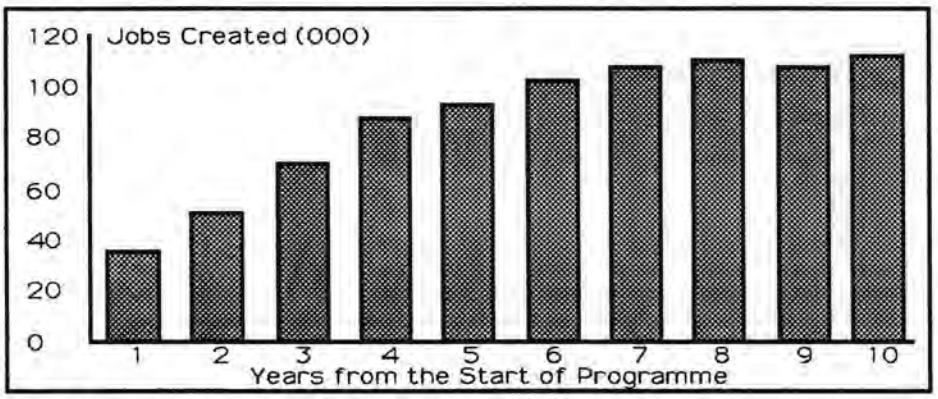

Fig 1: Jobs created through energy conservation.

which would be generated by the increased economic activity. Some 26 000 of these would be created through the 'multiplier' effect of employment induced by the spending of those newly employed in directly created jobs, and 17 800 jobs being created by 're-spending effects'. There would be only minimal reductions in employment in the energy supply industries: a reduction of only one job for every 50 new jobs created.

As important, however, as the total number of jobs which could be created by increased investment in energy conservation in the inner cities is what sort of jobs these would be, and where they would be located.

Installation of energy saving materials and equipment, such as cavity wall insulation or improving heating controls is relatively labour intensive. The manufacture of these materials and equipment is relatively capital intensive. A majority of the direct jobs which would be created would be in installation, accounting for 52% of the jobs created in the energy conservation industry, while manufacturing would account for only 15%. However, the preponderance of jobs in installation has two important consequences, which offer considerable further benefits from increased energy saving activities in the inner cities.

The first of these consequencies is that (with the exception of heating controls) installing energy saving equipment and materials requires only limited skills, that need only basic training. Among the unemployed, and particularly among the long-term unemployed, who face the most difficulty in gaining employment are the unskilled and semi-skilled groups.

The second major consequence of the predominance of jobs in installation is the location of those jobs. Rather than being created on remote factory sites, these jobs can be located anywhere, particularly in the inner cities themselves where the installation work needs to be undertaken. Thus expanding energy saving efforts in the inner cities not only creates a substantial number of much needed unskilled and semi-skilled jobs, but creates those jobs where they are most needed: in the inner cities themselves.

Comfort levels in the building stock of the inner cities is generally acknowledged to be woefully inadequate. It has been assumed therefore, that 67% of the net energy savings will be taken up as increased comfort levels, and only 33% will be net energy savings. On this basis, energy savings in the inner cities alone would still reach £267 million after ten years.

Cogeneration

Cogeneration (CHP) is the process of using plant to generate both electricity and heat, rather than the electricity alone in a conventional power plant, where the heat generated as a by-product of the generating process is dissipated as waste. The heat produced in a cogeneration scheme can be used as process heat in a factory. Alternatively, if the cogeneration plant is sufficiently large, the heat could be used in a district heating scheme; in this a central heat source raises either steam or hot water (and electricity) which is then circulated through a pipe network and sold to commercial, institutional and domestic customers for space heating and hot water heating, and to industry for process and heating needs.

CHP and district heating are not new technologies. Despite the paucity of such schemes in the UK, they have a long record of experience in European countries, particularly in Scandinavia. In 1979 the Government commissioned the Marshall report which examined the potential for cost-effective cogeneration and district heating schemes. In 1981 a short list of nine cities were selected for further study, and a number of these were given small grants to aid the costs of the detailed feasibility work. Several of the cities have now completed, or are near to completing these studies, and have formed joint public sector/private sector consortia in order to proceed further. Such cities include Leicester, Edinburgh, Belfast, Sheffield, and Newcastle-upon-Tyne.

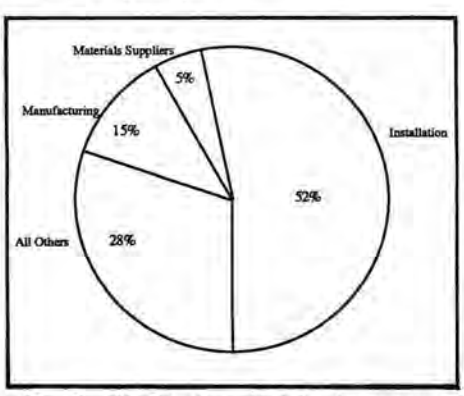

Fig 2: Distribution of jobs in energy conservation industry.

Investment in CHP and district heating, like energy conservation, has a number of important implications for employment in the inner cities. Some employment is generated in the construction of boilers and turbines; much more in the laying of the district heating pipe network; and in the connections to the heating grid for industrial, commercial, and domestic consumers. Jobs will also be created through the continued operation and maintenance of the CHP equipment.

The majority of the employment that such schemes would generate will be to the benefit of the mechanical engineering and construction industries, with the jobs created through pipe-laying and consumer connections occurring in the inner cities themselves. A study undertaken by the Tyneside cogeneration consortium based upon a district heating network in Newcastle fed by heat from waste incinerators, has estimated that 555 jobs would be created during the manufacturing and construction period, with some 70 jobs required to operate and maintain the system once completed. If these figures are extrapolated for other cities, where even larger schemes are planned, it can be seen that CHP/district heating can, together with energy efficiency, make an important contribution to increasing employment in the inner cities.

A paper published in October 1987 by the Conservative Bow Group entitled 'Moving Forward with Energy' estimates that together energy efficiency cogeneration projects could generate 400 000 new jobs within the decade.

New skills

It is a *sine qua non* that energy conservation programmes predominantly provide employment which requires limited skills. Whilst doubtless higher education graduates are to be found laying rolls of loft insulation or installing TRVs, it is not disingenuous to describe them as grossly over-qualified for the work they are doing.

One of the great attractions of energy conservation programmes is precisely that to succeed they can include within them those — and there will always be those — who have limited skills and capacities. There are precious few serious investment opportunities left in the age of the micro-chip where such a claim can be made.

However, successful programmes cannot consist exclusively of unskilled workers. For instance, contract energy management requires complex technical and financial skills, as does the installation of advanced controls systems. Even with the present limited investment in energy efficiency, many firms are reporting considerable difficulties in finding appropriately trained staff, particularly among mechanical engineers.

While the problem is particularly acute in the south-east (where it is exacerbated by housing price differentials), the same skill shortage has appeared in many other areas of the country. This is a legacy of the failure by companies to invest in training over many years, of the inappropriate nature of many higher educational courses, and the perceived low social status of engineers.

There are already facilities for those un-

employed for over a year to learn new basic trades under the Job Training Schemes. A number of leading building firms have provided programmes under this scheme, receiving funding from the Manpower Services Commission (MSC) for jobs not in existence over the previous two years. These might be adapted for the new energy efficiency enterprises.

There are two other primary sources of assistance from MSC: the Community Programme, aimed mainly at assisting the adult unemployed in inner city areas, and the Youth Training Scheme, designed to cater for the needs of the young unemployed.

The various Neighbourhood Energy Action schemes have normally used the Community Programme, as this enables the sponsoring voluntary group to pay trade union agreed rates to all the project staff. The Youth Training Scheme programme has historically been of more use to private companies training apprentices than the voluntary movement and few of these have yet developed skills directly pertinent to the energy efficiency industry.

Both programmes make available yearly grants, and apply just to the unemployed with eligibility determined by length of time out of work. Employment is limited to 12 months, under the Community Programme — although this can be extended up to two years for key posts (indeed some managerial posts enable staff to be retained throughout the length of a project's lifetime).

Despite all these initiatives, there remains a clear need for the government, the Manpower Services Commission and the education service — perhaps via its City Technology Colleges — to develop more vigorously courses and work experience more directly concerned with the needs of the energy efficiency industry. Only in this way can the full potential for energy saving be realised.

The built environment

The potential that incorporating energy saving investments has to improve the quality of the environment has been mostly extraneous to the majority of inner city initiatives undertaken to date. This is not predominantly due to any malignity. Rather it is because of the lack of any clear focus regarding its ability to provide a useful component part to any or all of the activities spawned by the inner cities. City Action Teams, DTI or DOE Task Forces, Urban Development Corporations or Phoenix Programmes, or even the 260 Enterprise Agencies — all simply have failed to recognise the potential to date. It might be hoped that the new Housing Action Trusts will prove an exception.

Only when there has been a deliberate attempt to identify an area specifically with the energy problem has a breakthrough occurred — and then to considerable effect. Taking Cardiff as the initial Energy Action City, the Government's Energy Efficiency Office has sought to spawn a number of similar ventures in other communities — Wrexham, Leicester, Stirling. In each case, government funding has been restricted either to providing the monitoring of the effectiveness of the exercise, or to some limited pump-priming, up to £15000 per city.

Instead the EEO has preferred to act as a catalyst, drawing together potentially interested parties from local authorities, voluntary bodies, utilities and the energy efficiency industries to provide a focal point for their activities. Essentially such exercises have been vehicles for propaganda about energy efficiency, and their short-term impact has been difficult to measure: one unfortunate aspect was the downturn in funding for homes insulation grants to Cardiff City Council at just the time when it was receiving national attention as the first Energy Action City. However, the energy dimension now incorporated into the Bay area rehabilitation project, together with the improvements at the British Steel works (itself responsible for over 10% of the City's energy usage) have more than justified the time input.

Energy Action Cities, whilst of themselves constructive, perpetuate the problem of dealing with energy issues in a vacuum, rather than as an important component of overall rehabilitation work. This is why the example of the energy-related aspects within the public/private initiatives of the Neighbourhood Revitalisation Schemes is so valuable.

These schemes — predominantly geared to the frequently forgotten sector of low-income owner occupiers — have proved to be an enormously successful means of incorporating energy improvements into rehabilitation packages targeted as specifically needy neighbourhoods. Following the development of a prototype energy advice scheme pioneered in the Hillsborough area of Sheffield, it is now proposed that each ensuing scheme (of which 23 have now been identified) should incorporate a similar service within it. This would provide recipients with precisely the personal advice required about how best to improve the energy performance of their home, together with guidance on how best to find the working capital to enable any necessary investment to take place. We believe such a scheme to be a model worth pursuing in many other inner city areas.

In itself it was partly modelled upon a package put together by Dudley Council in the West Midlands, whereby using their own funds topped up with Urban Aid Fund from the Department of Environment, they appointed in 1984 an officer whose sole task was to visit every home, office or factory in the Netherton area of the borough, specifically to give advice on how best to improve the energy performance of their buildings.

Among the achievements of this initiative was the stimulation of 54% of private individuals who were personally contacted, to undertake energy improvements in their homes. This success led the local authority to a deliberate targeting of these schemes for future years at lower income households.

Such schemes could be further extended to all inner city housing and commercial buildings if the EEC initiative for an energy saving advice scheme, modelled on the lines of the existing UK energy audit scheme in industry and commerce is implemented.

The role of the financial community

Building societies and banks, as the providers of the investment capital for our housing stock, can play a crucial role in improving the quality of the built environment in the inner cities through energy saving improvements.

Banks and building societies have two key roles to play: the first role relates to the lending criteria which these intitutions adopt for housing. In the US several banks have raised the maximum multiple of a borrowers income which can be lent as a mortgage, if the house in question is deemed energy efficient.

The rationale for this relaxation of the lending rules is that with the reduced fuel bills which the owner of an energy-efficient house enjoys, the borrower will have a larger proportion of their disposable income available to meet higher mortgage repayments.

In the areas where such schemes are operating they have had the effect of increasing the awareness of other consumers of the need to consider the energy running costs of a dwelling, and the considerable benefits of an energy efficient home.

In addition to relaxing the mortgage ceiling some US banks have also launched energy efficiency mortgage schemes. If a property is identified as being in a poor state regarding its energy efficiency at the time of the lender's survey, then the bank or building society will lend further sums (in addition to the purchase price of a property) specifically allocated to energy saving improvements.

As an experimental scheme several years ago the Abbey National Building Society introduced a basic 'check list' home energy survey as part of the standard pre-mortgage building society survey. How widely used this check list survey remains today is not known.

Although a number of lending institutions in the UK have prepared leaflets informing customers of their willingness to make loans available for energy saving improvement schemes, to our knowledge none in the UK set aside specific sums for energy conservation in the way that banks and building societies do for roofing or drainage repairs for example.

If the lending institutions in the UK followed the example of some of their American counterparts, by increasing mortgage ceilings for energy efficient dwellings, and by allocating specific sums for energy saving improvements at the time a house or flat is bought, we believe that this would help householders to be more aware of the benefits of an energy efficient home, and encourage investment in the improvement of the built environment of the inner cities. This is perhaps a role for public/private initiatives like Business In The Community to build upon this.

Role of local authorities

Local authorities own and manage a large part of the nation's building stock including offices, schools, old people's homes, community halls — and the three million and 1.5 million flats that comprises the local authority housing stock.

Concerning local authorities own buildings, attention has indeed been given to improving their energy efficiency. In 1986 the Audit Commission (for England and Wales), recognising the potential for cost reductions through cost-effective investments in energy saving improvements, took energy conservation as one of their main areas of activity. The Audit Commission recommended that all authorities should follow certain guidelines: appointing one member of staff as an energy manager for every £1 million spent by the authority on fuel, and reinvesting at least 10% of each year's revenue spending on fuel bills in energy saving improvements.

Concerning local authority housing, although tenants (or frequently the DHSS through fuel allowances) are responsible for paying fuel bills, authorities are nevertheless the owners and landlords of these properties, and therefore have a direct interest in improving the quality of the housing stock.

In 1986 the Department of the Environment published the conclusions of an 'Inquiry Into the Condition of the Local Authority Housing Stock in England'. It estimated that 17 out of 20 council homes, many of which are in inner city areas, require improvement expenditure, at an average of £4900 per dwelling. The largest single category of improvement expenditure identified in the survey was heating, followed by doors and windows, and insulation. In all, to bring these council homes up to an acceptable standard over £4 billion needs to be spent on heating, insulation, and condensation treatment.

Much of the local authority housing in the inner cities is in urgent need of improvement from the energy efficiency point of view. Local authorities have a clear role in devoting resources to improving the heating, insulation, and reducing problems of condensation and mould in public sector housing.

The Milton Keynes Development Corporation (although decidedly not charged with the development of a deprived inner city) has developed considerable expertise in the area of low energy housing, factories, and offices, expertise and experience that is highly relevant in the regeneration of the inner cities.

In 1986 the Milton Keynes Development Corporation organised a showcase exhibition called, coincidentally, 'Energy World'. Of the 50 energy efficient houses, some were upmarket detached house, but others were low-cost flats and sheltered housing. Currently the Development Corporation is overseeing the growth of the Energy Park, a 300-acre site where all the policies which promote energy efficiency will be combined to create low energy factories, offices and homes. Both of these projects have involved the setting of standards for energy efficiency, and the development of techniques to evaluate whether new buildings meet those standards, which could be of much assistance in the redevelopment of inner city areas.

The interests which Milton Keynes' Development Corporation has shown in developing energy efficiency standards could be most valuably replicated by the increasing number of Urban Development Corporations in the inner cities. By setting energy standards themselves, and by encouraging private sector builders and rehabilitators to incorporate best practice, a major impact upon the built environment could be achieved.

Overcoming fuel poverty

There are currently just over 20 million homes in Britain. Every year they consume some £10 billion worth of fuel. The vast majority of that is gas, responsible for approaching two-thirds the total.

For many households, fuel bills form a relatively small fraction of the household budget. Amongst the upper middle income bracket, this can be as low as 5% of disposable income (albeit still running annually into several hundred pounds). But amongst low-income households this proportion can soar up to between one-fifth and one-quarter of the weekly budget, as high a proportion as would ever be found in even the most energy intensive industry.

And the difference between industry and homes in energy use goes beyond this: there can be few recorded cases of the production line being stopped because the directors don't want to incur the relevant electricity or gas costs: there are, though, all too many cases of households seeking to reduce their fuel bills, not by investing in energy saving equipment, but rather by simply doing without. Without fuel, without lighting, without warmth.

Why as we approach the 21st century are we at the stage where every winter people still quite literally die of cold? Such tragedies do in part occur through ignorance of the assistance available from the Department of Health and the Social Services. Such assistance in the form of fuel allowances now covers some two and a quarter million homes (two-thirds of them council owned), and according to some estimates costs the Exchequer upwards of £1400 million each year.

And still people suffer and die of the cold. There are 90% grants available to many categories of low-income households, to cover the purchase of such basic insulation items as tank jackets and loft lagging. There are also a growing number of local neighbourhood insulation projects, funded by the Manpower Services Commission and the Department of Energy, which assist with the installation of draught-proofing and some insulation measures, to increase the basic comfort levels of the homes they service (and, research shows, to save money of the energy used too).

Many of these schemes come directly under the Neighbourhood Energy Action banner, a voluntary movement which has grown swiftly over recent years. This has employed 8000 people at a total cost to the Exchequer of £45 million — of which £9 million was on insulating materials, mostly draught-proofing.

The cost per home draught-proofed should — according to Energy Efficiency Office figures — work out at £255 each, of which just £45 is on materials. The basic cost per person employed is just £4500. Even when the cost of materials is added on, plus all the adimistrative overheads, it will mean that each person employed on these schemes will be costing the taxpayer just £5700.

However, it should be stressed that such work at this stage by no means provides a complete solution to making any home completely energy efficient — rather, it is a case of ameliorating only the worst problems from draughts and condensation. There is little attempt made to deal with any of the more major works which might be required, such as improving the heating system or insulating walls and floors.

For many social service departments and area health authorities, problems relating to cold and damp dwellings have become commonplace. They too have a major interest in ensuring that, for instance, all those in receipt of fuel benefits from the State also obtain help with retrofitting their homes to make them truly energy efficient. Otherwise we shall continue with a fuel poverty problem for which the best analogy is that of seeking to fill a bath without putting the plug in.

Fossil fuels 1850 to 2000

Prof Ian Fells MA PhD F Eng FInstE CChem FRSC FIChemE

The world's supply of fossil fuels, oil, gas, coal, lignite, peat, took some 200 million years to form, and provides 75% of world energy. All will be burnt in an orgy of combustion which is damaging the global environment, possibly irreversibly. As improvement in lifestyle requires increased supply of energy, peoples' rising expectations, particularly in the developing world, will be hard to reconcile with fossil fuel conservation and protection of the environment. The result may well be an uneasy and uncomfortable compromise but in the medium to long term nuclear power will remorselessly take over the role of fossil fuels.

Prof Fells originally presented this paper as a Milestone Lecture at the Royal Society of Chemistry's 150th Annual Congress in April of this year.

CIVILISATION began when man discovered how to make and control fire. The first fuel was probably wood and even today fuel wood provides just over 10% of man's enegy requirements. Nearly 80% is produced by burning fossil fuels; oil, coal, gas and associated hydrocarbons. They are a non-renewable resource and took 200 million years to form. Man started to burn them around 1000 years ago when simple coal mining techniques were developed, although seepages of oil and tar had provided a primitive fuel many hundreds of years earlier.

Once the Industrial Revolution got under way towards the end of the 18th century, the rate of consumption increased. We now know that in an economy undergoing industrialisation an increase of 1% in gross domestic product (GDP) requires a 1.5% increase in energy use (known as the energy coeft).

The earliest fuel consumption figures available[1] relate to the UK when in 1800, the UK energy coeft. was just about 1.5. In the latter years of the 20th century this figure has fallen to 0.5 in the UK and the rest of Western Europe and is typical of mature industrialised economies. In rapidly expanding and industrialising economies such as those around the Pacific Rim the energy coeft. is still 1.5 and with some economies growing at between 7 and 8% the increasing demand for fossil fuels in these developing countries could well dominate world energy demand early next century. Matters are exacerbated by massive increases in world population. Numbers have risen from 1.7 billion in 1900 to 5 billion today, and will rise to 10 billion in 2060. Each additional person requires his or her energy ration and anticipates a steadily improving life style. All these pressures conspire to increase the world's energy demand and use.

Energy reserves and use

This presents two problems. First, what is the extent of the world's reserves of fossil fuels; how long will they last? Second, all fossil fuels burn to form carbon dioxide; each tonne of oil burnt produces 3.3 tonnes of carbon dioxide, for example. Carbon dioxide has been steadily building up its concentration in the atmosphere since the start of the Industrial Revolution and has risen from 270 parts per million (ppm) in 1700 to 350 ppm today. Together with methane, to a lesser extent, and other gases this increase in concentration gives rise to the 'greenhouse' effect which is perceived as a serious threat to the environment, causing global warming and destabilisation of the weather machine. Sulphur and nitrogen oxide emissions from coal and oil combustion cause acid rain which seriously damages forests, crops, buildings and health.

The finite nature of the world's fossil fuel resources, taken in conjunction with the destructive effect on the environment caused by their combustion, makes an unassailable case for conserving and constraining their use. On the other hand, the expectations of the rapidly rising world population require ever increasing supplies of energy to 'fuel' their aspirations. This presents the governments of the world with a political as well as a resource dilemma which will steadily get worse. The extent of world fossil fuel reserves is always a matter of judgement and figures, particularly in the oil industry, and have sometimes been distorted for commercial reasons. The best and most objective figures are those provided by the World Energy Council and published in 1989. Reserves and consumption figures are set out in terms of tonnes of oil equivalent (TOE). One TOE equals 42 Giga Joules (GJ). Figures are divided between industrialised countries (IC) and developing countries (DC) and given in Table 1.

The figures given here refer to proved recoverable reserves. Estimates of proved and probable reserves are sometimes quoted but should be accepted with caution.

A simplistic life time for the different fossil fuels can be obtained by dividing the reserves by current annual consumption. The results are given in Table 2. Figures for uranium are included as it is a fossil fuel, although not always thought of as such. There is a striking difference in uranium reserve potential compared with other fuels if its energy release is calculated, assuming it is used in the highly efficient breeder reactor where the abundant uranium 238 isotope is converted to plutonium for use as a fissionable fuel rather than merely burning up the uranium 235 isotope in the currently commercial thermal reactors. The multiplying factor is 60.

Energy demand

Of course these 'lifetimes' shorten dramatic-

The author

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Prof Fells was President of the Institute of Energy from 1978-79. A member of the Electricity Supply Research Council from 1979 until privatisation, he is a special advisor to the House of Lords select committee on energy and the environment.

He has participated in several television series, including *Young Scientist of the Year* and *The Great Egg Race*, and is the author of a number of energy publications.

ally if, as seems likely, annual consumption rates increase. The attempts to predict future energy demand made by three well-known and broadly-based foundations, the International Institute for Applied Systems Analysis (IIASA), the World Energy Council (WEC), and the World Resources Institute (WRI) have been compiled by AEA Technology.

There are noticeable differences in the predictions for 2020. IIASA is pessimistic about the contribution of renewables (8%) and optimistic about the future nuclear component (21%), both WEC and WRI give renewables a 20% share whereas nuclear is 12% for WEC and a low 5% for WRI. In any event the brunt of demand will be taken by the fossil fuels coal, oil and gas; all the scenarios, whether high or low, give a figure of between 68 and 71%. WRI is more enthusiastic about gas and less enthusiastic about coal, probably for environmental reasons. All predict an increase in energy demand over the 1987 figure of 9 btoe ranging from 46% IIASA, 11% or 67% WEC to 18% WRI except for the WRI 'low' scenario which is not a projection at all but a 'target' involving enormous improvement in the efficiency of energy use.

These predictions were made over the period 1981 (IIASA) to 1987 (WEC) and 1988 (WRI). More recently (1989) the WEC has published *Global Energy Perspectives 2000-2020*. In it the figure for world energy consumption between 1985 and 2020 has been revised to grow between 50 and 70%. The rise in demand will be uneven with spectacular rises in developing countries and particularly centrally planned Asia.

Again there will be wide differences in per capita consumption, although the world average will stay at around 1.6 toe. In 1985 average per capita consumption in the South, including non-commercial energy sources such as fuel wood stood at 0.65 toe as against 4.25 toe in the North. By 2020 the corresponding figures will be 0.8/0.9 toe in the South and 4.45/5.15 toe in the North, so there is hardly any improvement in the ratio for the South in terms of consumption. The situation is particularly bad in countries such as Sub-Saharan Africa and South Asia where per capita consumption will rise from 0.36 toe in 1985 to only 0.39/0.46 toe in 2020. Of this, non-commercial energy would still constitute between 30 and 45% of demand.

It is clear that chronic poverty in the energy field will continue to exist in a region whose population is expected to double from 1.4bn to 2.8bn by 2020; that is, one third of the world population.

Energy supply

On the fuel supply side the 1989 WEC predictions are that coal demand will rise after 2000 to between 3 and 5 btoe but that before 2000 there will be strong competition from hydrocarbons, particularly gas. Nevertheless coal will only have around 30% of the market in 2020. Outlets are restricted and environmental constraints constitute a check on development.

Natural gas, because of its environmental advantages in not containing sulphur and producing less carbon dioxide per unit of heat output than coal or oil, is better placed than oil to maintain its share of world demand at current levels.

The nuclear power sector, despite its environmental advantage in producing neither carbon dioxide nor acid rain, suffers from public acceptability problems since Chernobyl and also increasing financial difficulties, so the WEC (1989) report has scaled down the anticipated nuclear contribution to between 7 and 8% compared with 4% in 1985.

Non-commercial energy sources will increase in the South and will still provide between 15 and 25% of third world energy needs in 2020 as compared with 33% in 1985. The inevitable consequence is increased pressure on agriculture, society and the environment.

Overall, renewable energy sources, that is hydropower and non-commercial sources taken together, are unlikely to provide more than 20% of energy demand by 2020, despite the enthusiasm of their supporters.

The position of oil will be maintained to a higher degree than foreseen in earlier reports and will still be meeting 26/28% of demand by 2020 compared with 32% in 1985. In particular, Third World demand will rise from less than 0.7 btoe in 1985 to 1.4/1.6 btoe in 2020 and the South's share of world consumption will increase from 26% to 43/44% in 2020 whilst industrialised countries will have stabilised their demand at 1985 levels.

World trade in energy

Oil is the largest single commodity traded in the world today. In 1989 trade rose by 6% figure to 28.5 million barrels/day (b/d) (7.2 bls of oil = 1 tonne). OPEC alone obtained net export revenues of $117bn in 1989. The US is the single largest importer of crude oil and in 1989 imported 7.8 million b/d, an increase of 19% on the 1988 figure. The role of OPEC is crucial to the continuous supply of oil in the world, particularly to the industrialised countries, it is ironic that OPEC was formed in 1960 because of the intransigence and greed of the large international oil companies, particularly Exxon. The fact that the major reserves of oil lie in a politically highly unstable area and that oil looks set to provide the major fraction of world energy into the next century, and certainly past 2000, bodes ill for price and supply stability.

The rising fortunes of natural gas with its environmental advantages has led to a broad geographic spread of gas supplies. Trade in natural gas is to some extent constrained by the development of gas pipe lines although a network of pipelines in the North Sea and from Russia into Europe are rapidly extending trade across national boundaries. Worldwide, ten countries export to 25 others and eight nations export liquified natural gas. Once again world natural gas reserves are concentrated in particular locations; USSR and the Middle East between them have 67% of world reserves, Western Europe an important 5%. Of the world's ten largest gas fields, five are in USSR and two in Western Europe. As far as Europe is concerned a gas market controlled by Norway, Russia and possibly Holland is a

Table 1. World energy reserves and consumption (1987)

	IC	DC	World
Economic reserves (btoe)			
Coal	380	160	540
Oil	16	100	116
Gas	50	46	96
Total fossil fuel	**446**	**306**	**752**
Uranium, non-communist world:			
Thermal reactors (LWRs)			33
Fast reactors			>2000
Consumption (mtoe)			
Coal	1200	1190	2390
Oil	2060	880	2940
Gas	1250	300	1550
Total fossil fuel	**4510**	**2370**	**6880**
Nuclear	370	40	410
Hydro/geo.	330	190	520
Wood	100	1100	1200
Total (btoe)	**5.3**	**3.7**	**9.0**
toe/cap	**4.8**	**0.9**	**1.8**

Table 2. Reserves/current consumption (yr)

	IC	DC	World
Coal	—	—	225
Oil	—	—	40
Gas	—	—	60
Thermal reactors	—	—	80

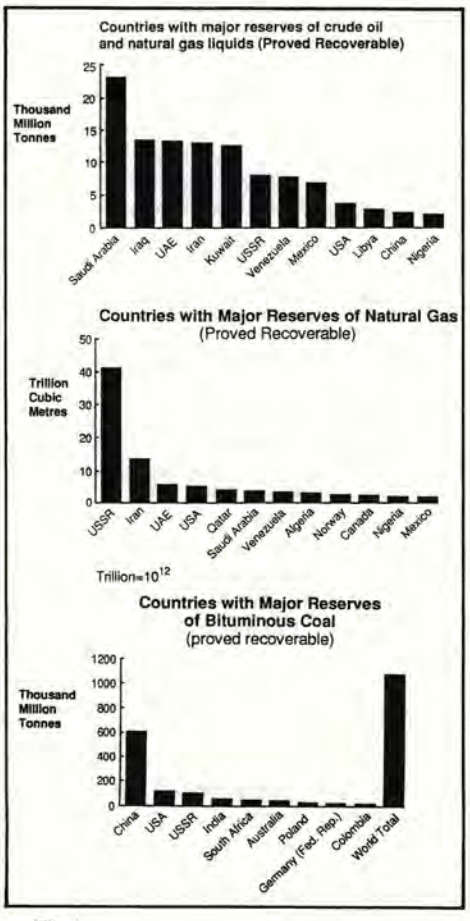

Fig 1.

strong possibility. A better arrangement would be the growth of a 'spot' market in gas which could constrain prices, although they will inevitably rise, possibly quite quicky in the late 1990s.

About 360 mt of coal is traded worldwide; that is, about 11% of production. Australia is the largest exporter with the US not far behind, followed by South Africa. China has great but unrealised coal export potential. Coal's major competitor in the world market is now natural gas and this will constrain growth in the coal trade to around 2 per cent for a time until the price of natural gas gives coal an advantage when burnt using clean coal technology.

Technology and chemistry

Perhaps the most important chemical reaction that exists is the combustion of carbon-based materials in air to form water and carbon dioxide with the generation of heat. Wood, coal, oil and gas can all be easily burned and have provided first heat and later electricity via heat engines. Combustion provides a reliable and continuous source of energy which makes our complex civilisation possible. Without heat and electricity we spiral down into chaos within as little as 24 hours, leaving people stranded in lifts, hospital life support systems paralysed and intolerable conditions of cold or overheat as heating and air conditioning systems fail.

As is often the case, people used fire and later boilers and furnaces before the chemistry of combustion was understood. After Priestley and Lavoisier, the work of Humphrey Davy at the Royal Institution on the combustion of methane following the Felling Colliery disaster in 1812 (ironically a disaster involving the extraction of another fuel, coal) started a train of combustion research by chemists that continues to this day. A great industry is built round research into combustion in gas turbines, fluidised bed combustors, furnaces, internal combustion engines and combined heat and power schemes, all with the intention of improving our understanding of the complex combustion process with its chain reactions and free radical mechanisms. But also with the intention of improving efficiency of fuel usage. Indeed the whole development of chemistry has been strongly influenced by fuel and combustion.

The treatment of fuels once they have been extracted from the earth involves a wide range of chemical techniques. Originally the primary fuel was coal; in the UK alone 287 mt were mined in 1913 and 100 mt exported. The Navy was only just in the process of switching to oil. The chemistry of coal utilisation included the analysis of coal, both proximate and ultimate, as well as many years of work in trying to establish the structure of the coal molecule. This information, embodying the measurement of calorific value, volatile content, propensity to cake during heating and so on was included in several methods for the classification of coal culminating in the NCB (National Coal Board) classification used today. This enables different coals to be directed to particular uses as steam-raising coals, coal suitable for conversion into strong metallurgical coke or, more appropriate, for gasification and the production of smokeless fuels.

The techniques of carbonisation and gasification are central to the development of coal technology. Coal is carbonised with the main object of converting it into products which can be utilised with improved efficiency and recovering valuable by-products which are generally lost when raw coal is consumed. An important product is coal gas and in the late 18th century coal gas was produced for illumination and this role of gas continued until well into the 20th century. Gas gradually came to be used as a clean and convenient fuel in the latter part of the 19th century. The by-products of coal gas manufacture were active coke which could itself be used as a clean, solid fuel and a host of organic chemicals, such as phenol, and oils which could themselves be converted into fuels, including petrol, and spawned an important chemical industry. This role was only taken over by the petrochemical industry, based on oil, in the late 1930s despite the discovery of oil early in the 19th century, when Col Drake drilled the first oil well in Texas (although he was looking for water at the time).

The chemistry and chemical engineering required to process oil had originally been developed in Scotland in the early 19th century by Young who retorted oil shale (Kerogen rock) available in the Bathgate area and then went on to distil and and chemically treat the products. As the oil industry grew, a powerful group of techniques, including catalytic and thermal cracking, reforming, acid treatment and so on, brought chemistry to bear and the petrochemical industry was born, leading to polymers, fibres, paints and a host of essential chemical products. Rather later, around the mid 1950s, steam reforming of naphtha led to a process to produce town's gas which replaced coal gas and this was only superseded in the UK when natural gas was discovered under the south North Sea in 1967. Natural gas brings its own chemical problems; the formation of clathrate compounds with water and the removal of sulphur compounds from sour gas.

Chemistry and the fuel industry have both benefited from their symbiotic relationship.

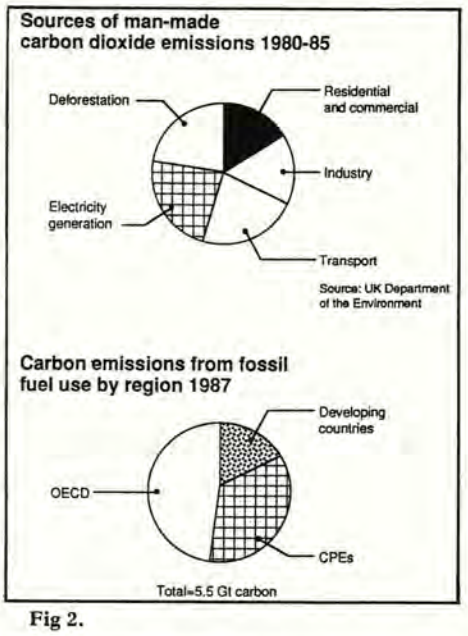

Fig 2.

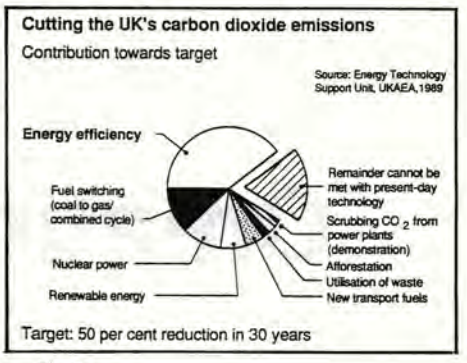

Fig 3.

Environment

The development of the oil industry and, more particularly, the coal and coking industries, were carried out initially with little thought for the depredation and dilapidation they caused to the environment. In the UK the clean air act of 1956, the result of the disastrous 'smogs' in previous years, triggered the national conscience into a belated interest in cleaning up the environment, but industry was reluctant to embark on an expensive clean up campaign without legislation. Even now it has required the European Community (EC) to adopt the Large Combustion Plants Directive (1988) and other legislation concerning dumping of waste and so on to force industry and others to clean up our polluted environment.

Table 3. Scenarios by fuel for 2020

	IIASA (1981) btoe	%	WEC (1986) btoe	%	WRI (1988) btoe	%
Coal High	4.6	28	6.0	31	1.4	31
Low			4.6	30	1.4	17
Oil	4.4	27	4.4	23	3.1	29
			3.2	21	2.3	29
Gas	2.7	16	3.4	17	3.1	29
			2.6	17	2.3	29
Nuclear	3.5	21	2.4	12	0.5	5
			1.7	12	0.5	6
Renewables:	1.3	8	3.4	17	2.6	24
Biomass etc			3.0	20	1.5	19
Total	**16.6**	**100**	**19.6**	**100**	**10.7**	**100**
			15.1	**100**	**8.0**	**100**

Problems outside the EC are highlighted by countries like Poland, Czechoslovakia and East Germany where the environment has been seriously, perhaps irrevocably damaged. The fuel industries must shoulder a good deal of the blame for global as well as national pollution. The production of acid rain by burning coal and oil on a large scale for electricity generation, leading to the destruction of forests and agriculture, as well as sterilising hundreds of thousands of lakes, is only dwarfed by the damage caused by the production of carbon dioxide which leads to global warming via the greenhouse effect. The consequences of this are as yet unknown, but the prospects of rising sea levels coupled with destabilisation of the weather machine are daunting. Most of this carbon dioxide is the result of burning one fossil fuel or another.

Whilst chemistry can do something to alleviate the formation of acid rain by scrubbing out the sulphur and nitrogen oxides from the flue gases, the prospect of removing carbon dioxide and then disposing of it in some acceptable way has proved an insuperable problem. Figure 3 shows some of the techniques which could be used to reduce carbon dioxide emissions in the UK, but the cost would be considerable.

Fossil fuels have sustained the growth of civilisation for several thousand years but the accelerating demand for more and more energy, encouraged by rapidly improving life styles and exacerbated by rapidly rising populations, particularly in the South, are beginning to emphasise the finite nature of fossil fuel reserves. Nevertheless, forward predictions suggest that fossil fuels will still supply some 70% of our ever-increasing energy demand well into the next century. More efficient use of energy is a paramount priority but even then the increasing combustion of fossil fuels leading to environmental damage by acid rain and, more insidiously, by carbon dioxide via the greenhouse effect, point to an uneasy and uncomfortable compromise between environmental protection and economic growth. Without population control and downgrading of lifestyle expectations, nuclear power will remorselessly take over from fossil fuels as reserves become depleted and world energy demand continues to accelerate. □

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Creating Higher Profits

by Johanna Fender

"CHP has a promising future since it gives . . . the opportunity to reduce energy costs and increase profitability." So said Dr Michael Clark MP in his keynote speech at the opening session of the Institute of Energy's annual conference *Creating Higher Profits*. As Chairman of the Commons Select Committee on Energy, Dr Clark was well placed to deliver his paper entitled *CHP — Can Parliament Help?*

But the conference was opened by the retiring President of the Institute of Energy, Douglas Willis. Mr Willis spoke of his personal involvement with CHP through the National Coal Board, spanning 30 years. He made particular reference to district heating schemes, such as the one in Nottingham, which was one of the earliest attempts in the UK to put 'all the talk' about combined heat and power into practice. The UK response to CHP however has not been as enthusiastic as that of the Swedes or the Danes, and Mr Willis attributed this to the traditional structure of the energy industries which has changed radically in recent years, opening up many possibilities for the further development of CHP.

In the first paper of the opening session Dr Michael Clark MP traced the history of CHP, giving three reasons why he believed CHP is a concept whose time has come. First, the 1973 oil crisis forced European countries to look for ways of using oil more efficiently. Second, environmental considerations have forced us to rethink the way we use fossil fuels. Third, and this point was emphasised again and again throughout the two-day conference, the privatisation of the electricity supply industry (ESI) has 'obliged local electricity boards to produce tariffs for the purchase of privately generated electricity', thus giving the opportunity to private operators of CHP plant of selling any generated power, surplus to their requirements, to the pool. That is the theory. In practice, so far at least, the pool price has remained so low that private generators have been unable to sell their surplus power at a profit. Disappointment was expressed by several speakers at the low pool price and its consequences for the profitability of CHP. By displacing fossil fuels, Dr Clark explained, the Department of Energy has estimated CHP could save one million tonnes of CO_2 per TWh: a potential saving of 55 million tonnes of CO_2 by the year 2020.

Dr Clark concluded his paper by explaining how parliament can help to promote the use of CHP. He cited the Select Committee on Energy's recent inquiry, which drew attention to the benefits and problems created for CHP by electricity privatisation. Parliamentary committees should raise awareness, and parliament itself should ensure there are no legislative barriers to the development of CHP schemes. Dr Clark was pleased to note that the European Parliament repealed the EC directive restricting the use of gas in power stations in March; and that in April, the UK government declared its intention to repeal section 14 of the 1976 Energy Act relating to the use of natural gas for power generation. Tax benefits and capital allowances might be introduced to encourage companies to invest in CHP facilities and heat grids, and the parliamentary committee had also recommended that the Government investigate ways to reduce the effect of pool-price uncertainties on CHP projects.

UK perspectives

Bill Houston, Chairman of the Combined Heat and Power Association (CHPA) was the second speaker of the opening session. Mr Houston welcomed the "much-needed competition" resulting from the privatisation of British Gas and the electricity industry. He went on to examine how CHP can cut energy bills and create higher profits. Technological advances in CHP mean that modern systems can achieve efficiencies of up to 90% — double that of a conventional power station. "We all benefit" he continued. "As the world strives to find acceptable solutions to . . . global warming . . . so the environmental benefits of CHP become clearer."

The economies of CHP, in addition to the corporate benefits of 'greening' an organisation, make compelling reading, said Mr Houston. With a lifetime in excess of 15

years, and a pay-back period of two to three years, savings accrue long after the initial capital costs have been recouped." In addition to this, fuel flexibility and its economic implications make CHP an obvious choice for many types of operation in industry, the public sector (eg hospitals) and local authority sector (community or district heating).

"CHP can be a powerful force in any organisation's marketing strategy ... (It is) therefore ... an important part of good business practice," proclaimed Mr Houston.

He concluded on an optimistic note: "recent developments in the energy markets have produced a combination of circumstances which mean that the prospects for CHP in industry have rarely been brighter." He highlighted several examples, among them CHP's exemption from the fossil fuel levy, 'insurance' against long-term uncertainty of electricity prices; and additional security of supply. He also welcomed the recently instated obligation on British Gas to offer transportation to third party gas on transparent tariffs, encouraging new entrants into the market, who are offering competitive long-term indexed contracts to large users of gas, so reducing the fuel-price risk inherent in CHP investments. CHP is now, he said, "looking like the shape of things to come" in the UK.

CHP in Japan

Chris Cragg, editor of Financial Times Energy Economist delighted the conference delegates with tales of being chased by a female-sounding robot in the Tokyo Gas headquarters, and quips about another Tokyo earthquake being due because the tube system was reaching capacity. On a slightly more serious note, his paper was a lively account of the Japanese experience with CHP, entitled *Small versus large generators: the case of Tokyo.*

Japan is an extraordinary case in many ways. The world's foremost economic power, it has high electricity demand growth, and a geographical range resulting in a temperature variation from 40°C to −14°C. These factors combined with high population densities in cities, and almost no indigenous energy resources have perhaps given rise to Japan's readiness to embrace new technology.

Mr Cragg traced the history of CHP in Japan from its first industrial application in 1970 to the late 1980's. In 1987 Japan possessed 850 MW of industrial CHP capacity and 130 MW of commercial capacity — almost a gigawatt, on a total of approximately 520 sites.

A total of 9.3 MW of CHP capacity in Japan is fuelled by gas from sewerage treatment plants, with some smaller units using animal waste. Yokohama alone has over 4 MW of 'digester' gas-fired CHP.

CHP in Japan has not so far been used for domestic heating, but Mr Cragg perceived this as a likely growth area. With an ageing population increasingly housed in condominium type accommodation, and a population "extremely addicted to very hot water in large quantities" CHP would seem the ideal solution.

Mr Cragg then turned his attention to Tepco, one of the world's largest power utilities, second only to EdF since the demise

The conference was accompanied by a highly popular CHP exhibition.

of the CEGB.

Long-term planning is made difficult for Tepco by the odd and unpredictable relationship between GNP growth and energy demand in Tokyo, where the winter peak, in terms of load factor, has been replaced by a summer peak due to abnormally high summer temperatures increasing demand for air conditioning. In percentage terms the change is not apparent: 56 percentage points of capacity in 1961, and 57 in August 1989. But in capacity terms the increase is enormous: from a few gigawatts in 1961 to over 24 GW in 1989, giving a projected rise to 38% in 1999. And this is where CHP comes in. Tokyo Gas's community energy system is a three × 300 kW gas turbine, fired by city gas producing 4 Gcal/h and 200 kW of electricity, which provides heating, air conditioning and that all-important hot water for the Shibaura district of Tokyo. The role of CHP would be to take off the excess peak load demand that Tepco will find increasingly difficult to meet.

A discordant note

Gordon MacKerron's was the first dissenting voice of the morning's proceedings. Dr MacKerron, of the Energy Policy Programme at Sussex University's Science Policy Research Unit (SPRU), gave a pessimistic paper entitled *The Environmental Contribution.*

He began by laying down tight perameters for his paper. It dealt only with medium industrial CHP projects (1 MW-20 MW). Coal was discounted in favour of gas. And the environmental focus was confined to SO_2 and CO_2. The contribution CHP could make to the environment was dependent on the scale of commitment to new projects, and the reduction in emissions per MW installed. Dr MacKerron pointed to the recent rise in gas prices by 35%, and the low pool price of around 1.7p/kWh on average, compared to the authoratively predicted 2.2p/kWh, as being major disincentives to investment in CHP. This was only offset by the relatively minor plus of the avoidance of the 11% fossil fuel levy provided no more than 49% of electricity generated be exported beyond the plant boundary.

In addition to the problems, sales to, and membership of the pool is far more complex than had been anticipated, and was seen as a further disincentive by Dr MacKerron. This limits the market scope. ETSU has estimated a maximum potential of less than 4000 MW of CHP plant, the Environment White Paper *This Common Inheritance* mentions a possible figure of 2000 MW. But a review by Ove Arup in 1988 concluded the likely scope was negligible to 700 MW, depending on the relationship between the prices of gas and electricity. On recent price trends Ove Arup's expectations fell to a total CHP market in the range of only 100 to 200 MW.

Dr MacKerron then outlined the potential contribution CHP could make to the environmental problems of SO_2 and CO_2 pollution. The key factor here, he pointed out, is whether CHP replaces coal or gas-fired plant: "if gas-based CHP replaces gas-based electricity, environmental benefits are unlikely to be very high." He emphasised that "it is the possible fuel-switching impact of CHP that makes much more difference to the net environmental impact than the improvements in overall thermal efficiency that cogeneration brings." Dr MacKerron saw CHP's only real potential contribution to the environment in its role in replacing coal-fired capacity, reducing both SO_2 and CO_2 emissions.

The voice of experience

British Coal's Head of Technical Services, Peter Mills, provided the conference with its first case history.

For the past 20 years Nottingham has benefitted from a district heating scheme. Back in 1968, the Nottingham Corporation chose waste incineration to deal with its landfill problem. At a time when inner city redevelopment was being considered, and the National Coal Board were seeking markets for coal-fired district heating schemes, a waste-fuelled CHP plant provided the best solution. The NCB's original intention had been to install new coal-fired boilers as back-up or for topping-up, but fortuitously an existing plant surplus to the requirements of its owner, Boots Pure Drug Company Ltd, was available, conveniently situated adjacent to the incinerator plant.

The aims of the Nottingham scheme at the time have even more relevance today: to solve refuse disposal problems (waste produces a higher level of CO_2 on landfill sites than it does when combusted); reduce pollution, boost local employment, and to provide a competitively-priced heat source for the people of inner Nottingham.

There were teething troubles. The cost of labour to operate the scheme was underestimated, and only 60% of those dwellings originally to be included in fact were. This has had an adverse financial impact on both the operators and the customers.

Charging customers has also caused problems. Bills are calculated on an annual

basis, and can vary greatly from year to year. 'Heat metering' using evaporative apportioning devices has also proved unpopular.

Further investment has been the greatest problem. The structure of the original agreement between the NCB, the City Council and the County Council stifles the incentive for further investment to improve either the financial or technical performance.

Technical difficulties also arose, such as the problem of fly-ash fouling at the back-end section of the boiler. After several years stress cracking occurred, and in 1982 an independent report suggested the boiler could be dangerous. The back end was replaced with another design, and since then the boiler has proved very reliable.

The underground pipe network has also caused problems, with leakage and corrosion from the secondary mains. This problem is gradually being overcome as the pipes are replaced.

A review by W S Atkins in 1987 recommended a new agreement be drawn up. But little changed until recent legislation "created a window of opportunity for restructuring the arrangement." This included electricity privatisation, new emission standards, and changes to responsibility for refuse disposal. The three existing partners are now seeking a fourth within the private sector, and it is hoped a large injection of capital will increase power production, whilst retaining the district heating.

Mr Mills hoped "that the Nottingham Story can continue to unfold well into the next century."

Business aspects

The Generation Manager for Midlands Electricity plc, Maurice Price, reviewed the business requirements for CHP in the light of the ESI privatisation and regulation, in his paper *CHP Business Aspects and Effects of Privatisation*. The "revival of interest in CHP was due to electricity privatisation and the increased availability of natural gas," he said; the financial performance of CHP being crucial. He described it as "a business venture rather than a technical adventure."

Concentrating on large-scale CHP, to meet industrial and commercial needs, Mr Price emphasised the importance of the realistic appraisal of CHP projects in environmental financial and engineering terms. If you don't already have the expertise on site, buy the very best advise: "it is very easy to build a CHP plant," he warned, "but it can be very difficult to build a *profitable* one."

Fuel options must also be carefully considered. Companies should aim to select a fuel which enables the financing debt to be covered, with adequate return, within the initial fuel supply contract period, thus removing much of the financial risk factor. For flexibility in times of fuel price fluctuations, two fuel options should be available at any one site. Not surprisingly gas emerged as the favoured option, coal and oil being constrained by handling complications and the emissions problem. In negotiating fuel contracts, plant operators should seek a price escalation formula to protect their long-term business interests.

When considering plant options, Mr Price emphasised the areas of capital and operating cost, reliability and over-all efficiency, fuel flexibility and the availability of spares. Look for a supplier with a demonstrable track record, he advised. Although he welcomed the privatisation of the ESI, Mr Price was less enthusiastic about the rigorous pool competition which has ensued, stating that the current low pool price precludes the guarantee of increased revenue from sales of surplus electricity generated. He concluded his paper by warning that "developers should take a realistic view of the true market value of (their surplus) power before taking a project to the full development stage."

Chairman of the third session of the conference, and Director of the CHPA, David Green (left), with speakers Albert Stocker (centre) and David Clementi.

Lessons learned

From Dream to Reality was the title of John Ashcroft's paper. Mr Ashcroft is Managing Director of Emstar Ltd, the energy management subsidiary of Shell. In January 1989 Emstar were selected by Tunnel Refineries to engineer, install, finance and commission a new CHP plant at their site in Greenwich, London. A 10-year operation and maintenance agreement was included in the contract, providing a complete 'utility service'.

Tunnel had considered a CHP scheme back in 1986, after realising that their forecasted electricity requirements over the coming decade were above the supply capacity of 15 MW available from the London Electricity Board. But unattractive gas prices caused the idea to founder. It was revived by British Gas' encouragement of CHP schemes, and its perception as a 'non-core' activity led Tunnel to sub-contract the project.

Emstar were faced with the formidable task of constructing the plant on site whilst Tunnel continued their normal operations. But in spite of all the difficulties, the new plant began operation in September 1990. It comprises two Ruston Tornado 6 MW(e) gas turbines, whose exhaust gases feed the waste heat boiler. This operates in conjunction with existing steam for use on the Tunnel process.

The boiler plant comprises one high pressure steam water tube boiler, and a medium pressure shell boiler, both from Senior Foster Wheeler.

The plant is manned 24 hours a day, seven days a week by shift engineers, who also conduct planned preventative maintenance. Although full CHP mode was commissioned in September 1990, the plant began generating power in May, allowing teething problems to be ironed out in the early stages.

The duel-fuel capability of both turbines and boilers has had its drawbacks, due to the differing combustion characteristics of natural gas and liquid fuels. A blade failure in one of the Ruston gas turbines lost a few day's operation in the early months, and each engine needs servicing every 8000 hours and allowance for cold washing resulting in a 96% availability. Tunnel will have to accommodate this by scheduling at least one maintenance shutdown into the Christmas period, and taking the opportunity to cold wash when an engine is shut down for other reasons.

The 'dream' has become a 'reality', he concluded, although there had been the odd nightmare along the way.

City-wide CHP

Bob Spain, Energy Manager for the corporation of London, described his approach to city-wide CHP.

The Corporation of London began to explore the potential of CHP in 1986. Almost 70% of their energy costs were accounted for by electricity. The all-electricity powered Barbican gave rise to the need for an alternative source. In addition the city centre has an exceptionally high demand for heat, cooling and power, and CHP offered an environmentally acceptable solution.

A working group was set up, and consultants were invited to submit proposals for a scope study, identifying and assessing all CHP

options in terms of scale, social and environmental impact and financial viability, with recommendations. W S Atkins were selected to conduct the study. They recommended a large-scale integrated scheme involving both Corporation and non-corporation buildings. The scheme provided environmental benefits, as well as improved security of supply, space saving from displaced plant as well as having public relations value. The public sector was encouraged to set up and manage the scheme, avoiding financial risk to the Corporation. Nine organisations were invited to demonstrate their success in funding, implementing and operating similar projects, with a view to reducing the costs of electrical, heating and cooling services.

Negotiations with the lead proposer, Citigen Ltd, have continued to establish a cooperation agreement with collateral agreements for electrical and heating services, hiring of plant and so on.

It has taken the Corporation of London five years to reach this point in the concept stage, and Mr Spain concluded his paper by looking forward to the "new and more exciting phase" — reality.

A new energy generation

The following paper in this second session of the conference was delivered by Bob Brown, and gave the Citigen side of the city-wide CHP story. Mr Brown, Director and Co-Chairman of Citigen, described the formation and structure of the organisation, why they were selected to undertake the project, and described the operational, organisation and marketing strategies they plan to adopt.

Citigen was formed as a joint venture company in July 1990 by British Gas and Utilicom Holdings Ltd. In 1989 the two companies submitted their joint proposals to the Corporation of London, and decided to join forces as discussions continued favourably. Citigen was finally selected to proceed with the planned scheme — the first city-wide scheme in Britain.

A central engineering station is to be installed in Charterhouse Street, on a site originally used by the Smithfield Market Electricity Supply Company, adjacent to the market. The 'core' distribution system will serve key Corporation buildings: the Guildhall, the Barbican, the Museum of London and Bastion House. Dedicated, insulated pipes will carry hot water for heating, chilled for air conditioning, and electrical distribution cables will be laid. In addition the local network of London Electricity will also be used. In April this year licences came into force to generate and supply electricity.

In accordance with EC standards for 1995 advanced flue gas cleaning techniques and equipment will be used, and it is anticipated that the CHP station will be cleaner than the atmosphere at road level.

Citigen anticipate a conclusion to the negotiations with the Corporation over the long-term Cooperation Agreement in the near future. In return for the Corporation's goodwill and support, Citigen will give them benefits in the form of "attractive and competitive energy changes." They also anticipate enquiries concerning such schemes from other areas in the UK, and intend to follow up any opportunities. Their development plan includes the pursuit of opportunities abroad as well, and Citigen see their potential as a major force in this sector of the CHP market.

Finance

David Clementi and Robert Lewin of Kleinwort Benson gave their paper *The Business Environment for CHP*, emphasising the benefits from the new arrangements for the ESI. But they also warned that the new licencing regulations brought obligations and burdens which had implications for CHP.

Giving the merchant banker's perspective on CHP, Mr Lewin described the two basic approaches to raising funds for a CHP project.

Robert Evans, the incoming President.

First the traditional corporate obligation, most suitable for small-scale plant with a single purchaser. And second, to arrange project financing, suitable in larger schemes, where the risk is apportioned between all participants. This has the advantage of 90% of costs being financed by long-term debt (up to 18 years for power stations). However, long-term obligations can be burdensome; costs may be greater as a result, and lack of confidence in the project's progress may develop.

Before seeking finance, a company must be certain of a scheme's technical and economical viability, with an independent engineer's report and proven fuel availability. And in the face of fluctuating pool prices, a parent company guarantee is "useful". Previous operating experience is looked upon favourably by financiers, and so entering into a contract with an existing generator would be advantageous.

Once construction is achieved, re-financing is possible on better terms. But a project must be up and running first, the classic 'chicken and egg' situation.

Both speakers concluded that financing CHP is "relatively complex."

Case study

Executive Director of Project Finance at the Swiss Bank Corporation, Albert Stocker gave the commercial banker's perspective on *Private Power Financing*. His paper gave the examples of PURPA in USA and Lakeland Power in the UK, and was illustrated with witty cartoons, much to the delight of his audience. PURPA is the Public Utility Regulatory Power Act, and was passed in the US in 1978. The Act set up so-called 'qualifying facilities' (QFs) exempting them from regulation, with the requirement on utilities with QFs in their service territory that they buy output from these at a price known as 'avoided cost'. This 'cost' is equal to the price the utility would have paid for a unit of electricity generated by itself. The new QFs are expected to be smaller, burn a greater variety of fuel, and be more efficient.

To date in excess of 38000 MW of independent power capacity has been installed, with an expected addition of 52000 MW over the next decade. The Swiss Bank Corporation has acted as arranger or co-arranger in $3 billion of project financing. The framework for private power generation in the UK was provided some time later, in 1989, with the Electricity Act. The Lakeland Power Project in Cumbria was the first independent scheme. The Swiss Bank Corporation also arranged the finance for this scheme, the progress of which Mr Stocker described as "swift", due to several factors. First, the site was "excellent" with an existing 120 MW coal-fired power station (Roosecote). Lakeland also negotiated the first 15-year gas supply agreement with British Gas, and a 15-year sales agreement with NORWEB. Lakeland had a fixed-price, date-certain, turnkey contract for the new plant, and a long-term fixed-price maintenance contract. Finance was closed in a matter of a few months, before the regulatory mechanism for licencing had been created. Lakeland had to sit and wait.

Mr Stocker observed that since Lakeland few projects had materialised in the UK, due to "growing pains" in the new ESI.

He then took the conference delegates through a case study in arranging finance. But before you approach the bank, he warned, have all the key project agreements to an advanced stage of negotiation, as Lakeland had.

British Gas approach

Colin Playle is Director of Industrial and Commercial Marketing at BG. He began his paper *CHP — The British Gas Approach* by highlighting the role of gas in CHP projects. Natural gas is, he said, a major contender to fuel CHP projects because of its "minimum impact on the environment of any fossil fuel." He went on to examine the environmental benefits of CHP systems, with their overall efficiency of up to 90%.

Mr Playle's second major point was to explain BG's pricing strategy. Recent events have made BG appear less than favourable to CHP schemes, but he claimed, this is not the case. Mr Playle explained that the Monopolies and Mergers Report on the pricing of industrial and commercial contract gas recommended that BG should change to a system of

published price schedules rather than individually negotiated contracts. "We were not too keen on these ideas ... nor were too many of our customers," he declared. But BG made "Herculean" efforts to comply, bearing in mind that such a schedule should aim to encourage the development of CHP.

Mr Playle continued by describing the types of CHP available, giving examples of their applications, such as the small-scale CHP installation at Hull Maternity Hospital, using high-efficiency gas boilers, which shows savings of 52000 therms per year.

In accordance with the theme of this second morning's session, Mr Playle examined the possibilities for financing a CHP project. He looked at leasing, purchase of heat and power and joint ventures. British Gas is working towards being able to facilitate and finance CHP schemes using, in part, BG funds. These funds will be used selectively, depending on several factors, such as viability.

Finally Mr Playle described BG's plans for market development. Their recent 'resource' advertisements "produced an overwhelming demand for information and literature on CHP." Mr Playle pledged that British Gas would devote extra staff and resources to developing the CHP market, and dealing with enquiries.

The 'overwhelming' amount of interest shown in CHP proved to BG that there is "a massive market waiting to be tapped." And they intend to be there to tap it.

Love affair

John Forte, the Executive Director of Environmental Services at Gardner Merchant Ltd, gave a torrid account of his company's "love affair" with CHP in his paper *Why Invest in CHP?*

Like many companies, Gardner Merchant were forced to examine their energy requirements by the 1970s oil crisis. For the first time they appointed an energy manager, and embarked upon a campaign of efficiency. The use of CHP was restricted at this time in the UK, but the Energy Efficiency Office was eager to run pilot schemes, and invited Trusthouse Forte, part of the Gardner Merchant group, to take part in a trial to test the feasibility of small-scale CHP.

The variable load factor determined that the scheme should supply a base load, with peak-time balance to be imported from the grid. The Castle Hotel, Windsor was the chosen site, with independent consultants monitoring the scheme. The pilot scheme proved that electricity of standard quality could be produced on a small site, that the system could run in parallel with the existing supply; that excess power generated could be fed to the grid system, and that financial benefits would result for the operator. Despite high maintenance costs, the project showed a payback period of four years.

In 1987 Trusthouse Forte embarked upon their second CHP trial at Manchester Post House, using a prototype by Combined Power Systems which claimed to have overcome the problems experienced at Windsor, and promised large energy savings with a three year payback period. The trial demonstrated this, with additional benefits.

Trusthouse Forte decided to go ahead with their first major installation at the Heathrow Post House and the first year showed annual savings in the region of £100 000 a year, and Mr Forte said, with confidence, that "in new hotels, extensions, new leisure centres and refurbishments, CHP will become the first option."

With 13 units now installed, and 14 to be commissioned within the coming year, Gardner Merchant have demonstrated their enthusiasm for CHP. John Forte concluded his paper, stating that they have identified a potential of 200 sites in which CHP can be economically justified.

International CHP

In the global context, SE Asia is the area which has the greatest potential market for CHP. Certain countries in SE Asia have been experiencing high growth rates in electricity demand, and projections suggest that this will continue through the 1990s. The increasing burden upon the public sector debt provides a strong motivation to privatise a proportion of the future capital required for power generation.

Peter Borré, President and CEO, Gas Ventures Advisers, used the Public Utility Regulatory Power Act (PURPA), previously mentioned by Albert Stocker, as a model, whereby traditional utilities work alongside private power projects in the 'bulk' power market.

Mr Borré went on to discuss fuel choice, which he immediately narrowed down to gas or coal. He felt oil price instability and uncertainty about nuclear power narrowed the field considerably. Environmental considerations were starting to become an important factor in many developing countries, and this would, Mr Borré felt, tilt the scales in favour of natural gas. In addition gas has in its favour lower capital intensity, with the possibility in many countries of using indigenous or neighbouring gas.

The conference proceedings were brought to a close by the President Elect of the Institute of Energy, Robert Evans. In a comprehensive summing up of what had been a highly successful, interesting and sometimes surprising, two-day conference he praised the speakers for their scope and eloquence, they were, he said, "masters of their subjects." He agreed wholeheartedly with Dr Clark's opinion that "the failure of CHP to become widely accepted as an efficient form of energy generation is one of the most disappointing examples of poor resource utilisation in the latter half of the twentieth century."

Mr Evans went on to describe the climate necessary for the greatly increased use of CHP, calling for future legislation to "positively encourage" its wider use. Both the financial and economic arguments in favour of CHP are very strong indeed, and with the knowledge that a rival is already doing it, the incentive to invest in CHP is, he said, compelling. □

Proven technology with substantial savings

THE BUILDING Services Research and Information Association (BSRIA) has recently completed a major research programme on condensing boilers, and has released a series of technical appraisal publications based on the findings. These address such issues as: improvements in boiler design; efficiency platforms; the roles of lead and lag boilers; how weather affects the performance of condensing boilers; which buildings offer the best condensing potential; the efficiencies of boilers in different heating circuits; and selecting suitable condensing circuits.

The aim of these documents is to make it a great deal easier for specifiers to decide when condensing boilers will be cost-effective. Also to indicate to designers a range of system options to encourage the most efficient and hence most environmentally friendly use of condensing boilers.

BSRIA research indicates that condensing boilers are not beneficial in every installation. As a rule of thumb it is difficult to justify economically installing non-domestic condensing boilers of less than 100 kW output. In general condensing boilers will form part of a multi-boiler installation. One used in isolation will rarely have a realistic economic justification. It is essential that installations with condensing boilers maximise their condensing potential in relation to payback. Boilers are a long-term investment and maximising efficiency makes excellent long-term environmental economic sense.

BSRIA's investigations suggest that where there is no condensing potential there is no economic justification for using a condensing boiler in the role of a high efficiency boiler.

The Old School Yards Complex of the University of Edinburgh, heated by an Atlantic condensing boiler system.

Combustion process

To understand condensing boilers it is necessary to understand the combustion process. Approximately ten cubic metres of air are needed to combine with each cubic metre of natural gas. The burning of this mixture results in a flue product with nine parts of hot gasses combined with two parts of water vapour. This can lead to a substantial amount of wasted energy in two forms: sensible heat due to the elevated gas temperature, and latent heat in the water vapour. Together these amount to around 2 kWh per cubic metre of gas burned. That is around 20% of the gross calorific value of the fuel. It is these energy losses which condensing boilers aim to minimise.

Boilers fall into one of four categories — conventional, high efficiency, single condensing, and double condensing. BSRIA has categorised boilers types alongside seasonal efficiencies.

Every boiler specified today should be operating above the 80% efficiency platform. New European Commission Directives and Standards seem likely to insist that this must be so and even higher efficiencies may become mandatory.

Seasonal efficiencies based on the gross calorific value of the fuel are the mean heat to water efficiencies over the full heating season with a varying boiler load. The instantaneous efficiency measured by combustion test equipment will be higher than the seasonal efficiency.

These platforms are intended as an easy and reliable reference to the efficiencies to be expected using the different technologies. The high seasonal efficiencies result from the much-improved part-load operating characteristics of modern boilers. Work by British Gas indicated efficiencies of 84-92% at 10% load and full load boiler efficiencies of 85-99%. Given these figures the seasonal efficiencies shown in BSRIA's technical appraisal are clearly achievable.

Conventional boiler designs do not reach the 80% efficiency platform now proposed.

Boiler designs

With conventional designs approximately 20 kWh is lost through the flue for every 100 kWh of energy consumed. In addition, traditional boiler designs often have poor boiler thermal insulation resulting in high casing losses of 3% or more. Even when the boiler is off, up to 8% of the total output can be lost through stack ventilation. The result is an efficiency over the heating season of around 60% — rising at the very best to 77%.

Better results can be obtained from modern high efficiency boilers. Standing losses are virtually eliminated and modern designs of combustion path aim to form a natural air lock to inhibit stack ventilation losses. High efficiency boilers are capable of operating with a seasonal efficiency of up to 84%.

To get onto the 85% platform and above, it is necessary to use a condensing boiler. In a single condensing boiler an additional heat exchanger cools the flue gases below the dewpoint releasing some of the latent heat in the water vapour and transferring more of the sensible heat in the flue gas so that the boiler has a seasonal efficiency of up to 95%.

Double condensing boilers incorporate three separate heat exchangers and are capable of operating at 98% efficiency.

BSRIA concludes that condensing boilers are a proven technology and produce very substantial savings provided they are understood and specified correctly. The first three parts of this technical appraisal series are now available as a set at £10. Discounts are available for multiple sets. For further information contact: Publication Sales, BSRIA, Old Bracknell Lane West, Bracknell, Berks RG12 4AH. □

Joint undertaking

'European Electric Power Trends'
Arthur Anderson & Co,
SC/Cambridge Energy Research Associates
1990-91 Edition, 111pp, $95.00

THIS book is the product of a joint undertaking between two firms providing strategic management services to energy industries worldwide. As such it is an eye-opener. It comprises an interesting essay of some 15 pages, which analyses the trends in electric power generation in Europe, and some statistics which are almost all from secondary sources.

The introductory essay is nicely arranged, but has no particularly new insights. It identifies the "new perspective" as being driven by "competition and commercial orientation", the "transition of the Eastern European countries" and "public demands for a cleaner environment". This would seem to be conventional wisdom of a sort with which most people in need of strategic management services would already be quite familiar.

The graphics in the data section are more beautiful than anything produced by the IEA or the OECD (from where much of the information comes), but it is hard to understand how this can compensate for the high price and the obsolescence compared to the original sources. Anyone seriously interested in these issues will have more comprehensive and recent data; anyone with a passing interest will have difficulty in justifying the money.

Dr Nigel Lucas

Review and assessment

'Coal gasification for IGCC power generation'
by Toshi'ichi Takematsu and Chris Maude
IEA Coal Research, London, 1991
80pp. Report No: IEACR/37
IEA Coal Research Member Countries, £60.00. Non-member countries, £180.00

CONCERN for environmental issues has generated increasing interest in new technologies for coal utilisation which offer increased efficiency with reduced emissions.

Coal gasification is a well established technology for the production of pipeline or synthesis gas. Processing of the raw gas can remove particulates, sulphur compounds and other impurities. Efforts have been made to take advantage of these proven commercial scale systems and to adapt them to coal conversion for electric power generation.

This report reviews the various gasification processes that have been developed and makes an assessment of their readiness for application in utility service.

A simplified technique for comparative analysis of different schemes is presented, which introduces the concept of heat by-pass. Attention is drawn to various facets of the process where additional development could be expected to result in increased plant efficiency, with particular emphasis on hot gas cleaning.

A brief survey at the end of the test shows that more than twenty countries have active programmes aimed at furthering development of IGCC applications, including several with plans for full-scale demonstration plants.

This report should act as an important source of reference for anyone interested in the subject.

Andrew W Cox

Best chance for future

'Physical Limitations to Photovoltaic Energy Conversion'
Edited by A Luque and G L Araujo
Adam Hilger, Bristol, Philadelphia and New York, 1990
173pp, £32.00

THE Ramon Areces Foundation brought a group of leading authorities to Spain for a seminar in 1989 to discuss the limits of efficiency of solar cells.

Improved efficiency will be the key to lowering photovoltaic electricity costs for two reasons: it reduces (per energy unit) costs of the solar cell and it also reduces the 'balance of system' costs (the costs of the rest of system). This is particularly true with concentrating systems which are especially suitable in clear regions such as countries round the Mediterranean basin.

Professor Luque starts by discussing the broad range of developments in solar cell efficiencies achieved during the past decade. Silicon cells in concentration had achieved 29.3%, while gallium arsenide had reached 29.2%. But a tandem of GaAs/GaSb cells, a two bandgap device, had achieved 37% in the laboratory.

Subsequent chapters include Professor W T Welford's presentation of the physical bounds of the concentration of light, resulting from the conservation of the space of phases, and underlining how resonance effects based on the wave nature of light can lead to high luminous intensities in certain structures. The general question of the conversion of radiant energy into useful work is taken further in a discussion of the thermodynamic limits to photovoltaic energy conversion by J E Parrott.

The second editor, Professor Araujo, presents the limits of the efficiency of cells under radiative recombination, and shows that with an infinity of cells under a spectrum of splitting scheme, this limit could be 86%. Professor P T Landsberg discusses the mechanisms of recombination in solar cells. In the final chapter Professor R Mertens presents Belgian work on the analysis of surface recombination mechanisms.

By presenting a better understanding of efficiency limits, the book will be of considerable value to active workers in the field. The editors also hope that it will give policy makers something to reflect upon. As leading authorities, they are firmly convinced that photovoltaic energy is one of the most promising technologies for future energy production. When it is appreciated that millions of people in the developing countries live in remote areas where centralised power is very unlikely, the use of photovoltaics is probably their best chance for future electrical power requirements.

Dr Cleland McVeigh

For reference

'Dictionary of Environmental Science and Technology'
by Andrew Porteous
Open University Press, Milton Keynes, Buckingham
403pp, £12.00 (P/B), £32.50 (H/B)

THE AIM of this new dictionary is to provide both the student and the general reader with a working knowledge of the scientific and technical terminology associated with environmental studies and appraisals of current issues.

In addition to the alphabetical list of definitions there are appendices giving over 200 organisations concerned with pollution and the environment, an abbreviated table of elements and a conversion table for SI and British Units.

Murphy's Law for Authors states that any reviewer will open a book at a page with an error and this book proved to be no exception. The Solar Constant is approximately 10 times smaller than the value quoted by Professor Porteous, his initial definition of Lithosphere is "The earth's crust . . ." and figures 59-65 are described as "A summer of the common fission reactor types". But there are many elegant definitions and explanations contained in this concise work which should become a useful addition to the reference literature when the minor errors are expunged.

Dr Cleland McVeigh

Recently published

'International Coal Encyclopedia'
Coal Services International Ltd, 1991
620pp, £299.00

'International Marketing Data and Statistics 1991' (15th edition)
Euromonitor, 1990, 608pp, £130.00.

'Alternative Uses for Sewage Sludge'
Conference Proceedings
Edited by J E Hall
Pergamon Press, 1991, 391pp, £45.00.

'Solar Photovoltaic Products
A Guide for Development Workers'
by A Derrick, C Francis and V Bokalders
New revised edition
Intermediate Technology Publications, 1991, 128pp, £12.50.

'Sin' or 'artefact'?

Sir,

I hesitate to do battle with such an eminent engineer and thinker as Prof Thring, but swallowing my fear, I draw my sword from its scabbard to make a few tentative prods at his article — Viewpoint (*Energy World*, May 1991).

First, his apocalyptic view of man's impact on the environment and his new definition of original sin — "All these are a sin against our descendants". Derelict power stations — a sin! Artificial radioactivity — a sin! The mind boggles. If this view is to take root in engineering education, then I can envisage the following types of question appearing on an engineering finals paper:

Q The three-phase induction motor is morally inferior to the horse and trap. Discuss.

Or, how about:

Q Please arrange the following thermodynamic cycles in ascending order of sinfullness;

a) Otto, b) Stirling, c) Carnot.

Give full reasons for your choice.

A power station — working or derelict — is simply a human artefact and is no different to Hadrian's Wall or the pyramids of Egypt. They were designed to fulfill a function and when finished with were discarded to undergo recycling by those twin eternal 'ions', erosion and corrosion; sometimes man assists with demolition. This cycle of creation and destruction is the blind, careless activity devised by Mother Nature; painstakingly building mountains over an eon and remorselessly grinding them to rubble in the next. A derelict power station is no more a sin than an extinct volcano. Incidentally, an active volcano is a natural source of pollution far worse that the dirtiest power station that man ever allowed to fall derelict.

Man has learnt to his advantage how to store energy and control its release by observation from nature. Modern man may have more power at his elbow than had the average neanderthal, but the amounts are infinitesmal compared to that present in the sun — the source of all our being. Prof Thring seems to support a thesis which says that the decayed results of previous solar activity — the fossil fuels and nuclear material — shall not be touched by modern man. Essentially all we should be allowed to use is the daily dose of solar energy received by this planet. Inevitably this implies a vast increase in the use of renewables, even if energy demand was drastically cut. The environmental impact of the large scale developments of renewables could be quite significant and therefore such a scenario is fraught with uncertainty.

What is this perceived characteristic of 'traditional wisdom' that Prof Thring sees people returning to? I see no evidence that our forefathers possessed some higher morality, or wisdom, which enabled them to have lives of 'creative self-fulfilment'. By the use of his ingenuity and exploitation of the natural resources, man has enabled a segment of his race to rise above the mere drudgery of existence. Obviously, the benefits are not available to all and it is not possible to predict how rapidly this segment will expand. Inequalities have always existed and in spite of our best efforts will continue into the future.

Unfortunately, there is nothing in the historical or prehistorical records that engenders confidence that our civilisation can succeed where others have failed. There is no way that I can guarantee my own future in the next decade, never mind the future for any grandchildren that I might have. It is no more selfish to be concerned about this generation, as it is to express concern for some future, containing our descendants. This is not to argue that we should ignore all the issues raised by Prof Thring and do nothing at all, but making haste slowly in most circumstances is often the best policy.

Alan Wright *(Member)*
Newcastle-upon-Tyne

'Piltdown' coincidence

Sir,

With reference to Wilfrid Beswick's 'Times Remembered', article (*Energy World*, May 1991), I would like to add that the discovery of natural gas near Heathfield railway station was made by a certain Charles Dawson.

It is a delightful coincidence that the same Charles Dawson discovered the fossil remains of 'Piltdown Man' a few years later. The originator of this well known archaelogical fraud was hidden even to Sherlock Holmes in a recent TV programme!

David Morton *(Member)*
Moseley, Birmingham

TV star to name Britain's top young inventors

THE UK's brightest young inventors are competing for the prestigious title of 'Young Engineer for Britain 1991' — with the winner being announced on 11 September by Carol Vorderman the star presenter of TV and radio science and maths programmes.

The environment is being highlighted in this year's Engineering Council competition, with two environmental prizes worth more than £5000 being awarded to schools entering the best projects which investigate engineering solutions to environmental problems.

The national final of the competition will be held at the National Westminster Hall in the City of London and Carol Vorderman, who gained an engineering degree at Cambridge, will be announcing the winners.

The competition aims to encourage young people aged 11 to 19 from schools, colleges and industry to undertake engineering project work and to strengthen links between education and industry.

The overall winner of the competition itself will be awarded the coveted 'Young Engineer for Britain 1991' title, a trophy and £1250 for his or her school or organisation for the purchase of engineering equipment.

Runners up will receive prizes of study visits to companies, cash prizes of up to £600 for themselves and their schools and the opportunity to discuss projects and career prospects with highly-qualified people in the field of engineering.

The best project by a girl or team of girls will win the WISE (Women Into Science and Engineering) award of £500 from the Engineering Council.

Nominations invited for 1991 Young Woman Engineer of the Year

THE ANNUAL search is underway for the Young Woman Engineer of the Year and suitably qualified young women, under the age of 30, now have the opportunity to compete for the coveted title 1991 Young Woman Engineer of the Year. Entrants for this prestigious award — now in its fourteenth year — will be required to prove that they hold a responsible position at Incorporated Engineer level and they should have successfully completed all the necessary technical education and training.

The Institution of Electronics and Electrical Incorporated Engineers (IEEIE) jointly sponsors the award with the Caroline Haslett Memorial Trust. Its aim is to highlight the exciting and rewarding career prospects available to women in electronic and electrical engineering. It is hoped that the example of the winner — previously they have been chosen from the whole spectrum of electronic and electrical engineering — will motivate and encourage more women to embark upon professional careers leading to Incorporated Engineers status.

Copies of the award nomination form and brochure are available from: The Secretary, IEEIE, Savoy Hill House, Savoy Hill, London WC2R 0BS (telephone: 071-836 3357).

Recommended salary levels for 1991

UKAPE has revised and reprinted its booklet — *Recommended Salary Levels for Professional Engineers.* This is a set of recommended scales renumeration in 1991 for application with *A Guide to the Classification of Professional Engineering Responsibility Levels* also published by UKAPE.

Both publications are available at: Hayes Court, West Common Road, Bromley, Kent BR2 7AU. Tel: 081-462 7755, both priced at £10.00.

September 1991

Measurement and Instrumentation of Electroheat
Short course, 2-6 September, Worcester, UK.
Details from: BNCE, 30 Millbank, London SW1P 4RD. Tel: 071-834 2333 ext 6339.

Offshore Europe 91
Exhibition and conference, 3-6 September, Aberdeen.
Details from: Judith Patten, Offshore Europe 91, Neville House, 55 Eden Street, Kingston-upon-Thames KT1 1BW. Tel: 081-547 1566. Fax: 081 547 1143.

Energy Efficiency in the Metals Industry
Conference, 6 September, Birmingham, UK.
Details from: Ms H Grainger, The Institute of Metals, Conference Dept, 1 Carlton House Terrace, London SW1Y 5DB. Tel: 071-839 4071. Fax: 071-839 3576.

1991 ASME Cogen — Turbo V
5th international symposium and exposition on gas turbines in cogeneration repowering and peak-load power generation, 3-5 September, Budapest, Hungary.
Details from: ASME Public Information Dept, 345 East 47th Street MS-13C, New York, NY 10017, USA. Tel: (212) 705-7740. Fax: (212) 705-7740.

Sixteenth Annual Symposium of the Uranium Institute
Symposium, 4-6 September, London.
Details from: Uranium Institute Symposium, Concorde Services Ltd, 10 Wendell Road, London W12 9RT. Tel: 081-743 3106. Fax: 081-743 1010.

Fifth International IEE Conference on Electrical Machines and Drives
11-13 September, London.
Details from: IEE, Conference Dept, Savoy Place, London WC2R 0BL. Tel: 071-240 1871 ext 282.

Michael Faraday 1791-1867
Exhibition and lectures, 13 September - 18 January 1992.
Details from: National Portrait Gallery, St Martins Place, London WC2H 0HE. Tel: 071-306 0055.

Focus on Environmental Law
Conference, 17-18 September, London.
Details from: Alison Jones. Tel: 071-236 4080. Fax: 071-583 7107/071-489 0849.

Inpower 91
Exhibition and conference, 24-25 September, London.
Details from: Inpower 91, Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS. Tel: 0737 768611. Fax: 0737 761685.

Solid Liquid Separation
Short course, 24-27 September, Bradford, UK.
Details from: Dr Ing J Svarovska, Course Organiser, Fine Particle Software, 8 Carlton Drive, Bradford, W Yorks BD9 4DL. Tel/Fax: 0274 546276.

The Power and Efficiency of Marine Propulsion
Conference, 26 September, London.
Details from: Miss Caroline Little, Conference Officer, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Tel: 071-636 1004.

Success — A Matter of Course
Short courses, September 25 and November 14, Luton, UK.
Details from: Lucas CEL Instruments Ltd, 35-37 Bury Mead Road, Hitchin, Herts SG5 1RT. Tel: 0462 422411.

October 1991

Hydrocyclones
Short course, 1-3 October, Bradford, UK.
Details from: Dr Ing J Svarovska, Course Organiser, Fine Particle Software, 8 Carlton Drive, Bradford, W Yorks BD9 4DL. Tel/Fax: 0274 546276.

Amsterdam EWEC '91
Conference and exhibition, 14-18 October, Amsterdam, The Netherlands.
Details from: Van Manen & Westerlaken Congress Organisation Services, PO Box 1558, 6501 BN Mijmegen, The Netherlands.

Auditing Environmental Air Pollution
One-day practical workshop, 18 October, London.
Details from: Profex, Buckingham House, The Broadway, Stanmore, Middlesex. Tel: 081-954 9546. Fax: 081-954 5772.

Particle Size Measurement and Sampling
Short course, 22-24 October, Bradford, UK.
Details from: Dr Ing J Svarovska, Course Organiser, Fine Particle Software, 8 Carlton Drive, Bradford, W Yorks BD9 4DL. Tel/Fax: 0274 546276.

Control of Oil Pollution
Short course, 20-25 October, Hertfordshire, UK.
Details from: Miss Caroline Little, Conference Officer, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Tel: 071-636 1004.

International Trade Fair for Environmental & Safety Technologies
Exhibition, 22-25 October, Ostend.
Details from John Haigh Exhibition Services, 14 Station Way, Peckham, London SE15 4RX. Tel: 071-639 7265.

Classification of Fine Solids
Short course, 29-31 October, Bradford, UK.
Details from: Dr Ing J Svarovska, Course Organiser, Fine Particle Software, 8 Carlton Drive, Bradford, W Yorks BD9 4DL. Tel/Fax: 0274 546276.

November 1991

Gas Turbine Conference on Target
Conference and exhibition, 31 October - 1 November, Harrogate, UK.
Details from: Ms Frances Colbourne at ID Exhibitions Ltd. Tel: 0895 622233.

World Clean Energy Conference
Conference, 4-7 November, Geneva.
Details from: CMDC, Zentralsekretariat, Kellerweg 38, CH-8055 Zurich. Tel: 41-1-463 02 26. Fax: 411-463-02-52.

Hazardous Chemicals
One-day seminar, 11 November, London, and 26 November, Coventry.
Details from: Profex, Buckingham House, The Broadway, Stanmore, Middlesex. Tel: 081-954 9546. Fax: 081-954 5772.

Back to the Future — Subtech 91
Conference forum, 12-14 November, Aberdeen.
Details from: SUT. Tel: 0224 823637. Fax: 0224 820236.

Nuclear Power — A Fresh Start
Conference, 13-14 November, London.
Details from: Amanda Wright, IBC Technical Services Ltd, Bath House, 56 Holborn Viaduct, London EC1A 2EX. Tel: 071-236 4080. Fax: 071-489 0849.

Business Gains from Energy Efficiency
Conference and exhibition, 20 November, Cardiff.
Details from: J W Wallington, Energy Efficiency Officer for Wales, Industry Dept, Welsh Office, Cathays Park, Cardiff. Tel: 0222 823126.

December 1991

The Use of Polymers in Drilling and Oilfield Fluids
Conference and exhibition, 9 December, London.
Details from: Cathryn Evans, PRI, 11 Hobart Place, London SW1W 0HL. Tel: 071-245 9555. Fax: 071-823 1379.

Subsea 91 International Conference
Conference and exhibition, 4-5 December, London.
Details from: Subsea 91 International Conference, Themedia Ltd, PO Box 2, Chipping Norton, Oxon OX7 5QX. Tel: 060884 700/888. Fax: 060884 796.

January 1992

1st Mediterranean Oil & Gas Exhibition & Conference
28-31 January 1992, Valletta, Malta.
Details from The Spearhead Group, Rowe House, 55/59 Fife Road, Kingston upon Thames, Surrey KT1 1TA. Tel: 081 549 5831.

ENERGY WORLD YEARBOOK 1992

CALL FOR INFORMATION

Work on the next edition of the Institute's yearbook has already begun and the editor would welcome any input from readers – particularly on the following topics:

- **Conferences seminars and exhibitions** planned for 1992/93 in the UK or overseas
- **New energy awards.** Details of any to be introduced, or deletions/amendments to existing ones
- **Energy-related courses**. New or revised at universities, colleges and polytechnics, or specialist courses sponsored/organised by professional bodies and industrial organisations
- **New technical journals** relevant to energy, or changes in address/publisher of existing title
- **Online or CD-ROM databases** relevant to energy. New or existing databases not listed in the current issue that members can recommend
- **Organisations and trade associations** in the energy sector – new or changes in the present listings
- **Firms not listed in the Buyers' Guide section**. Information on product lines or services

You can write to the Institute's headquarters at 18 Devonshire Street, London W1N 2AU, or contact the editor, Alan Field direct at:
Underdown, Ledbury, Herefordshire HR8 2JE (Tel: 0531 631110 Fax: 0531 631176)

INSTITUTE OF ENERGY CONFERENCES

The following programme is currently being organised by The Institute of Energy.

For further details please contact Judith Higgins or Jill Leigh on 071-580 0008.

9 October	**ENERGY FROM WASTE — Green, Clean & Profitable** **Venue:** CBI Conference Centre, London WC1 **Chairman:** Mr B Lees (Institute of Energy)
12 November	**Challenges in ENERGY STATISTICS** **Venue:** The Royal Society, London SW1 **Chairman:** Dr A W Cox
9-11 December	**5th International Fluidised Combustion Conference** **FBC TECHNOLOGY & THE ENVIRONMENTAL CHALLENGE** **Venue:** The Mount Royal Hotel, London W1 **Chairman:** Mr J S Harrison (British Coal)

Conferences co-sponsored by The Institute of Energy

7-10 October	**2nd International Symposium on Coal Combustion** **Contact:** Dr Chen Changhe, Dept of Thermal Engineering, Tsinghua University, Beijing 100084, China
10 October	**The Environmental Audit and The Estate** **Contact:** Rosemary Flewitt, The Institute of Hospital Engineering, on 0705 823186

In 1992

14-17 June	**ECO World '92** **Contact:** ASME, on (212) 705 7148 (fax: 705 7143)
14-16 September	**Electrical and Control Aspects of the Sizewell B PWR** **Contact:** Sheila Griffiths at the IEE on 071-240 1871