ENERGY WORLD

The magazine of The Institute of Energy

Number 212
October 1993

INSIDE THIS ISSUE

Features on gas turbines and CHP

INSTITUTE OF ENERGY CONFERENCES

Please note that the conference programmes are subject to modification. For the latest information please telephone Judith Higgins on 071 580 0008.
The Institute of Energy, 18 Devonshire Street, London W1N 2AU, UK.

Making Energy Privatisation Work

The Future of Regulation

17 November 1993, London

Queen Elizabeth Conference Centre, London SW1

Speakers include: Tim Eggar MP, Minister for Energy; Professor James Harrison, Institute of Energy; Professor Nigel Lucas, Imperial College; John Baker, National Power plc; Malcolm Chatwin, Yorkshire Electricity Group, plc; David Jefferies, National Grid Company plc; Cedric Brown, British Gas plc; Alan Marshall, AGAS; Lady Wilcox, National Consumers' Council; Ian Blakey, British Iron and Steel Producers' Association; OFGAS speaker to be advised;Richard Morse, Kleinwort Benson; Richard Caborn MP, Trade & Industry Select Committee. Conference Chairmen: Mr Ian Powe, Gas Consumers' Council and Professor Nigel Lucas, Imperial College.

Modernising Central Europe's Energy

Opportunities & Experience

Organised in association with the Parliamentary Group for Energy Studies

9 March 1994, London

The Church House Conference Centre, London SW1

Senior figures have been invited to address financial and political aspects of the subject, issues such as: options for institutional/structural change the role of financial and technical assistance and its effectiveness. The afternoon session will focus on the opportunities and experience for major players in the UK. The areas covered include: Power Generation — international ventures the theoretical opportunities and practical solutions; Networks on upgrading and expansion; and opportunities for British expertise with observations on the opportunities available and those presently being missed.

2nd International Conference on

Ceramics in Energy Applications

20-21 April 1994, Regent's College, London W1

This two-day conference will consider material solutions to new and existing applications of interest to energy suppliers and users. Important aspects of materials innovation in energy saving will be explored. Sessions will cover the following areas: New Developments & Applications; Energy Saving & Heat Transfer; Evaluation & Performance; Power Generation; Sensors & Catalysts; Energy Efficiency.

Events Co-Sponsored by The Institute of Energy

26 October 1993

The Monitoring & Management of Combustion Processes following the EPA 1990

and
8 December 1993

Process Controls For Boilers & Furnaces

General Enquiries should be directed to:
David Suthers, Combustion Engineering Association, PO Box 15, Farm Road, Aberaman, Aberdare, Mid Glamorgan CF44 6YZ. Tel: 0685 879119

January 1994, Calcutta, India
First International Conference on
General Enquiries should be directed to:

Combined Cycle Power Generation

Professor Prabir Basu, Technical University of Nova Scotia, PO Box 1000, Halifax,
Nova Scotia, Canada B3J 2X4, Tel: 1-902-420 7531
Paper Co-ordinator for the submission of abstracts from European Countries:
Dr J R Howard, Tel: 44-21-705 1946

ENERGY WORLD

OCTOBER 1993 Number 212

CONTENTS

COVER

The gas turbine pictured on this month's front cover achieved a milestone in October 1992, when GEC Alsthom's Frame 9F was successfully load tested at over 200 MW at the Electricite de France Gennevilliers power station in north-west Paris. It was at the time the highest ever recorded output by a single gas turbine.

The Frame 9F was manufactured in GEC Alsthom's European Gas Turbines factory in Belfort, France, and was delivered to Gennevilliers in early March 1992. It is due to start commercial operation before the end of the year.

The magazine of The Institute of Energy

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Need for MMC inquiry

The following Viewpoint is a summary of a recently published report by ***Stephen Fothergill*** *and* ***Nigel Guy*** *of the Coalfields Communities Campaign, entitled* ***Magnox: The need for a Monopolies and Mergers Commission inquiry into the operation of Nuclear Electric's Magnox power stations.***

When the government privatised the electricity supply industry in 1990 it was unable to find buyers for nuclear power stations. However, Nuclear Electric was given a uniquely privileged position in the electricity supply market in England and Wales. It has a guaranteed market for all the electricity it can produce, regardless of price, and receives a subsidy of over £1 billion a year from the electricity consumer via the nuclear levy.

Nuclear power stations generate more expensive electricity than either of their main competitors — existing coal-fired stations or new gas-fired plant. The government's coal White Paper accepts this. Nuclear Electric's Magnox stations are old and are the most expensive of all suppliers of base-load power. Their continued operation displaces eight to nine million tonnes of coal a year.

Nuclear Electric argues that the Magnox stations should be kept open because their 'avoidable costs' are low — that is, very little money would be saved by closure because fuel and other costs are largely fixed. The savings that would arise from closing the Magnox stations are, it is argued, less than the savings from closing fossil-fuelled stations. This is a perfectly acceptable argument, as long as Nuclear Electric's figures for avoidable costs are reliable.

Claims of low avoidable costs are largely dependent upon its £14 billion fuel services contract with British Nuclear Fuels (BNFL), the terms of which mean that very little money can be saved by the early closure of Magnox stations.

There are, in fact, strong grounds for believing that Nuclear Electric's figures on Magnox avoidable costs, based upon this contract, are misleading as the basis for public decision-making:

- in Scotland one of the best performing Magnox stations closed in 1990 because its operator, the South of Scotland Electricity Board (SSEB), decided that its avoidable costs were greater than those of the company's main coal-fired power station;
- the SSEB's estimates of Magnox avoidable costs are nearly twice those put forward by Nuclear Electric;
- Nuclear Electric and BNFL have a strong mutual interest in defining most Magnox fuel costs as unavoidable, because both companies benefit from the continued operation of the stations;
- BNFL is the monopoly supplier of Magnox fuel fabrication and reprocessing services — there are no competitors against which to judge whether its practices or charges are reasonable;
- the BNFL chief executive admitted in oral evidence to the Trade and Industry Select Committee that £2 billion in Magnox fuel fabrication and reprocessing costs could be avoided if all Magnox stations were closed immediately.

Nuclear Electric and BNFL remain publicly owned. The public has a right to expect that such large amounts of money are spent in the best interests of the tax payer and the electricity consumer.

Further doubts about the validity of Nuclear Electric's calculations of Magnox costs arise because of the company's income from the nuclear levy, which obscures the true position of the company's day-to-day finances:

- income from the levy allows Nuclear Electric to withstand the drain on its finances which would otherwise occur because Magnox operating costs are substantially higher than the market revenue from its electricity;

- the Magnox stations that have so far closed either failed to meet safety standards or were unable to benefit from the nuclear levy, whereas all the serviceable stations that benefit from the levy have stayed open.

The all-party House of Commons Trade and Industry Select Committee did not have the time to get to the bottom of these claims in its recent investigation of the energy market. The government shied away from a thorough investigation of the economics of Magnox stations in its own coal review.

There has therefore been no full and independent inquiry into Nuclear Electric's claims of low Magnox avoidable costs, despite the strong suspicions which exist about these claims.

What is needed is an in-depth study of the operation of Nuclear Electric's Magnox stations. This should be carried out by the Monopolies and Mergers Commission (MMC), a body with powers to investigate areas claimed by Nuclear Electric and BNFL as commercially confidential.

Until the MMC has carried out such an inquiry, there can be no confidence in Nuclear Electric's claim that there is a sound economic basis for the continued operation of its Magnox stations.

Stephen Fothergill
Director, Coalfield Communities Campaign and Professor, Centre for Regional Economic and Social Research, Sheffield Hallam University
Nigel Guy
National Research Officer, Coalfield Communities Campaign

Magnox: The need for a Monopolies and Mergers Commission inquiry into the operation of Nuclear Electric's Magnox power stations *is available from CCC, 9 Regent Street, Barnsley, S Yorkshire S70 2EG. Price £10.00.*

Renewables study in CIS

AN 11-month study into the prospects for renewable energy in the Commonwealth of Independent States (CIS) has been commissioned from Intermediate Technology's consultancy arm (ITC), and German consultants DECON.

The consultants will look at the technical and economic possibilities for renewable energy sources up to the year 2010 in all seven countries of the former Soviet Union. It will build on a study commissioned by the EC into renewables in EC countries, which started in 1991.

The study aims to evaluate the future technical performance of renewables and their environmental implications, as well as their effects on infrastructure and manufacturing. It will identify the resources available and the current status of renewable energy sources in each CIS country. Finally policy recommendations will be made to secure energy supplies.

Safety review for Russian reactors

TEN contracts have been awarded to a German-French consortium by the EC to review the safety of VVER pressurised water reactors in the former Soviet Union.

Parties to this consortium are Siemens AG, EDF and Framatome. The measures are being financed within the scope of the European aim programme TACIS, which has a total budget of 32 million ECU for upgrading the safety of the VVER reactors in the CIS.

The objective of the review is to make Western know-how in the field of safety engineering available to CIS countries. Pressure vessels of the older VVERs will be checked for embrittlement along with the integrity of the coolant system. Monitoring, maintenance and training are further fields of activity.

Finns say 'no' to nuclear power

THE Finnish parliament have abandoned the government's positive decision in principle on the fifth nuclear unit in Finland.

The final vote was close, with 107 against, and 90 in favour.

Power utilities Imatran Voima Oy (IVO), Industrial Power Company (TVO) and Perusvoima Power Company (PEVO) have issued a statement saying solutions to cover the baseload demand for power for the year 2000 and beyond remain completely open.

No decision need be taken as yet, however, as the construction time for alternatives, such as coal-fired plant, are much shorter than those required for nuclear power.

The Finnish utilities claim that nuclear power is still a favoured energy source for baseload generation, and IVO and TVO aim to continue their nuclear cooperation.

North American company to market clean coal technology

A NORTH American company, Duke Energy is the preferred provider of the British Gas/Lurgi (BGL) gasifier design for coal gasification combined cycle (CGCC) projects in North America.

Under an agreement signed in September, the company will lead the marketing of CGCC technology and development projects in the US, Canada, Mexico, Central America and the Caribbean.

In the gasification process coal reacts with oxygen and steam at high temperature and pressure to produce a fuel gas. The fuel gas is then cleaned and burned in a combined cycle power plant. The result is higher efficiency and a significant reduction in emissions, as compared to conventional coal-fired plant.

The BGL design consists of a gasifier in which a 'fixed' bed of coal is constantly maintained. The slag produced leaves the gasifier and is quenched with water. The resultant material is non-hazardous.

Developed from Lurgi's fixed-bed dry-bottom gasifier, the design is used worldwide.

Duke Energy's proposal was selected for funding by the US Department of Energy (DOE) in May under round five of the US Clean Coal Technology Program.

The proposed 484 MW project will also utilise a molten carbonate fuel cell which will produce 2.5 MW of electricity.

EC transfrontier waste transport

THREE European waste companies recently launched an action in the European Court of Justice, *according to Nabarro Nathanson's Community Dimension newsletter*, claiming the a new EC regulation on the shipment of waste has hit their businesses badly.

The regulation does not come into force until May 1994, but reaction so far reflects the political sensitivities surrounding transport of waste across national boundaries.

The regulation aims to phase out the export and import of waste to and from EC member states, promoting self-sufficiency in waste disposal. It also aims to encourage waste disposal as close as possible to the point of production and ensure the environmentally sound management of waste.

It adopts the distinction found elsewhere in EC waste legislation, between waste finally disposed of (landfilled or incinerated without energy recovery) and waste which is 'recovered (recycled or used for power generation).

Waste will be divided into three categories: red (highly hazardous), amber (less hazardous, includes waste oils and sludges) and green (other types).

'Baby Arun' delay

THE World Bank's 'Baby Arun' dam project in Nepal has been delayed while the bank's appraisal team return to Nepal to re-examine the case for the $764 million hydro scheme.

An alliance of local groups have been opposing the scheme on the grounds that it could overwhelm Nepal's burgeoning small-scale hydro industry, which is succeeding in supplying power to poor rural areas.

The controversy has come as the World Bank begins a period of heart-searching about their policies and their implementation.

If the dam project goes ahead Baby Arun would be three times the size of the largest power generation scheme in Nepal. Funding, technology and expertise would all come from abroad, by passing local capability and the potential for creating employment.

First PFBC in Japan

THE first pressurised fluidised bed (PFBC) plant in Japan was fired successfully in September at Wakamatsu.

Design and manufacturing of the plant began in February 1991, and system tests have been in progress since July.

The unprecedented speed of construction was aided by the repowering of the original steam turbine, and the use of infrastructure at an existing site. The plant was supplied by Ishikawajima Harima Heavy Industries of Japan and ABB of Sweden.

The Japanese utility EPDC will own and run the plant when it is commissioned at the beginning of 1994. In addition they will run a three-year demonstration programme to veryify the plant performance under varying conditions and with the use of different coals.

PFBC plants are currently in operation in Sweden, Spain and the USA. Construction of another similar plant in Japan is already underway.

Didcot CCGT approved

ON BEHALF of the President of the Board of Trade, Tim Eggar has given consent to National Power plc for the construction and operation of a 1500 MW combined cycle gas turbine (CCGT), which will be known as Didcot B.

An inquiry held in December 1991 and January 1992 concluded that consent should be granted, subject to certain conditions. These cover issues raised by the relevant planning authorities, among others. Mr Eggar added further conditions requiring the company to monitor emissions and establish a local liaison committee and companies procedure.

Appointments

THE new director general of gas supply has been announced as Claire Spottiswoode. She will serve a team of five years in the post. She will take over from Sir James McKinnon as of 1 November this year.

Roger Hayes is to become director general of the British Nuclear Industry Forum. He replaces Dr John Gittus.

OFFER has appointed a new deputy director general. Mr Peter Carter replaced Miss Penny Boys at the end of September.

A new independent director has been appointed to United Kingdom Nirex Ltd. Mr Alex Ferry (general secretary of Confed) replaces Ray Buckton, former general secretary of ASLEF, who is stepping down after seven years. Mr Ferry will be taking up his post in 1994.

Dr Christopher Fay has been proposed to the board of Shell UK Ltd to succeed Sir John Collins as chairman and chief executive, as from 1 November this year. Dr Fay has been a managing director of Shell UK Ltd and also Shell UK Exploration and Production — the UK's biggest offshore operator.

And Conoco (UK) Ltd has appointed a new chief executive and managing director: Dr George Watkins, succeeding Mr Bob Irelan.

September saw the official opening of the Central Area Transmission System (CATS) and Teeside power station by Lord Wakeham (above, right). The project marks the first time North Sea gas has been piped ashore directly to a major industrial area in the UK. The 250-mile CATS pipeline comes ashore at Coatham Sands and then crosses under the Tees to the Seal Sands site. The project is a joint venture between Amoco, Amerada Hess, British Gas, Phillips, Agip and Fina. Close to 300 million cubic feet of gas per day will provide fuel for Teeside power station on a 15-year contract. Teeside is the world's largest gas-fired combined heat and power plant at 1875 MW, and began commercial operation in April this year. Its process steam goes to nearby ICI.

THORP criticised and defended

THE LATEST issue of *Science and Public Affairs* has defended the beleaguered thermal oxide reprocessing plant (THORP) at Sellafield.

William Wilkinson, chairman of the British Nuclear Industry Forum, and Sir John Hill, former chairman of the UK Atomic Energy Authority, were responding to claims in the previous issue of *SPA* that the nuclear processing industry is a commercial dead end.

When planners designed THORP, the cornerstone of their strategy was the retrieval of uranium and plutonium from overseas nuclear wastes. Critics now argue that economic prospects are bleak. But Hill and Wilkinson insist that decommissioning THORP would incur huge costs and would leave the UK with several thousand tonnes of imported spent nuclear fuel.

SPA is a joint magazine of the Royal Society and the British Association for the Advancement of Science. It had earlier claimed that "the fuel cycle is badly out of balance."

US company joins UDM in pit bid

US MINING company, Jim Walter Resources (JWR), has joined the UDM in a British Coal privatisation bid for deep mines in the Nottinghamshire coalfield.

JWR operates four mines in Alabama with an output of 10 million tonnes. The company president is a former miner from County Durham, and he claims that his company can double British Coal's productivity levels.

UDM president, Neil Greatrex, said that JWR was the only company among those considered that took a long-term view of the future of UK pits.

HSE launch NESC network

THE Health and Safety Executive joined forces with the EC to launch a network for evaluating steel components (NESC) used in the nuclear industry. Apart from the UK, other EC countries expected to participate include France, Germany, Japan and the USA.

NESC aims to create a forum to evaluate inspection and assessment methods, and to work towards the use of best practice and the harmonisation of standards.

Hartlepool AGR operating extended

The HSE has given approval to Nuclear Electric's application to extend the operating periods between statutory shutdowns at the Hartlepool advanced gas-cooled reactor.

The intervals will be increased from two to three years. The move marks a significant change in the operation of nuclear power reactors in the UK. Since licensing began in 1960 all power reactors have been subjected to two-year shutdowns.

Edwards launches mining project

FORMER British Coal commercial director Malcolm Edwards (right) has launched out into his own coal mining project. Heading a new company — Coal Investments plc — Mr Edwards hopes to build a strong independent coal mining business based on licensing pits British Coal no longer wishes to operate.

To obtain a quick stock exchange quotation, Coal Investments backed into the shell of the former tin and coal mining company, Geevor plc, with the support of merchant bankers Guinness Mahon and Co Ltd.

The company was launched on 20 September, aiming at a preliminary rights issue of £1.75 million to finance the redevelopment of the first mine in the group, Cwmgwili, near Ammanford. Cwmgwili is an anthracite pit first developed by the National Coal Board in the 1960s and licensed by them to UK Consolidated Mining Ltd last year. Coal Investments has agreed to acquire UK Consolidated.

Cwmgwili mine has reserves of top grade anthracite, conservatively estimated at 800 000 tonnes, with options on further reserves. The high quality fuel is superior to most of the anthracites currently being imported into the UK, and the reserves will last at least seven years.

Tenders have been lodged by Mr Edwards for five of the nineteen collieries offered by British Coal for lease and license. These are understood to be: Markham Main and Rossington, Coventry, Trentham and Betws. Together, Betws and Cwmgwili would be the largest producers of Welsh anthracite in the private sector, second only in size to British Coal.

Said Mr Edwards: "There is business available for some of the best mines closed recently. As British Coal focuses more and more on its core electricity business, there will be room for companies operating a small number of mines and concentrating on markets other than power stations. It will require a wise and well-informed choice of mines and a thoroughgoing understanding of the markets available. Fitting mines to markets and markets to mines is the key to the whole concept. The small mine technology developed around the world in the past 20 years if carefully deployed within the existing structures of these mines should generate a healthy cash flow with little delay and requiring only modest levels of investment."

While the pits will produce lower tonnages than when they were operated by British Coal, that will reduce business risk in the current market uncertainties. Mr Edwards' intention is that pits which would otherwise disappear will be staying open to preserve access to valuable coal reserves and provide wealth and jobs for local communities.

He is confident that the threat of foreign coal competition has greatly reduced, thanks partly to the devaluation of the pound to around $1.50. British-mined coal is in a stronger position to resist import penetration.

An experienced team to run the enterprise already exists in embryo. Director of mining will be Brian Nicholls, a British Coal trained engineer who managed pits in Yorkshire and the Midlands before going to Australia, where for 20 years he has acquired practical experience of large-scale successful private sector mining. Elizabeth Peacock MP has agreed to join the board as a non-executive director.

Obituary: Andrew Holmes

ANDY HOLMES, who died at his home in Brighton on 11 September after a long struggle against brain tumour, packed into his 36 years enough hard work and experience to satisfy the career ambitions of several people. In a very short time he built up an unassailable reputation as a political and technological commentator. He was the first to recognise the impossibility of privatising the nuclear generation business when the true cost of decommissioning was eventually revealed.

Born in Greenock and educated at Stirling and London Universities, he joined the civil service as a press officer, first in the Department of Industry, then Energy. This was a valuable insight into the workings of Whitehall and gave him an edge in his developing journalism.

He joined Financial Times Newsletters in 1982, where he edited the *European Energy Report*, and in 1987 oversaw the launch of *Power in Europe*, which quickly became required reading for electricity executives throughout the EC.

Andy Holmes' ability to predict the outcome of major policy decisions was phenomenal. He foresaw the collapse of the coal industry almost as soon as the Government announced electricity privatisation, and it was with reluctance that the Government pundits acknowledged the accuracy of his analysis of the nuclear energy situation.

He exposed the secretiveness of the generating industries so incisively that he quickly became an acknowledged 'expert', and was in great demand at energy conferences and for radio and television. He will be sorely missed by those who believe in the freedom of information.

Two of the most energy efficient buildings to be constructed in Scotland collected the top prize in ScottishPower's 1993 Business Energy Awards, announced in Glasgow in September.

The revolutionary design of two new residences for the University of Strathclyde maximises every energy efficiency opportunity. The result is that energy use is half the average for similar buildings. They make greater use of solar energy, with specially constructed areas of the south facing walls collecting solar energy, which is stored and then released slowly into the building.

Pictured above is ScottishPower's Peter Hare (left) with Cameron Johnston (right) of Strathclyde University's Energy Systems Division , displaying a section of the transparent insulation material used on the award winning James Blythe Court building, which can be seen in the background.

Among the winners of the Industrial Awards was Peebles Electric Ltd of Edinburgh, part of the Rolls Royce Group.

Manx contract awarded

THE CONTRACT for the Peel 'B' power station on the Isle of Man has been awarded to John Mowlem Construction Ltd by the Manx Electricity Authority.

The turn-key contract, worth in excess of £19 million, is for the design and construction of a diesel-fired power station, which will eventually replace the Peel 'A' station, now approaching the end of its life.

Two Mirrlees Blackstone MB430 diesel engines, each rated at 10 MWe at 500 rpm using low-sulphur heavy fuel oil, will supply 20 MWe of power to the Isle of Man high voltage distribution network.

The scope of supply includes diesel engines, electrical generators, waste heat boilers, cooling towers of the latest 'low plume' design, an 80m high multi-core chimney with slip formed concrete windshield, fuel treatment units, HV and LV switchgear, transformers and cabling, a distributed control system with interface to the island's control centre at Pulrose together with site clearance, civil engineering and buildings works, which include substantial piled foundations and engine foundation blocks.

In addition to meeting the requisite environmental standards for emissions, a condition of the planning consent was that the plant should meet exacting noise standards which requires the engines to be mounted on suspended foundation blocks to minimise transmitted vibrations. Considerable emphasis has been placed on maximising local employment opportunities for the benefit of the Isle of Man economy and on minimising inconvenience to the local community. Close attention is being paid to achieving exceptionally high safety and quality standards.

John Mowlem Construction is one of the UK's foremost engineering and construction contractors. They have undertaken a substantial number of power generation and CHP, including a 15 MWe combined cycle facility at Harworth Colliery.

Devonport Royal Dockyard has made a 40% reduction in its annual energy costs, thanks to its effective energy management policy. The company's energy saving programme was instigated in 1988, and has achieved savings in the region of £6 million since then. Energy manager, Andy Vodden has pioneered a number of innovative new systems, and works within a annual budget of £200 000. A recent investment was in three light units used to control the lighting circuits in the frigate refit complex, pictured above. The units combine with a photosensor which shuts down each of the 30 kW sodium lighting systems when the ambient light reaches a predetermined level.

World first in solar energy

A UK company has designed and developed a world-first in solar energy. Kestrel Solat Technology Ltd has created the world's first mobile solar power and water purification unit, called SolaGen.

Small, highly efficient and highly mobile, it has the ability, as well as supplying a remarkable amount of power, to pump and purify large amounts of water and to provide refrigeration to preserve vaccines and other medicines.

Because of its mobility — it can be towed across difficult terrain or even lifted in by helicopter — SolaGen has already interested those in emergency and aid services.

SolaGen is fitted with a 1 kW array of solar electronic panels, and was the result of two years' intensive research by Kestrel into the solar industry, in particular, photovoltaics. They found rapid progress in terms of cost and efficiency, but little thought given to making mobile units for use in remote areas or in emergencies.

"There is nothing like it currently available," said William Unwin of Kestrel. "It is absolutely perfect for rapid response situations and for use in remote areas where power does not exist at all. It will pump and purify up to 2000 gallons of water a day. Twelve purification units were recently used in the chaos of the Mississippi floods.

"With this and its power and refrigeration capabilities, one unit can meet the needs of a school or a medical unit, or even several homes. In the case of a school, SolaGen will power the water supply, four classrooms, library, TV and video equipment and other aids presently unavailable to the remotely-based teacher, because of lack of power. Medically, the unit can meet many needs, by powering operating theatres, lighting, computers and so on."

Nottingham upgrade commissioned

A £5 million scheme to upgrade an energy from waste district heating plant in Nottingham has been completed on time, without any disruption to heating and hot water supplies.

The project, which involved modifications to the city's London Road heat station and the installation of a new steam turbine to increase generating output, was carried out by the British Coal consultancy, Coal and Energy Services.

The upgrade has an environmental spin off, increasing capacity of the nearby Eastcroft incineration plant, which supplies steam to the heat station, by 15% to around 140 000 tonnes of domestic and trade refuse a year. It also more than doubles — to 10 MW — the amount of electricity which can be generated by the station. Surplus electricity will be sold through the grid.

Higher efficiency lower emissions

*by Dr Detlef Viereck**

The GT13E2 gas turbine, developed by ABB, is the result of further evolution of the successful GT13, of which 120 units have been sold. It combines a proven basic design with advanced burner and combustor technology. The GT13E2 is the first gas turbine in its class to have an annular combustor fitted with ABB's double cone, lean premix burners, known as EV (environmental) burners. With a turbine inlet temperature of 1100°C and a pressure ratio of 15:1, it is capable in single-cycle applications of a power output of 164.3 MW and a thermal efficiency of 35.7%. Combined cycle gross efficiencies of up to 55.5% can be achieved.

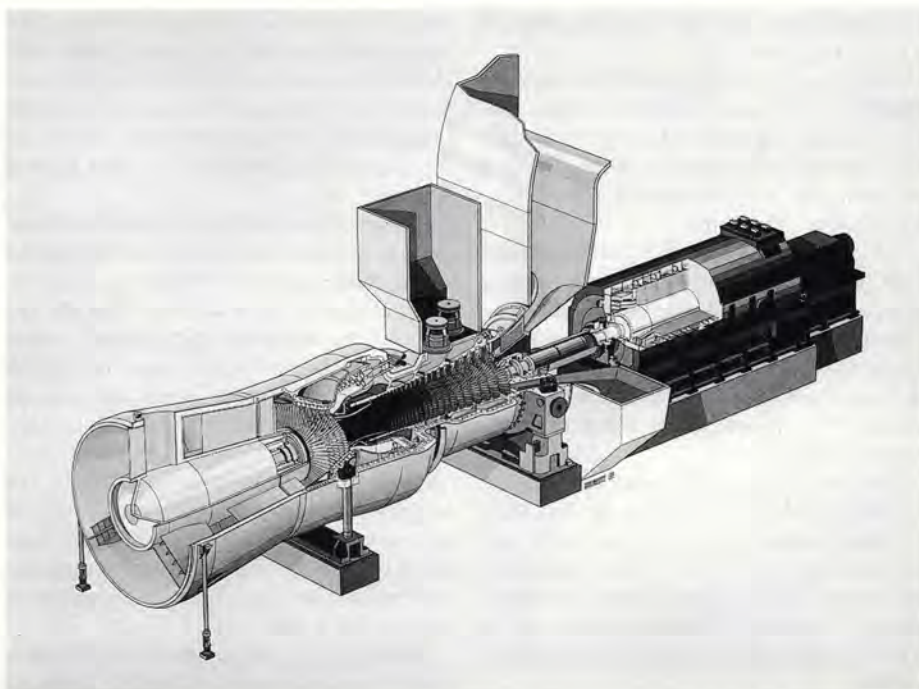
In an ecologically-minded world, modern-day power plant technology is expected to satisfy very high standards, and produce power in a way that does minimum harm to the environment as it makes maximum use of available resources. Against this background, gas turbines, particularly those installed in combined cycle plants, are gaining steadily in importance. Gas Turbine development engineers have two main goals: a significant reduction in pollutants, particularly of the nitrogen oxides (NOx), at their source, and the optimisation of the gross efficiency of combined cycle power plants in order to improve the utilisation of the primary energy and lower CO_2 emissions.

Besides these ecologically-orientated aspects, development work on advanced gas turbines also seeks to secure the turbine's and the overall plant's reliability and availability, and so allow them to be operated economically.

The new GT13E2 gas turbine shares some fundamental aerodynamic and mechanical design features with the proven GT13 gas turbine family. These include a single shaft supported by two bearings, a welded, maintenance-free rotor, a subsonic compressor, five turbine stages, an efficient cooling system for the turbine rotor, blade carrier and front stages, and a single combustor. The development of the new gas turbine benefited particularly from the extensive experience accumulated with the GT13E; its basic design, with verified high component efficiencies, has been largely retained in the new gas turbine type. The main difference between the GT13E2 and its predecessor is the new unit's annular combustor, which replaces the GT13E's silo combustor. Additionally, the turbine inlet temperature has been raised from 1070°C to 1100°C and the compression pressure ratio from 13.9:1 to 15:1. The result is a high specific power output for single-cycle applications as well as a high combined cycle thermal efficiency.

The relatively moderate turbine inlet temperature of 1100°C is in line with ABB's philosophy whereby an increase in thermal efficiency and power output has to be achieved not only by increasing the turbine inlet temperature and pressure ratio but also by enhancing the efficiency of the different gas turbine components and the overall gas turbine process. Thus, the thermal and mechanical loads exerted on the blading are low, leading to a direct improvement in the reliability and availability of the power plant.

The GT13E2 has an air-cooled ABB generator of type WY21Z as standard. Situated on the 'cold' side of the turbine, this two-pole, three-phase synchronous generator has three radical journal bearings located outside of the split generator casing, an arrangement which provides easy access for maintenance of the bearings and the generator components. The brushless exciter with rotating rectifier in three-phase bridge circuit is situated at the end of the turboset. The brushless



Thermal block of the GT13E2 gas turbine with air-cooled generator of type WY21Z.

*ABB Kraftwerke AG

exciter has two main advantages: it requires no maintenance and sparking is eliminated.

The inlet casing of the GT13E2 surrounds the journal and the thrust bearing on the compressor side of the rotor. The bearings can be inspected with the turbine in operation. The subsonic 21-stage compressor of the GT13E2, with variable inlet guide vanes and extraction points after the fourth, eighth and twelfth stages, is practically the same as that in the GT13E.

Extensive testing of the first GT13E machine in Hemweg showed that the blade loads were low and the surge margin is high. Given this knowledge and the very good operating experience with the GT13E compressor, to increase the suction mass flow it was only necessary to increase the angle of incidence of the compressor vanes; no changes had to be made to the dimensions or the blade profiles.

The compressor is enclosed by the compressor casing and the compressor combustor casing, both of which are split axially and radially for easy maintenance. The compressor combustor casing carries the fuel lances of the EV burners and the manifold which supplies the burners with gas and oil fuel as well as water for oil firing.

The turbine casing has a manhole at the top through which the combustor internals can be inspected without having to dismantle the casing. Besides the annular combustor, the turbine casing also encloses the five-stage turbine and the turbine vane carrier.

All of the turbine blades have the same profiles as the GT13E blades. The second and third row of rotating blades and all the vanes have shrouds fitted. The first three rows of rotating blades and the first two rows of vanes are cooled.

The exhaust casing, a welded structure mounted on the rear end of the turbine casing, encloses the journal bearing of the turbine shaft end. The bearing can be inspected when the machine is at standstill without having to remove the casing.

The rotor of the GT13E2 is of traditional ABB design, being welded and maintenance free, and has a total of seven forged discs. Due to the annular combustor, some minimal changes had to be made to its middle section, although the distance between centres and the diameters in the compressor and turbine area stayed the same.

The most obvious difference between the GT13E2 and its predecessor is the GT13E2's annular combustor, which replaces the silo combustor of the GT13E . This has reduced the overall height of the machine by about 4 meters, which translates into a major saving as the power plant building can be made smaller.

The GT13E2 combustion system consists of one annular combustion chamber with 72 double cone, lean premix burners. The annular combustor is divided into two zones. Zone one, in which the combustion of the fuel takes place, contains the front segments with the EV burners and the rows of outer and inner cooling segments. Zone two, which contains the inner and outer liner, guides the hot gas to the turbine with very low cooling leakage.

Bladed rotor of the GT13E2 gas turbine, with welded, maintenance-free rotor.

The compressor diffuser is based on extensive design calculations and flow tests carried out at ABB's research laboratories. The diffuser directs the main air flow from the last stage of the compressor to the plenum, where a small amount of the air is used to cool the first two rows of vanes, while the main air flow enters the combustor via the EV burners. Another small air stream is guided direct to the flow sleeve of the inner liner of zone two to provide controlled conductive cooling of this section. The cooling air for the first three blade rows is also directed via the compressor diffuser and fed into the rotor by means of small guide nozzles.

In the annular arrangement of the EV burners, two pairs of burners are slightly displaced on the radius to form four annular burner rows. This burner arrangement ensures homogeneous mixing of the hot gas for an even temperature distribution in front of the first-stage vane. The fully symmetrical arrangement of the burners and the homogeneous temperature distribution under both full and part-load conditions is unique for gas turbines in the power class of the GT13E2. The arrangement significantly reduces the fatigue loading of all the parts exposed to the hot gases, leading to improved reliability and availability for the gas turbine.

The EV lean premix burner is the key component of the low NOx combustor. It is the result of an extensive R&D programme started by ABB in 1987 to reduce NOx levels to less than 25 ppm. The EV burner is basically a cone split axially into two halves and offset to provide two constant width inlet slots. Combustion air enters through the slots and, when the unit is run on gas, mixes the fuel injected through fine holes at the end of the slots. Because of the burner's special design, a high-speed vortex flow develops inside the cone and enters the flame. The flame is stabilised by an aerodynamically induced recirculation zone in free space, ie, there is no flame holder.

The EV burner is designed to be used with gas or oil. When oil is used the fuel is

sprayed into the burner through an atomiser at the apex of the cone and the vapourising oil mixes with the air as described above. When only gas is used as fuel, the GT13E2 guarantees NOx values of less than 25 ppm (without steam/water injection); with oil NOx values of 42 ppm are achieved. Since 'cold' combustion air flows around and into the cone and ignition occurs outside the body, the burner itself remains relatively cool.

ABB's decision to use the annular combustor in the GT13E2 was based on good test and field experience with both low-Nox EV burner technology and annular combustor technology. Following extensive testing under atmospheric pressure and with high-pressure ratios, the EV burner technique was used commercially for the first time in a GT11N gas turbine with silo combustor installed in the Midland (USA) combined cycled power plant in 1991. The emissions measured at the design point were, referred to 15% O_2:

- NOx <15 ppm
- CO <8 ppm

Measurements after more than 4000 operating hours confirm the very low values and understood the successful commercial introduction of this technology.

In parallel with the Midland field tests, two GT9 gas turbines and nine type GT11N units were equipped with EV combustors. These are now being successfully operated. In addition, two GT10 gas turbines with annular combustion chambers and EV burners began operation in the district heating stations at Angelholm and Lund in southern Sweden in late 1991. NOx levels of less than 25 ppm have also been measured with gas firing in these two plants.

In addition to developing the GT13E2, ABB also revised the layout planning of the GT13E with a view to reducing the site area to the minimum. This will serve as a standard for all the new gas turbines from ABB. Below right is the plan view of a combined cycle plant in which the waste heat from three GT13E2 gas turbines is used to generate steam for a steam turbine.

The KA13E2-3 combined cycle plant with three gas turbines in circuit with a steam turbine achieves a gross efficiency of 55.5%.

The decision to build a power plant depends not only on the evaluation of the gas turbine technology but also on the construction time. Advanced project management methods have substantially shortened the time needed for this.

For example, the Roosecote combined cycle plant in the UK began commercial operation just 22 months after signing the contract. And the Paka gas turbine power plant, with two GT13D units, in Malaysia, went on stream in little more than 12 months. Assuming a comparable scope of delivery, the same project time frame is valid for power plants with the GT13E2.

It was due to the decision to combine advanced combustion technology with a field-proven basic design, plus the very high combined cycle efficiencies and the speed at which projects can be completed, that five units of the GT13E2 could be sold shortly after it was launched. Four of these five turbines are installed in combined cycle plants.

The first unit, for Kawasaki Heavy Industries Ltd has been manufactured jointly by ABB and KHI (an ABB licensee for gas turbines) and assembled in Japan. Commissioning of this gas turbine was scheduled for August 1993. The next two machines are for the Deeside combined cycle power plant in the UK. These will be shipped at the end of 1993. The fourth and fifth GT13E2 units are for the Lage Weide 6 and Diemen power plants in the Netherlands. ❑

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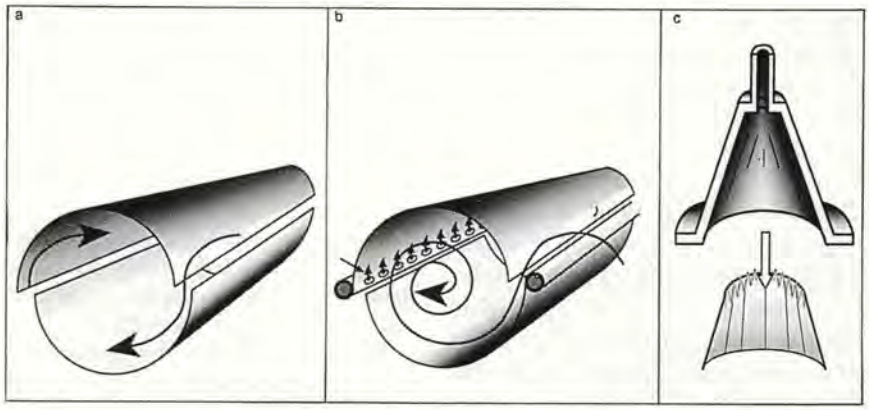
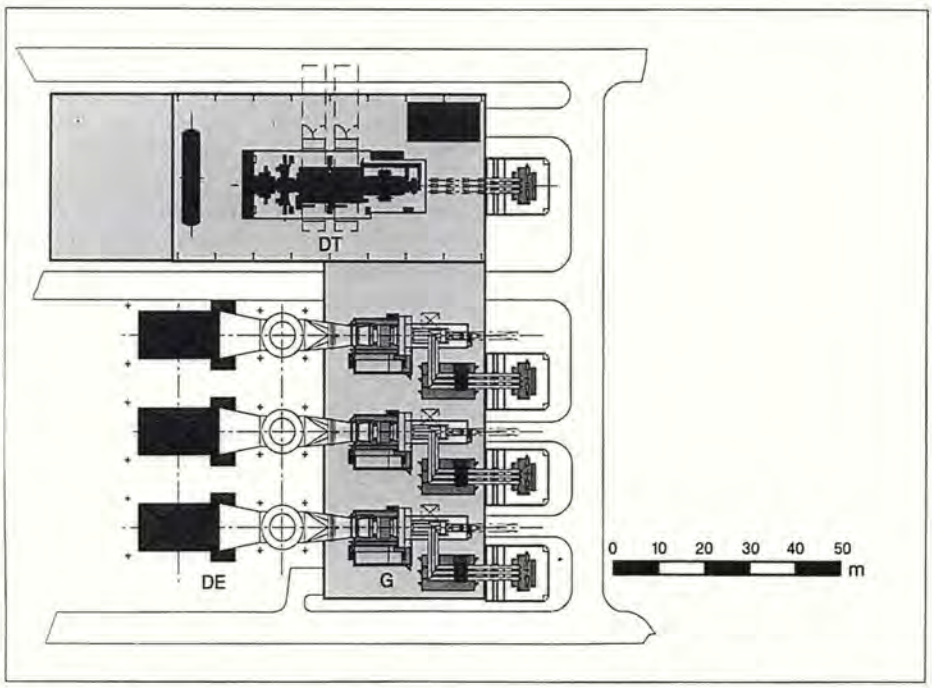


The EV burner consists of two offset cone halves which form two constant-width inlet slots (a).. Air enters through the slots and mixes with the fuel gas injected at the end of the slots to form a vortex flow in the burner (b). The lean mixture leaves the cone and enters the flame, which is stabilised in free space without a flame holder (c). The combustion temperature and the emissions are low.



Plan view of a KA13E2-3 combined cycle plant which makes use of the heat recovered from three gas turbines (G) to produce steam (DE) for a steam turbine (DT). The feedwater tank (S) is situated at top left. This arrangement achieves a gross efficiency of 55.5%.

EcoFeedback

*by Perry Walker**

The following article was written to accompany the national launch of EcoFeedback in Helping the Earth Begins at Home week, which runs from 23 - 30 October, and describes schemes conducted in the US and the Netherlands.

IF TELLING people to 'go green' is not enough to change behaviour, why do most energy conservation projects still use this blunt approach? EcoFeedback is a new interactive method for engaging households in making changes in behaviour that will be needed to reach a sustainable economy. It is a method well suited to energy, but valuable also for other ways in which households affect the environment.

Research on energy conservation was begun in earnest in the US in response to the oil crisis in the second half of the 1970s and early 1980s. The research shows the strength of feedback in comparison with other methods. It is flawed, however, to the extent that it is based on very small samples. Much more substantial evidence comes from the Netherlands. Since 1980, a national scheme has developed, with up to a quarter of the population taking part. It is this scheme that is now being applied in Britain; and the British approach that I shall describe here, referring back to the US research and the Dutch experience to see just how and why feedback works for the environment. Many different factors contribute to success. The current UK schemes are evaluated against these factors, to measure their success and, finally, to predict future development.

US research

The fundamental point which has recurred in countless studies on energy conservation is the importance of the human factor in energy consumption. Even when households are matched on the demographic characteristics of the occupants, and the physical structure and location of the houses themselves, electricity use varied considerably.

Attempts to influence household consumption are divided into two categories: antecedents, which take place before the act of consumption, and consequents, which take place afterwards. Antecedents consist of information, appeals, prompts and consumption modelling; consequents comprise of feedback and rebates.

Antecedents were not found to be effective. Information alone is almost totally ineffectual. Prompts such as labels, reminding people to turn off the light, have only a transient effect on a small proportion of people. Modelling, ie household energy audits seemed more promising, but at that point not enough had been done to gauge effectiveness.

Consequents were consistently more successful; various experiments using rebates as inducements produced reductions of up to 36% in energy use. The rebates were based on the saving on the original electricity bill.

Despite its evident success in the reduction of measured household energy consumption, the rebate system was not an unmitigated triumph. In addition to the expense of implementation, there was also concern about whether rebates might be spent on goods whose production and use involved the consumption of additional energy.

The other tool in the consequent armoury is feedback. In practice, this simply means feeding back to householders the amount of energy they have used. There were at least thirty experiments with feedback in the US during the period of the oil crises, taking many different forms. Here is just one example: residents of a town house were given feedback every day from Tuesday to Friday. The feedback took the form of plastic figures placed outside the residents' kitchen windows. The figures showed the ratio of actual to expected energy consumption. Since the purpose of the experiment was to reduce the use of air-conditioning, expected consumption was based on the mean air-temperature over 24 hours.

The reduction in consumption in this experiment, 10.5%, was in the middle of the range of reductions in the various experiments, which effected a reduction in consumption of between 0% and 20%. A further question is whether the reduction in use occurs only when feedback is actually being provided. Two independent experiments found that after feedback was abruptly discontinued, the reduction in energy use continued for the length of the monitoring period. This was six weeks in one case, and twelve weeks in another.

Despite the success of these experiments, one must be careful not to impute too much to the results. The experiments were relatively short lived, small scale and often amateurish (one researcher, for example, listed the number of participants in four experiments he undertook. They were 31 people; 125 people and 12 people: 'any person in room' in a Kentucky University classroom). We now turn to the use of feedback in Holland on an altogether different scale.

The Netherlands experience

A physicist called Jan Hanhart initiated the use of feedback in energy efficiency — a concept which he called EcoFeedback. He had come across the power of feedback in the quality control movement in Japan. In a pamphlet on EcoFeedback, he wrote: "Now, if indeed feedback is so powerful, why not apply it to re-establish ecological equilibrium? Why not enable consumers to take their share in meeting environmental requirements?" This question provided the motivation for private experimental work in the Netherlands on gas conservation in households using his experience in industry.

A feature of fuel consumption for domestic heating is that it is constant. It varies considerably with weather conditions. Hence it is not possible to follow the results of previous action by periodic gas meter registration (ie, readings). This lead to the creation of a single weather dependent reference figure for comparison with consumers' own gas consumption. This has advantages in terms of simplicity and ease of compliance.

Three types of information are provided as follows:

Present performance — People record how much gas they use each week from their meters.

Desired performance — The local paper provides a reference figure. This tells them how much gas they would expect to have used based on their annual consumption and the weather that week. Households then try to better this.

Ways of getting from the present to the desired position — The local paper also describes ways of cutting gas use.

*Chairman, The New Economics Foundation

There are a number of factors worth noting. The reference figure takes account of the weather. Since each household is comparing its performance with its own previous record (weather adjusted), there is no need to take account of the condition of the building, number of bedrooms, etc. Hence the simplicity of the scheme. EcoFeedback has so far been used almost entirely to monitor gas and electricity consumption. But it can also be used to monitor waste, recycling, transport and so on.

The development of EcoFeedback has been in three phases. In the first, a growing number of households took part in Hanhart's private scheme. In the second, the municipalities, led by the Hague, adopted the scheme. The Dutch had the advantage over Britain in having municipal energy utilities that they could ask to run EcoFeedback. In the third phase, it became a nationwide scheme. It is now run by the association of energy utilities.

The scheme started there in 1979. Now, virtually all households receive a card on which to record the figures, and 75% recognise the scheme. Almost a quarter of all Dutch households participated in the scheme. Of those, 60% were saving gas, by an average of 10%.

EcoFeedback in the UK

I met Jan Hanhart at a conference five years ago, and was struck by the power and potential of the idea. In turn, I introduced it to various local authorities, two of which took the brave decision to run pilot projects. Leicester started up the scheme on energy in their City Challenge area; Richmond on Thames ran a scheme for household refuse in two of their wards. The challenge is to see whether the scheme will survive a change of environment. The principles should apply here but the legislative, political and cultural conditions are not the same. Both pilots have been successful in showing that EcoFeedback is technically feasible in the UK. Both intend to increase significantly the number of participants, through successfully refining the schemes and making participation easier. There was no registration in Leicester, so it is difficult to tell whether the small number of cards returned reflects the numbers who took part for at least some of the four month period.

The national launch of EcoFeedback marked by this article is due to the number of local authorities which have been sufficiently impressed by the scheme to launch their won versions this autumn. In addition to Leicester and Richmond, schemes will begin in Cardiff, Middlesborough and Nottinghamshire, where there are several pilots involving the County Council, the City Council and several District Councils. In addition, Surrey County Council and Woking Borough Council hope to collaborate on a scheme likely to start early 1994. All, bar Richmond, cover energy. We would be delighted to hear from any other interested local authorities.

All the three components of feedback play their part. Consider present performance in the case of the Shaw family, the British participants in 'Happy Families' — a BBC Television programme which challenged six families from different countries to change their lifestyles in an environmentally beneficial way. The household, to their amazement, produced 1.24 kg of domestic waste and used 234 gallons of water per day, and their annual energy expenditure was £1000. A Leicester participant interviewed for BBC Radio's 'Costing the Earth' said that he had reduced his thermostat setting by one degree and found his home perfectly warm, so he was considering a further one degree reduction. Such minute changes like this add up. More significantly, they show a transition from an 'on/off' binarism with regard to energy use to an attitude seeing energy use as a function of need. Returning to the Guardian and the Shaws, "little things ... have resulted in an 18% reduction in energy use, and projected annual saving of £150 ... the daily output of waste is down to just 0.3 kg."

Concerning desired performance, the US research showed that feedback's effect was enhanced if consumers were asked to select "difficult but achieveable" goals. A reduction in energy sufficient to counter the effect of VAT on domestic fuel is an obvious target in the UK.

Jan Hanhart compares households trying to beat their EcoFeedback target to golfers trying to beat their handicap. Market research in Holland has found that the second most important reason for people taking part, after the potential for saving money, is that they find it fun.

Finally, the first two parts of feedback motivate people to attend to the third — the information on how to change. As the US research found, this information, when provided in isolation, is unheeded.

The final motivation is that EcoFeedback is a communal activity. Returning to the Guardian report on 'Happy Families', "... the Shaws had also helped in their area to become more aware of recycling and the environment. Getting to know people in the area had been an important aspect of the greening process, and had given those involved a sense of working together for a common purpose ..."

The future

The US research provides some pointers. Evidence suggests that feedback which is provided more frequently, and which is more readily accessible and comprehensive is more effective. Practically, this would probably require devices that could provide automatic readings, in terms of cost as well as energy. The research found that costs figures greatly increased the impact of feedback, because people have little feel for what a kWh is, for example.

Several other uses for such devices were being developed in the US at that point, or were suggested by researchers. They could provide feedback on street or community consumption. They could provide more striking feedback — one device had a lamp that lit up when consumption had exceeded a specific level. Other devices provided information about specific devices, such as air conditioning.

EcoFeedback has great potential that is just starting to be explored in the UK — the challenge is to make it work here. I was once struck by a conference speaker who said " there is no limit to what you can achieve if you don't seek to take the credit for it." Fortunately, in this case that goes without saying. As Jan Hanhart put it: "EcoFeedback is a service to the individual, ending at his doorstep." It is to the residents of Leicester, Richmond, Cardiff, Middlesborough and Nottinghamshire that the credit will truly belong. ❑

The optimisation of co-generation problems

*by Francis Hogan**

ONE OF THE toughest challenges in designing or operating a facility is providing energy at the lowest possible cost over the life cycle of the asset. Co-generation is a popular solution to the challenge. However, successful projects must be based on careful and detailed evaluation of the engineering, economics, financing, reliability and operability of the projects.

Co-Generator is a computer software system for the design, costing and economic optimisation of co-generation projects. Co-Generator considers such problems as the equipment selection and operation, fuel selection, and the purchase or generation of electricity. It develops the design and operating schedule which is able to supply all steam/heat and electricity requirements at the lowest cost. The model may be applied to the analysis of either new or existing facilities.

Co-generation is the on-site generation of electricity and the simultaneous generation of useful steam and/or heat. It has been most widely practised by various manufacturing industries, but has also been used in large commercial and residential properties. It has received considerable attention in recent years as an energy conservation technique.

The author

Francis Hogan has extensive experience in structuring and negotiating project finance and leasing transactions in the oil and gas, electricity supply industry and mineral resources industries. He has published several articles on project financing in the aforementioned industries, which are available from him directly on request.

Francis Hogan outlines the virtues of the computer software system Co-Generator.

A mainframe computer package, Co-Generator combines the capabilities for conceptional engineering design, costing, economic optimisation, and financial evaluation of co-generation projects. The package requires the input of data on the thermal and electrical loads to be supplied for the co-generation system. The prices for fuel and electricity must be also be input. Co-Generator will then solve for the equipment selection, fuel selection, equipment operation, and electricity purchase or sales arrangement with the REC, the electricity pool, or a third party that allows the thermal and electrical loads to be supplied at lowest total cost. It will then perform a financial analysis of the optimal design.

Co-Generator can be applied to the analysis of industrial, commercial and institutional co-generation schemes. Customer, REC, generator and third party ownership options are available — and either internal or user supplied equipment data can be utilised. Various electricity tariffs can be evaluated, including seasonal time of day, Hopkinson and Wright and multiple rate schedules. Both the purchase or sale of electricity and steam can be analysed.

The software system takes forecast energy prices (using forecasts prepared by Power Development Consultants utilising Box Jenkins, ARIMA and/or Spectral forecasting techniques), electricity tariffs and financing specifications, together with available data on energy conversion equipment, and designs the equipment combinations and operating schedules to meet user specified energy demands at the lowest cost. Co-Generator accomplishes this by building a detailed mathematical model of the co-generation system.

The model consists of equipment selection and operating variables that represent physical design, operation and the scheduling of energy purchases. The model is solved for the optimal design and operating schedule using mixed linear programming techniques. The following sections provide an overview of the capabilities of Co-Generator.

Problem formulation

In analysing co-generation at a specific facility, it is convenient to view the problem as consisting of two parts. One side of the target facility contains energy conversion equipment. This side is the focus of Co-Generator. The energy conversion side consumes fuel and supplies electricity (some or all of which may be purchased) and thermal energy. The thermal energy may include steam at several pressures, and both the electricity and steam requirements may vary with time.

The other side of the facility consists of energy equipment. This might be industrial process equipment or the heating and electrical system of a commercial office building. For the purposes of Co-Generator, all energy consuming equipment is treated as being supplied with known quantities of electricity and thermal energy. It may return condensate and/or process residuals which can be used by the energy conversion side of the target facility.

The system takes defined load data and internal data, and builds a database for the co-generation problem. It then uses this database to construct a detailed mathematical model of the energy conversion side of the target facility. The model includes variables and equations that represent physical design, operation and scheduling of energy conversion activities. The data required by Co-Generator to construct the model includes:

- a description of the energy requirements for the energy consuming side of the facility to be analysed, such as the temporal pattern of steam/heat and electricity demands;
- a description of the energy conversion technologies available for use or installation by the plant, including capital cost and performance data;
- a set of prices for the different fuels, pur-

* *Managing Director, Power Development Consultants*

chased electricity and financing methods.

Typically, the client will supply the first set of data. Alternatively, consultants will execute a comprehensive energy audit. The data on equipment can be either client supplied or taken from the internal Co-Generator database.

The internal database consists of cost and performance data on energy conversion technologies. This includes state-of-the-art and advanced technologies. Included among the state-of-the-art technologies are the most commonly used types of power generation equipment, and commonly used design configurations for each of the equipment types.

State-of-the-art technologies included are: fossil fuel-fired steam generators; waste fuel-fired steam generators; steam turbine generators; combustion turbine generators; and diesel, gas and duel-fuel engines.

The unit sizes available for this equipment accommodate demands as low as 50kW of power or 5000 lb/hr steam, as well as demands in excess of 500MW or 5 000 000lb/hr of steam by use of multiple units.

Also available in comparable unit sizes are a variety of advanced technologies. These technologies include: advanced open-cycle gas turbine generators; advanced closed-cycle gas turbine generators; and advanced gas turbines for combined cycle applications. Heat recovery steam generators are also available for both state-of-the-art and advanced technologies.

Co-Generator determines the lowest cost design and operation for a co-generation facility that meets specified demands. Within the framework of forecast prices and available equipment, the model is able to resolve questions such as: which technology, if any, should be installed? How should the equipment be operated? What kind and how much fuel should be purchased? How much electricity should be purchased? How much electricity should be sold? How much top-up and standby electricity should be purchased, if any, given the reliability and economics of the plant design?

As presented formulated, Co-Generator selects the equipment and economic operating dispatch of the plant which can supply the required process steam and/or heat and electricity at the lowest cost. The cost concept employed is that of levelised annual cost. Investment decisions based on levelised cost are equivalent to decisions based on discounted present value methods. Cost minimisation is used as the decision criterion since it is most likely to be that used by individual companies. However, other criteria, such as cost minimisation subject to a budget constraint, can easily be incorporated into the model.

In determining the lowest cost alternative, the model automatically considers all possible design alternatives such as: sizing equipment to match thermal load; sizing equipment to match electrical load; using co-generation to shave peak electric load; power purchase arrangements with an REC, the electricity pool or a third party; power purchase/standby purchase contracts with an REC, the electricity pool or a third party. Co-Generator can be used by companies in all member states of the European Community, with a degree of modification to the model parameters.

An Operational and Management Information System (OMIS) are being developed which will work in conjunction with Co-Generator to ensure that the installed plant for the generation and utilisation of heat and power performs optimally, safely and cost effectively over its entire life cycle.

Co-Generator and OMIS may be used to review the overall plant performance, effectiveness and costs from time to time over the life cycle of the plant, taking account of changes in demand, fuel prices and availability, legislation and taxation regimes to ensure that the plant remains the optimal solution for meeting the energy requirements at the lowest possible cost.

The genuine underlying economic value in a co-generation project will be realised through incremental increases to revenue savings that will follow improvement in quality and reliability of service over the life cycle of the plant.

Project finance

Co-generation and power industry projects must compete for funds with other investments on the basis of levels of risk, yields, terms and liquidity. The sponsors of such projects must be able to identify rewards which are commensurate with those that can be achieved elsewhere and with the risk involved. It is important to be able to project with some certainty the income stream that will be available to service the finance that is put in place and produce an adequate return.

Risk reward analysis is a key element of any financial investment decision. It is therefore only right and proper that the allocation of risk is fully considered.

Project financing is not the financial philosopher's stone turning base metal into gold by mystical transmutation. It is rather the delicate but systematic process of minimising direct financial recourse to sponsors, while providing lenders with an acceptable credit risk by other means. Power Development Consultants offers a comprehensive project finance advisory service to the co-generation and power industries.

Power Development Consultants have now joined forces with Terotechnology Systems and Services, the creators of OMIS, to offer their services under the umbrella of Integrated Energy. Integrated Energy can be contacted on 0322 289367 or 0732 461175 (fax 081 460 7908; 0732 461175). ❑

Tunnel Refineries at Greenwich in south east London was one of the first process manufacturers in the UK to recognise the tremendous advantages of combined heat and power. Their 15 MW CHP plant was commissioned in October 1990.

Building behaviour — food for thought

by Eur Ing Ron J Moore BEng(Hons) CEng MCIBSE MInstE MASHRAE MIEEIE BIM

In the following article Ron Moore explains why he believes that engineers should act to improve the built environment, which in turn will be beneficial to the global environment. Such action may even raise the standing of engineers in the eyes of the general public, a possible consequence that is long overdue.

BUILDING behaviour probably means different things to different people, depending on their perspective and understanding.

In the light of changing views and legislation, ECO audits and the awareness of the community to environmental issues, it is my belief that some engineering practices and poorly behaved buildings will come in for much criticism in the coming years as a result of their behaviour or lack of it. We need to sharpen our pencils, take stock of our buildings and plant, along with their associated behaviour.

Whilst I accept we do not live in a perfect world and there will always be a percentage of buildings that do not behave in a friendly way to the environment, I believe this percentage is too high at present, and we should address the situation immediately. I do feel alienated at times when I think of the environmental legacy we are leaving our children especially when we can do so much to correct the behavioural patterns of plant and buildings.

Have you ever stopped to think of how our buildings and plant are behaving even when we are not apparently receiving any complaints from the occupants?

It is easier to assume that everything is okay, and the building and occupants are in harmony so to speak, but are they?

What are the energy implications of our buildings behaving badly?

There are some of the questions I have asked myself over the years, especially as a practising engineer with experience in design, installation and maintenance of building services.

I believe a lot of our buildings do behave badly and as a guestimate perhaps as high as 80%. So what is bad behaviour in buildings?

When analysing a building for its behaviour you should remember that the building has many behavioural facets that need to be identified and examined if you are to gain an overall or complete picture, these are, but not necessarily limited to:

- structural behaviour and response;
- controls;
- human behaviour;
- plant behaviour;
- comfort.

Of course, there are many reasons why a building is not functioning correctly, ranging from poor maintenance, bad design and installation, change of building use and so on. Accepting these more obvious issues and putting then to one side there is I believe a real need to examine our buildings more closely both at the design and operational stage. In doing so we must look at every aspect of behaviour both singularly and overall, to give a global understanding.

For many years now we engineers accept buildings do not conform or respond to steady state conditions and behaviour, moreover they are more responsive to cyclic behaviour. Although at times we can get be using steady state techniques, there are times when we cannot. A thorough understanding at the beginning will assist in the long term, with the interaction of controls and comfort.

Controls obviously play an important part in any building. With the ever increasing plethora of controls and controllers on the market, all claiming wonderful things, selection can at times be difficult and confusing. Optimisers are one of the 'in controls' at present and if installed correctly in the right application, will serve the building and occupants very well. There are two main drawbacks to this device (especially the cheaper versions), namely they attempt to learn the building over a period of time, ranging from three days to two weeks continually updating themselves and their normal linear algorithms. They are very often installed by the inexperienced, where some of the parameters are incorrectly set and the best energy conservation is not realised. I have also seen optimisers installed as a time clock, and no more, the occupants and client would not know, they still achieved 21°C plus, and most of the time that is all they are interested in, aren't they?

Human behaviour is one of the hardest things to predict as far as the building services engineer is concerned. He cannot get his calculator or slide rule out for this one. (I accept there are reasonable guidelines for this one. But how long is a piece of string?) We, of course, have all come across it: the heating is on full blast, the windows are open in a deep plan office, and not surprisingly, someone is cold. Of course, the window was probably opened in the first place because it was too hot, due to solar gains (even in colder months solar gains can be troublesome).

Very often plant behaviour is forgotten, especially by the non-technical, who only visit the plant or boiler room because they have run out of storage space elsewhere.

Of course, our plant rooms should be regarded as the heart or epicentre of our building. We often forget, do we not, plant behaviour means one thing when a building is handed over, but something entirely different ten years on, especially without a structured maintenance regime.

Comfort as we all know is very subjective, meaning different things to different people. We all accept that comfort does not end at a maintained temperature of 21°C. It is only when one or more of the known comfort criteria, such as temperature, humidity, lighting, and air quality go adrift do we scream 'sick building syndrome!' (SBS). Generally we are too busy to notice small changes in our own micro climate within our offices. Often they are corrected before they become a nuisance. Most cases of potential SBS I feel can easily be overcome, normally resetting the controls does the trick.

Hopefully I have provided some additional 'food for thought' — not because they are any new breakthroughs, but because it needs to be highlighted. Why? Energy is the answer. I believe all our actions can have a tremendous impact on energy use in our buildings. Our buildings currently represent, and are responsible for, a large proportion of CO_2 emis-

sions, either directly or indirectly through their power consumption, adding to the problem of global warming.

It also makes sense to save as much money and energy as possible in these times, or any time for that matter. Badly behaved buildings cost money.

So what should we do to improve the situation? We can go someway to eradicating behavioural problems of buildings in the following ways:

- keeping a closer eye at the design stage, making as much use of standard codes of practice, such as those produced by CIBSE and ASHRAE;
- ensuring that our plant and boiler rooms are suitably maintained — its cheaper in the long run;
- prevent, where possible, inexperienced personnel altering set points and control functions;
- educate the occupants of the buildings regarding the energy implications of their actions;
- make more use of computer software and models for building plant predictions. Use techniques such as the admittance method for greater understanding of cyclic behaviour, where appropriate;
- have a greater understanding of the clients' needs and perceptions. In some instances the entire project team, from architect downwards, should address this.

In providing some food for thought I am not suggesting there is a magical cure, or a way of eradicating bad building behaviour overnight: it will take time, and overall costs money.

If we can hit a nerve, jolt a conscience or two into a more global thought process, then perhaps we are on the environmental road to recovery and moreover, we the engineers and professionals should be seen to be taking the lead. Who knows, it may help lift people's perceptions of the engineer's standing in society — something we have lost in the last fifty to 100 years, but something we rightly deserve. ❑

The diesel debate

'Seven Tenths' is the latest challenger of the diesel-powered world land speed record attempt and the European speed challenge. The Institute of Energy has put its name to the project, and it is hoped that the challenge will highlight the environmental benefits of diesel-powered vehicles.

IF DIESEL power brings to mind noise, smell, dirt, low power and low speed, then be prepared for a surprise. First Extreme International will be putting diesel power to the ultimate test of speed and reliability by embarking on the Challenge of Europe.

What is the Challenge? Apart from designing and building the world's fastest diesel-powered vehicle, First Extreme International aim to set the national records in the 12 countries of the European Community — during a 40-day period!

Record speed

Launching the Challenge of Europe at the Speed Record Club forum in July, professional racing driver Kristan Hosea outlined the design features of the 'Seven Tenths' vehicle. Based on the concept evolved by Piers Harding for Project 275 UK, the streamlined, low frontal area vehicle should be capable of speeds up to 350 mph on the right course.

When Dr Rudolf Diesel developed the compression ignition engine over 100 years ago, no one could envisage a vehicle travelling at 35 mph, let alone 350 mph! A major manufacturer has accepted the challenge from First Extreme International to build and tune a diesel engine to achieve target speeds. Compound pressurised charging and intercooling will be the outward signs of the engineering expertise that will provide the necessary power, but a lot more will be hidden beneath the surface.

The whole programme will use the most up to date construction technology, with the vehicle monocoque built from aero-space carbon fibre composites. The use of these materials enable the vehicle to have the smallest frontal area possible, whilst accommodating the driver and the least weight, yet remaining strong enough for safety and stability.

Range of options

Delivering the power to the rear wheels will be the task of a semi-automatic gearbox using the clutchless 'finger-tip' gearchange mechanism, pioneered in Formula One. There are, however, no plans at present for automating the upshift system in the gearbox, so there will be a role for the driver in this record vehicle.

Whilst many of the design features of 'Seven Tenths' have been decided, the complete 'packaging' of the mechanical parts and control elements will be carried out by final year automotive technology students at Loughborough University's department of transport technology. Working with the First Extreme International team under the guidance of their tutors, a design team will investigate various aspects of the vehicle layout to achieve optimum performance. By having more than one group working on specific areas, such as weight distribution, powertrain or driver controls, a range of options can be evaluated, and the most efficient incorporated into the final design.

Institute involvement

The Institute of Energy, the premier professional body for engineers and technologists working in energy production, utilisation or conservation, is lending its name to the land speed record project as a way of promoting

development in diesel power. Development that will maximise the environmental benefits of reduced emissions and improved fossil fuel consumption. With these benefits being achieved by a high-speed diesel road vehicle, manufacturers could be persuaded to carry out improvements in their diesel cars.

As well as coordinating the design and vehicle construction, the team are putting forward proposals to major UK-based businesses, with European and international interests, to attract financial support for this high-profile programme. As might be expected the unique features of the Challenge of Europe are attracting interest, but more investment is needed before the tour can begin.

Of all the records to be attempted the most difficult will be the international and Italian record, set by Keke Rosberg in the ARVW. A kilometre average speed of 215 mph was set on the 7.8 mile banked circular test track at Nardo. Seven Tenths is designed as a straight-line vehicle, and the airfield tracks it will use will be about 3000 metres long, thus demanding dragster-style acceleration rather than the progressive speed build-up that these longer courses permit. The fastest speed by a diesel vehicle at Bonneville is 236 mph, and this will be the target for a 13th speed record attempt, although the team may seek a venue on the other side of the world.

First Extreme International intend to raise media and public interest in land speed record breaking across Europe to a level that was last seen in the late 1930s. The team's motto sums up its approach to motorsport: *be daring, be different, be first.*

As there are no second places in land speed record attempts, and the daring challenge of 12 records in 40 days with diesel power is definitely different. The Challenge of Europe by First Extreme International fits the motto, and is a programme to followed closely in the months ahead.

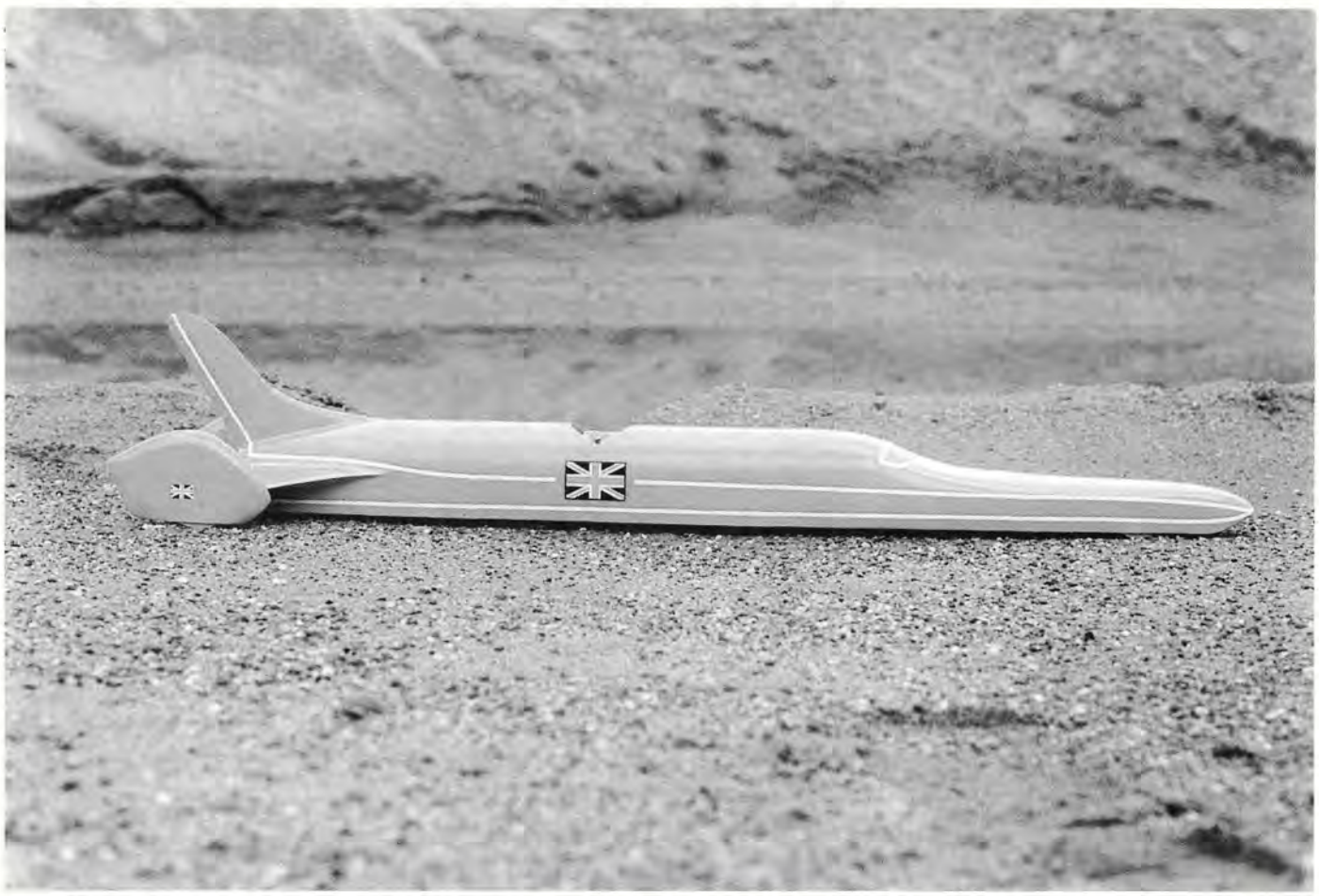
Anyone interested in the Challenge of Europe, and able to offer assistance or expertise to the project should contact First Extreme International at Northacre House, 37 Springwood Drive, Oakwood, Derby DE21 2HE. ❑

Driver profile

Kristan Hosea — 19 years old
Graduate of the Jim Russell Racing Drivers School
Professional Racing Driver since July 1933, having completed media studies at South East Derbyshire Technical College
Interests — motor racing, fast cars and music
Ambitions — driving in Formula 1 before 2000

Theme music

The theme music of the team used during the AV presentation at Coventry for the speed record forum was composed by Rob Hart of Derby band Libretto. If you wish to obtain a copy of this instrumental music, a cassette incorporating this track can be made available (price on application).



A 1/17th scale wind tunnel model of First Extreme International's diesel-powered Seven Tenths lsr vehicle

Test facility for Energy Studies

*by Dr Philip Few CEng FIMechE FInstE**

THE NEW De Montford University engineering building will house the School of Engineering and Manufacture.

Many courses will concentrate on the application of electronic and mechanical engineering principles to industrial production. The building is the first of its kind to serve as a learning tool and to be used for research into further methods of improving energy conservation.

Besides the excellent facilities provided in the purpose equipped laboratories, the building acts as a full size experiment, with opportunities for students to access all the features for the control of the environment throughout the building.

The aim of this article is to highlight the use of the new building as a source of learning for students with a special interest in thermodynamics and energy-related topics.

The main areas of interest to students specialising in Energy Studies are listed below.

Total energy concepts. Investigations will be made into the total energy requirements of the building and how they may be satisfied. The energy management system installed will provide a useful tool for both under graduate and postgraduate students. Examination of the daily, seasonal and annual variation of energy usage will be made. Information will be instantly available on temperatures, humidity, fuel usage, heat and electrical loads which may be used to facilitate optimum energy utilisation. Casual gains from equipment and occupants together with solar gain will also be evaluated.

The beginning of the academic year for Universities this month was marked by De Montford University in Leicester with the unofficial opening of their award-winning new engineering building. The official opening will be by HM The Queen in December.

Combined heat and power and energy recovery. Demonstration of the first and second laws of thermodynamics can be effected by a performance analysis of the CHP unit. Detailed studies of heat to power ratio will also be made.

A review of heat recovery and performance characteristics of relevant heat exchangers with a view to pinch technology will be available.

Factors influencing the life of the engine together with control and monitoring of exhaust gases will be investigated.

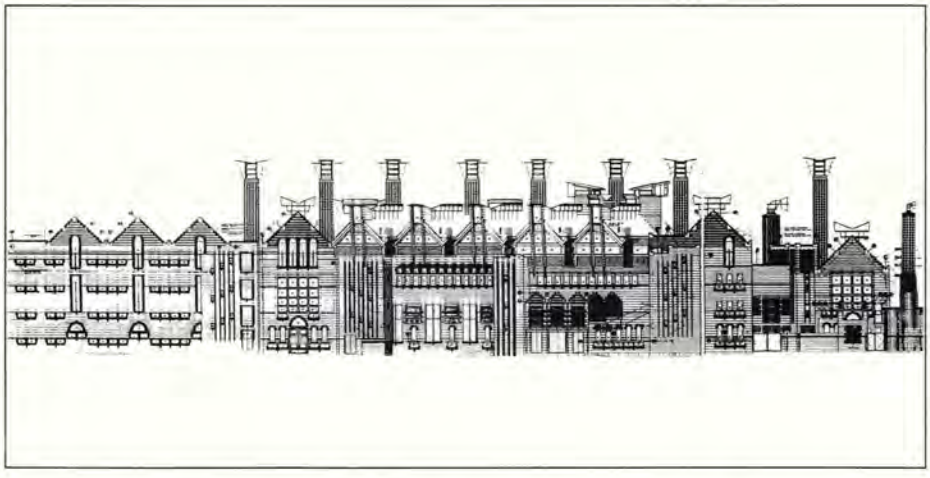
Heat transfer. Correct heat transfer is an important aspect of a building or system design. It is important that heat losses from pipes, vessels, building and hot exhaust gases are minimised. The building which has many insulation measures incorporated in its design ensures minimum heat loss through walls, windows, roof and floor. Demonstration of all modes of heat transfer will be possible, including in particular practical studies of composite walls and natural convection.

Ventilation. The new building will use a natural ventilation system whereby large ducts on each floor, and smaller ones in the rooms, will transfer air. The installation has low capital and running costs and its performance characteristics can be analysed and compared with more conventional systems.

Boiler studies. A comparative study of the condensing boiler as installed with a conventional boiler can be made. Studies will evaluate boiler efficiency, 'green' issues relating to boiler efficiency, global warming and atmospheric pollution. The experiments conducted by students will be supported by hand-outs giving background information and theory, together with methods and instrumentation techniques needed to carry out the investigations. The building which has been designed to be environmentally friendly, takes advantage of natural ventilation, lighting and solar gain. It will provide the most advanced technical facilities to support the courses offered.

● *It was recently announced that local entrepreneur, Tony Marmont, a visiting professor of the University, has given De Montford £250 000 to fund initiatives looking into clean, 'green' energy.*

The money will be used to buy a 300 kW wind turbine generator, making De Montford the first University worldwide to have such a large facility. It is hoped to establish the new wind turbine at Caythorpe in Lincolnshire, in partnership with Lincolnshire College of Agriculture and Horticulture



Original drawing for the new engineering building at De Montford University, Leicester.

* Principal Lecturer, De Montford University, Leicester

First international conference on Combustion and Emissions Control

THE INSTITUTE OF ENERGY held the first international conference on Combustion & Emissions Control in September at the University of Wales, College of Cardiff.

The two-day event was structured into five sessions, each with a distinct but connected theme. Day one's sessions went under the titles of 'Waste utilisation' and 'Emissions reduction — gas and oil'. There was a notable predominance of papers dealing with NOx emissions, although the keynote address at the opening of the conference gave a more general overview with a paper from Professor Linnhoff, who is Professor of Process Integration at UMIST.

'Total site integration and emissions targeting by pinch analysis' outlined a recently published methodology, describing procedures to enable designers to set site-wide targets for fuel, cogeneration and cooling. This approach takes account of capital costs and the trade offs between process fuel, central fuel, steam, CHP and fuel mix.

The 'Waste Utilisation' session consisted of five papers, including the keynote address for this session, which looked at 'Municipal waste combustion in the USA', and was presented by David B Sussman, vice president for environmental affairs with Ogden Martin Systems Inc. The US waste utilisation programme begun about 20 years ago, and managed 196 million tons of municipal solid waste (MSW) in 1992. In recent years attention has shifted towards recycling and composting, although combustion remains the only option for much of the State's MSW. Mr Sussman reviewed the results of a recent survey. The US Environmental Protection Agency (EPA) has estimated that by 2000, 21% of America's MSW will be processed by combustion (although not necessarily with energy as a by-product).

The remainder of the session saw contributions from ETSU, the New University of Sunderland, the Energy & Environmental Research Corporation, a US research company represented at the conference by Institute Fellow, Dr Anupam Sanyal.

Another Fellow of the Institute, Professor Alan Williams of the University of Leeds, presented the keynote address for the next session: 'Emissions reduction — gas and oil systems'. His opening paper dealt with 'Low NOx domestic water heating appliances', and described how increasingly stringent emissions laws have led to further development of low NOx appliances using natural gas. Professor Williams and his team concluded that present limits can be met by the current generation of low NOx burners using conventional techniques, but there will come a point when their limit is reached, due to combustion inefficiency and stability problems. Making use of catalytic combustors will become essential for ultra low NOx combustion, as they operate at very low temperatures and burn fuel lean mixtures outside the usual flammability limits.

The first international conference on combustion and emissions control took place recently in Cardiff, covering both fundamental and applied aspects of the science and technology of pollution abatement.

Further contributions to the session came from British Gas, the University of Adelaide in Australia, University of Leeds, BP Oil, Hamworthy Engineering Ltd and the University of Portsmouth, the University of New South Wales and the Tokyo Gas Company.

Dr Sanyal returned to the podium the following day to give his keynote address, introducing the third session. Session three dealt with 'Boilers and furnaces', and Dr Sanyal's opening remarks covered 'Low NOx burners and gas reburning — an integrated advanced NOx reduction technology.'

The remaining three papers in this session came from PowerGen plc, the National Engineering Laboratory (NEL) and Tsuruoka College of Technology in Japan.

Counter balance

To counter-balance the second session on gas and oil emissions, the fourth session dealt with 'Emissions reduction — solid fuels', the keynote address being a 'Reflection on FBC — lessons for the future' by Professor John Davidson of the University of Cambridge. He reviewed the mechanisms governing combustion of carbon in air-fluidised inert particles at 700°C—950°C. He came up with the surprising result that with propane in the air supply (to simulate coal volatiles) the carbon may burn faster as bed temperature is decreased.

A further contribution from the University of Leeds followed, with additional papers from the University of Newcastle upon Tyne and International Combustion Ltd.

The final session of the conference was on the highly topical subject of combined cycle power generation. It began with a keynote address from Stephen Dawes of British Coal, recalling the 'History and achievements of the Grimethorpe pressurised fluidised-bed combustion facility: from conception to demolition, 1970-1993.' Mr Dawes pointed out that although the Grimethorpe facility has been closed, work on the project continues, as results of materials experiments are still being assessed, and modelling work continues. And it does appear that the original point has been proved: a gas turbine can operate successfully on coal-derived gas at an elevated temperature. The DEn Working Party confirmed that Topping Cycle showed the greatest promise of the clean coal technologies. It was also commended in the recent White Paper.

British Coal Corporation, Marine Gas Turbines Ltd, the Tokyo Gas Company Ltd and the International Flame Research Foundation of The Netherlands all contributed papers to this final session.

The sessions were chaired by Doug Willis (Past President), Barrie Church (Chairman, CEA), Professor Alan Williams (Leeds University), Dr John Whitehead (Director, CRE) and Dr George Thurlow (Fellow and Past President).

Exhibition

The conference was accompanied by a large exhibition which excited a lot of interest, and gave delegates plenty to think about during their tea and coffee breaks. Exhibiting companies included Babcock Energy Ltd, BP Research and Engineering Centre, Coal Research Establishment, CODEL, Credfeld Camtorc Ltd, Dantec Electronics Ltd, ETSU, Land Combustion, Linnhoff March, Orbital Gas Systems Ltd, Pentol/Wahlco, Pergamon Press Ltd, PowerGen's Power Technology Centre and SWALEC. ❑

● *A complete set of papers, in a perfect-bound volume (430 pp), is available to members from Institute headquarters for £30.00 (inc p&p, UK). Non-members should obtain copies direct from Pergamon Press, Headington Hill Hall, Oxford OX3 0BW.*

Your ideas on energy storage, please

AN interesting assertion was recently made at a conferences advisory committee, the Institute's forum for determining ideas for future conferences.

The received wisdom, amongst committee members was that in recent years little coverage in technical conferences has been given to problems associated with, or developments relating to, energy storage.

We would value members' advice on this issue. Below are some areas of interest which have been identified.

Energy storage:

- for efficient use of energy;
- to increase attractiveness of renewable energy sources;
- to increase flexibility of energy usage;
- new technology and improvements to existing technology: mechanical, chemical, thermal or electrical storage.

Implications:

- for energy supply/supply management;
- transport.

Your suggestions in writing would be gratefully received by post to Judith Higgins, Conference Manager, The Institute of Energy, 18 Devonshire Street, London W1N 2AU.

Regulation: conference and exhibition

A MAJOR Institute of Energy conference will be held in London at the Queen Elizabeth Conference Centre on 17 November.

The conference organising committee for *Making Energy Privatisation Work — The Future of Regulation* has assembled a distinguished cast of speakers (further details of which appear on the inside front cover of this issue). Although places are still available, and if you wish to attend we would urge you to register as soon as possible, as places are quickly being taken up.

An associated exhibition will run alongside the conference, and will be visited by conference participants during refreshment and lunch breaks. Exhibition space is available **free** to organisations sending a minimum of three delegates to the conference, or for a fee dependent on floor space requirements. For further information please contact the Institute's conference department on tel: 071 580 0008; or fax: 071 580 4420.

South Wales and West of England Branch programme

Thursday 14 October, 2.30 pm
Visit to the Wessex Water Biodrier, Avonmouth. Visit and talk. Tea and biscuits at 4 pm. Attendance limited to first 40 applicants.

Tuesday 9 November, 6.30 pm
Joint meeting with CIBSE. Talk on wind and geothermal power generation at the University of Bath. Please contact John Treeby, tel: 0272 223215, fax: 0272 2239950.

Thursday 11 November, 2.30 pm
Visit to the Inco Europe works at Clydach, Swansea, with a talk on their process and energy usage. Attendance limited to the first 40 applicants.

Wednesday 8 December, 6.30 for 7 pm
Talk and video on 'Energy and utility management at the Royal Mint' by Mr Dave Honeyman and Mr Alan Williams. University of Glamorgan, Pontypridd, tea and sandwiches in college refectory at 6.30 pm. Please call Harry Hibberd, tel: 0272 276407 daytime, or 0272 624872 evening to reserve your place.

Wednesday 19 January, 2 pm
Visit to Avonmouth zinc/lead smelter. Attendance limited to the first 20 applicants. Please book early to reserve your place.

February 1994
Joint lecture with IChemE at Exeter University, to be confirmed.

Wednesday 2 March, evening
Young person's paper evening, to be held at SWEB offices, Aztec site. Almondsbury, Bristol. £200 total prize money for the best paper and runner up. Contact Harry Hibberd on 0272 276407, or fax: 0272 273317.

Thursday 24 March, AGM 5.30 pm, tea 6.30 pm, lecture 7.15 pm
Branch AGM and prestige lecture: 'The future of the British coal industry' by Mr A Horlser, director general of marketing, BCC. Trevithick theatre, University of Wales, College of Cardiff. Please contact Harry Hibberd, tel: 0272 276407 for advance information.

Friday 22 April, morning and lunchtime
The 21st Idris Jones Memorial Lecture, 'The Hamersley Iron HIsmelt Process for iron making' by Dr R J Batterham of CRA Technological Resources, Melbourne, Australia. Followed by luncheon. To be held at Cardiff Castle, sponsored jointly by CRA and the RTZ Corporation. Advance bookings accepted by Mr Doug Mustoe, tel: 0656 654070.

May 1994, afternoon (to be confirmed)
Visit to West Wales Opencast coal pit, Great White Tip site, Merthyr Tydfil. Attendance limited to 30. Please contact Harry Hibberd for advance information.

Friday 17 June, 11 am for lunchtime
Annual lunchtime lecture at British Coal's Coal Research Establishment, Stoke Orchard, Cheltenham. Talk by Dr Kevin Brown, director of ETSU on 'The renewables — will there be a significant impact on the UK energy mix?'

Nuclear issues

'THIS country will need nuclear power in 2000'; 'nuclear power is a force for good in the environment'; 'nuclear power is safe and getting safer year by year'; 'the nuclear industry is beneficial to the UK economy' 'nuclear power can pay its way'.

These are some of the issues that will be debated at the Institution of Electrical Engineers headquarters at Savoy Place in London on Friday, 5 November. Each topic is contentious and carefully designed to sharpen people's thinking as they address the key subject areas. Fireworks can be expected that day!

In such a topical debate a vote is not appropriate to settle the questions. What will be important is that all sides of the vital issues are addressed by the experts, whether they be for or against nuclear power.

To arrange this event, the major engineering institutions — the electricals, mechanicals, civils and chemicals — have joined forces with the Institute of Energy and the Watt Committee for Energy, which in turn represents the interests of nearly fifty other professional institutions.

There will be key speakers from the nuclear industry, as well as from the anti-nuclear lobby.

The scope of the discussion will range over global, regional and local issues of supply and demand, the environment, accidents, finance, and insurance, and will bring in views from City financial institutions and the academic world.

Members interested in attending this important event should contact

Illustrates difficulties

'Environmental Impacts of Waste Paper Recycling' by Y Virtanen and S Nilsson
Published by Earthscan for the International Institute for Applied Systems Analysis, London, 1993, 166 pp, £25.00.

THESE days most of us take aluminium cans, bottles, paper and cardboard to the municipal recycling centre. We believe that this not only generates money for the local authority, but also is the environmentally right thing to do.

For paper and cardboard this may not necessarily be true. This book analyses the procedures with and without recycling, assesses the energy requirements of the alternatives and derives the emission of various polluting and greenhouse gases.

In fact, the situation for paper recycling is extremely complex, and the information and data require interpretation. And, of course, trends from the 1980s will not necessarily still be relevant for the 1990s.

The factors that weigh against paper recycling are:

a) in Europe (the analysis covers Western Europe) the forests used for paper and pulp are replanted and the industry is at present indefinitely sustainable;

b) much of the energy in pulp processing comes from the wastes from the trees — bark, wood chips and so on — and the liquor, which separates the liquid and other unsuitable constituents from the fibre can be burnt to generate power and regenerate the chemicals;

c) to get the paper to the recycling plant it has to be transported long distances, requiring liquid fuels which add to emissions;

d) recycled pulp has fibres of poorer strength than those of fresh pulp.

In addition, a high degree of recycling could depress the price for fresh pulp and discourage replanting.

However, the authors conclude that in a field as complex as this there is a strong case for a more elaborate analysis. But for the general reader interested in energy and emissions the present volume is both stimulating and a useful reference source for the technology of the pulp and paper industry. The authors do, in fact, make a suggestion which would make many environmentalists shudder — from energy and emissions aspects there is a case for using some of the paper as a fuel.

Obviously these are special factors in the recycling of paper, but this book illustrates how difficult it can be to evaluate the advantages and effects of recycling policies for any material. The cases for recycling relatively rare metals requiring a high energy input to produce them from raw materials, such as aluminium, seem to be strong, but how does glass recycling rate for energy and emissions?

Norman Worley

Authoritative handbook

'Windpumps: a guide for development workers' by Peter Fraenkel, Roy Barlow, Frances Crick, Anthony Derrick and Varis Bokalders
Published by IT Power Ltd, London, 1993, £14.95.

WINDPUMPS have been important in many parts of the civilised world. They have lowered the Fens in East Anglia by three metres since the time King John of Magna Carta fame. (He found the depth of water embarrassing, remember, when he lost his jewels in The Wash!). Windpumps were used to recover most of The Netherlands from the sea and in the last century they opened up the Great Plains of the United States — how else would all those cattle have survived the dry, dusty conditions? Only the coming of 'the electrics' with the building of the great dams killed the windpumps off there. Australia, Argentina, South Africa — many countries have been opened up by the windpump.

Less developed countries still have a need for windpumps in regions where electricity and diesel fuel are not readily available. When an area is electrified, electric pumps tend to win out because they are cheaper and easier to maintain. Where diesel fuel is cheap, diesel pumps can be attractive, but only if regular servicing and maintenance can be provided. So there are still many undeveloped parts of the world where water pumping is best done by the wind.

There are many types of wind turbine around, of course, and anyone who is looking for information about the electricity-generating grid-connected wind farms that have sprung up in great numbers around the world recently — 18 of them in Britain alone, generating 116 MW — will need to look elsewhere for enlightenment. *Windpumps* is a handbook intended as a guide for development workers and project managers concerned with sustainable rural development, water supply and farming in developing countries.

Peter Fraenkel, the leading author, was a founding member of the British Wind Energy Association, and has been in intermediate technology for two decades. His colleagues and co-authors have considerable experience between them of installing windpumps for water pumping in developing countries, and they know what they are talking about. They have produced sections dealing with all the important aspects of such projects from beginning to end: assessing the wind resource; evaluating the economics; sizing and specifying the windpumps; procuring the equipment (Appendix B is a useful buyers' guide); installing and operating it; and, very importantly, maintaining it. Oh! — and finding how much water there is to pump in the first place, of course!

If you worry about water supplies for developing countries and the energy needed to pump them, this is a valuable and authoritative handbook that you must have.

D T Swift-Hook

Impartial survey needed

'The Global Greenhouse Regime — Who Pays?' by Peter Hayes and Kirk Smith. Published by Earthscan, London, 1993, 382 pp, £24.95.

IN FOUR parts, excellently sub-divided, this book is a compilation produced by two authors, published in conjunction with the UN University Press. The first part deals with measuring responsibility; the second, resource transfers; the third, national greenhouse gas reduction cost curves; the fourth, a conclusion constructing an appropriate regime. There are 382 pages of which more than four list explanatory figures, tables and 'boxes'. There is a five and a half page index. This UN University research project is no more or less than a compendium of known fact — virtually impossible to check for omissions. Omissions, of course, meaning extracts from conclusions and data resulting from the many official enquiries, multiple government statements and meetings of the UN itself. One has to assume this extensive and authoritative volume covers the field.

But if its usefulness is measured against the yardstick of maximising energy efficiency and minimising pollution, one has to admit to some bewilderment. The index has only one reference to electricity generation, and that concerns Brazil. In the global context there is no comparable data or comment. In the chapter devoted to carbon abatement in Europe and the former USSR, there is one passing mention to heat and power — relating to Eastern Europe. There is no apparent awareness on the part of the editors of the achievement in Western Europe reducing urban pollution levels of negligibility; one seeks comparison of the scale of the existing solution to compare with the task remaining. An informed and impartial survey is desperately needed. UNICHAL (not mentioned) has an example ten times as great as the total of electricity generated in the UK: by no means either negligible in scale or lacking in energy strategy significance.

All this would suggest virtually complete ignorance of the achievement in Western Europe, succeeding in reducing pollution emissions virtually to nil effect. And the ignorance is understandable. but inexcusable. In 1954 nine countries' representatives set up the International Union of Heat Distributors — meaning, in the main, heat from electricity generation. Such organisations were, of course, subordinate to the electricity producers, geared to disposal of a significant waste product — heat. And in excess of 65% of the energy concerned.

Until now the UNICHAL achievement has remained virtually concealed: the electricity industry does not want it known that disposal of its waste actually promotes a public utility service several times larger than its own prime concern. At one time members voted for no publicity: they cannot any longer hide this success, electricity must take on a subservient role, relinquish the dominant service to distributed heat. Taken to the limit, where distribution of heat is fully exploited there is a measurable loss of electricity business: for every MW of heat, two MW of electricity are rendered redundant.

Regrettably, such books as this from the UN cannot fulfil their role without some acknowledgement of the UNICHAL case and its results. Even if there is an electricity-biased answer, the pro and con must be tabled. The scale of effect is now so great it cannot any longer be ignored.

Norman Jenkins

Up dates anticipated

'Gas cleaning for advanced coal-based power generation' by Kelly V Thambimuthu. Published by the International Energy Agency (IEA) Coal Research, London, 1993, 163 pp, £85.00 (member countries) £255.00 (non-member countries)

THIS publication is the latest in a series on coal emission topics from the IEA Coal Research. There are 14 countries supporting the programme, which is centred on the UK.

With the installation of natural gas fired gas turbine generating plants with low emissions and efficiencies approaching (or planned plant exceeding) 50%, the conventional coal-fired boiler/steam turbine, favoured by the CEGB, is unlikely to be built in the UK in the future. However in the long term, there must be a need to employ coal for power generation, but which of a number of alternative schemes — gasification/gas turbines, pressurised fluidised bed, direct coal-fired turbines or fuel cells — are most likely to be used is, at present, far from clear.

This book first outlines the main features of the principal alternative technologies (the section gives only limited details) identifying the location and requirements of the cleaning installations. There follows a short section on the level of cleaning required by the processes and emissions to the environment allowed in various countries.

There follow sections on low temperature cleaning, particulate removal at high temperatures covering cyclones, agglomerators, electrostatic precipitators, bag and ceramic filters, granular and fluidised bed filters.

Removal or reduction of gaseous contaminants — sulphur and nitrogen and minor trace elements at high temperatures conclude the technical sections.

In a field such as this much of the information is obtained from the literature and continuing research programmes and there is an extensive reference section with papers and conferences for the period 1970 to mid 1992, and including several from the Institute of Energy's Journal and fluidised bed conferences.

This is clearly a reference book, and the style does not lend itself to reading from cover to cover. The volume is reasonably up to date, comprehensive and therefore indispensable for those involved in coal technology. The equipment and techniques are of wider applicability than advanced coal technology and the metallurgical and high temperature oil and chemical exports would find the material here valuable.

In a field such as this, where research and equipment is continuing, there is a case for further editions of this in the future. The present volume is both in format and classification the basis for a regular up date, it is hoped that this is planned.

Norman Worley

Recently published

'Cogeneration Technology 1993'
Published by VDI-Gesellschaft Energietechnik, Postfach 10 11 39, D-40002 Dusseldorf, Germany, 40 pp, DM 15.

'Materials performance in waste incineration systems'
Published by NACE International, PO Box 218340, Houston, Texas 77218-8340, USA, 538 pp, $60.00 (NACE members), $78 (non-members).

'Heat losses through windows'
Published by Building Research Establishment, BRE Bookshop, Bucknalls Lane, Garston, Watford WD2 7JR, £3.50.

'Valves and actuators for fluid control'
Published by BVAMA, available from The Secretariat, Bridge House, Smallbrook Queensway, Birmingham B5 4JP. 522 pp, £25.00 (inc p&p).

'The Construction and Operation of a Rice Husk Burner'
Published by Natural Resources Institute, Central Avenue, Chatham Maritime, Kent ME4 4TB, 41 pp, £7.50.

'Desulphurisation III'
Conference proceedings, published by IChemE, 165-171 Railway Terrace, Rugby CV21 3HQ, June 1993, 370 pp, £40.00.

'Combustion and emissions control'
Published by The Institute of Energy / Pergamon Press. IoE members can obtain copies from IoE headquarters. Non-members should obtain copies direct from Pergamon Press, Headlington Hill Hall, Oxford OX3 0BW. 430 pp, £30.00.

'Simply build green'
Published by Findhorn Foundation Development Wing, The Park, Findhorn, Forres IV36 0TZ, Scotland.

'Guidance for Examination of Boiler Endplate to Furnace and Shell Welded Joints'
Published by HSE, available from Associated Offices Technical Committee (AOTC), St Mary's Parsonage, Manchester M60 9AP, tel: 061 839 7038. £8.00.

'Going with the wind — a summary of wind turbine generators supplied and manufactured in the United Kingdom'
Published by Leicester Environment City Trust. Available from Mr Les Newby, Team Leader, Best Practice Research Unit, Leicester Environment City Trust, tel: 0533 554244. £3.00.

'Renewable energy resources: opportunities and constraints 1990-2020 Report 1993'
Published by the World Energy Council, 34 St James's Street, London SW1A 1HD. Fax: 071 925 0452. 388 pp, £25.00.

'Public Transport — what's in it for me?'
Published by the Institution of Civil Engineers, Great George Street, London SW1P 3AA

The European Market for High Voltage Switchgear
Published by ABS Publishing, tel: 0276 474828. 278 pp, £440.00.

Significant improvements

I HAVE read with interest the article in *Energy World* (January/February 1993) by David C Gunn on combustion in clinical waste incinerators, and would like to make the following comments.

My company, EUS Ltd Energy & Environmental Services, alone has undertaken comprehensive performance and emission tests on over 120 clinical waste incinerators of all types and sizes, both existing and new, and would not agree with Mr Gunn that "we are *all* on the low learning curve of combustion in these appliances". I am sure many clinical waste incinerator manufacturers would also disagree.

With regard to the main substance of the article, it is not possible to relate combustion techniques for clinical waste incineration with those applicable to coal combustion, as clinical waste and coal have totally different characteristics, particularly with respect to composition, volatile matter, content and combustion heat release rates. In fact, clinical waste is unique amongst conventional, alternative and waste fuels in the magnitude of the inconsistency of physical and chemical properties.

The design and waste feed arrangements of many existing, and most new, clinical waste incinerators are capable of enabling a satisfactory overall performance to be achieved. However, the main reason why such a performance is rarely achieved is inadequate or inappropriate control, with the fundamental combustion requirements for the waste in question not being fully considered. This is an area in which EUS Ltd from experience has devoted considerable attention, with significant improvements in performance having been obtained in many instances by modifications to control regimes.

Alan G Horsler BSc CEng FIGasE MIChemE
Managing Director, EUS Ltd

In favour of a federation of institutions

REGARDING the Fairclough Initiative: why does the Unification Steering Group insist on claiming that a united voice may only be achieved by the eventual formation of a single institution? Why could it not just as effectively be achieved by a federation of institutions? This would result in:

- institutions retaining control of the Council, rather than vice versa;
- majority verdicts on important matters of policy issued to the government and the general public by institution representatives (possibly some form of proportional representation, whereby the weight of each institution's vote is directly related to the number of members it has may be necessary);
- the 'richness' of the profession would be left unimpaired — as many disciplines will make up the combined membership, rather than a series of mergers resulting in a few institutions, then finally one with six divisions;
- a federated voice would be able to speak much sooner than a single institution, which is probably light years away.

A united voice is not an impossible ideal to achieve in the short term. On the European front, FEANI has already liaised with the EC, and it was agreed that FEANI should act as the 'umbrella organisation' representing all aspects of European engineering. What is now required is a British equivalent. I propose that the formation of a legally constituted 'British Engineering Parliament' would result in a much more democratic organisation, with important decisions being made by member institutions, leaving the Engineering Council to fulfil their function in implementing these.

If this is agreed, I am sure that the desired objectives will be achieved painlessly in a comparatively short time to the satisfaction of all concerned.

Eur Ing Henry Watts
Broadstairs, Kent

Young Engineer for Britain won by a girl — second year running

A 16-YEAR-OLD girl carried off the title of Young Engineer for Britain 1993 in September. It was the second year running that a girl has won the top award.

Lucy Porter, of Bath, won the coveted trophy, a £500 personal prize and £1 500 for the purchase of engineering equipment by her school. She also carried off The Engineering Council's WISE (Women Into Science and Engineering) award of £500 for the best project by a girl.

Lucy won the awards by inventing a swing exerciser for children with special needs, who are unable to use their legs. She plans to be an engineer and said: "Engineering is really addictive — it is so satisfying to design and make something which can solve a problem."

Lucy was one of 53 finalists, aged 11 to 19, competing in what is the leading event of its type in Europe. They had been selected at 12 regional events from a record 970 young people, competing for prizes totalling a record £20 000.

The winning projects also included a walking aid, a caravan parking device, a wind machine for developing countries, healthcare and environmental inventions.

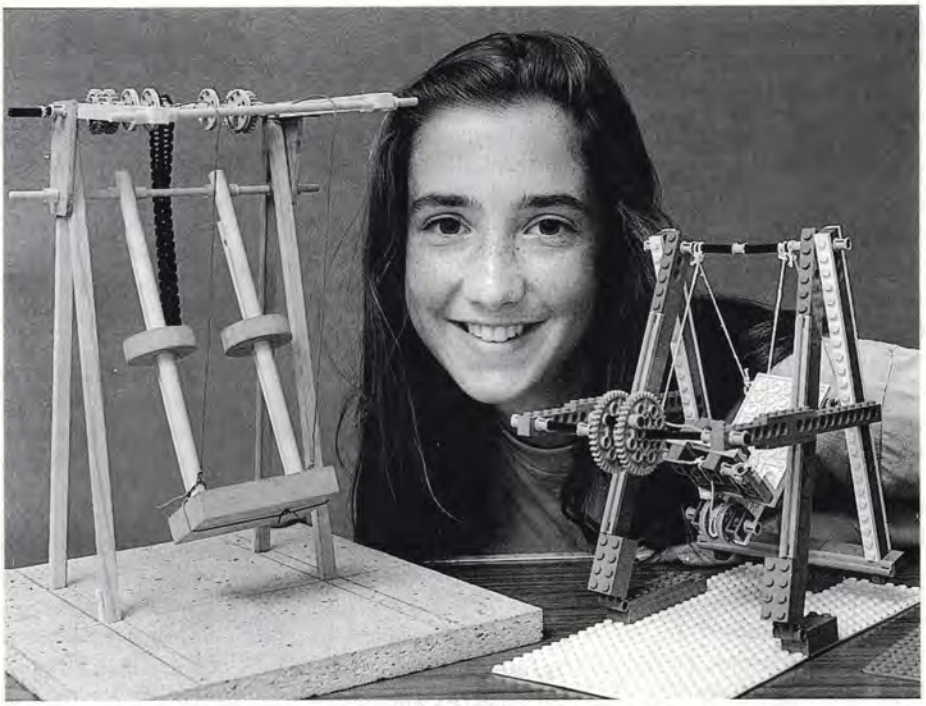
Runners up received prizes of study visits to companies, cash prizes for themselves and their schools and the opportunity to discuss their projects with eminent engineers.

Presenting the awards, The Lord Mayor of London, Sir Francis McWilliams FEng said: "It is highly appropriate that the final of the Young Engineers for Britain competition is taking place within the City of London, one of the oldest and still one of the most important business centres in the world.

"That fact should serve to remind us that the worlds of engineering and of commerce, often portrayed as remote from each other, are in fact inextricably linked. Quite simply, trade, banking, insurance and all the various business operations carried out in the City of London ultimately depend upon and derive their justification from the manufacturing and construction industries."

In the environment category, sponsored by National Westminster Bank, prizes were awarded to schools entering the best projects which investigate solutions to environmental problems. Philip Alderson, aged 18, from Dalgety Bay, Fife, was awarded first prize of £1250 for his wind machine, suitable for developing countries. Philip also won a prize of £1500, sponsored by Esso, for the best project demonstrating energy efficiency.

The three principal sponsors of the competition are British Gas, Lloyd's Register and the National Westminster Bank. Other major sponsors include Blue Circle Industries, BP Oil, GEC, London Electricity, National Grid, Nuclear Electric, Shell UK Exploration and Production and ICI.



Lucy Porter (above) with her winning project, the Swingex-L, an exerciser for children unable to use their legs, which won the two main categories at the Young Engineer for Britain 1993 awards. Philip Alderson (below) won both the environmental and energy efficiency categories.

October 1993

Clean coal technologies: future in the European Community energy scene
Robens Coal Science Lecture, 25 October, London. Details from Dr J C Whitehead, BCURA, Coal Research Establishment, Stoke Orchard, Cheltenham GL52 4RZ. Tel: 0242 673361.

November 1993

Oil and money: shifting oil fortunes
Conference, 25-26 October, London. Details from Brenda Hagerty, International Herald Tribune, 63 Long Acre, London WC2E 9JH. Tel: 071 836 4802; fax: 071 836 0717.

Negotiating contracts in the 'new' UK gas industry
2nd annual conference, 1 November, LOndon. Details from Helen Williamson, IBC Legal Studies & Services Ltd, 57-61 Mortimer Street, London W1. Tel: 071 637 4383; fax: 071 631 3214.

The businessman's energy saver
Three-day short course, 2 November, Ashbourne, Derbyshire. Details from NIFES on 0602 589047.

Electricity pricing
Conference, 2-3 November, London. Details from: AIC Conferences, tel: 071 779 8848.

The National HVAC Show
Exhibition, 2-4 November, London. Details from: Susan Fairley, EMAP Trenton International Events, Beech House, 840 Brighton Road, Purley CR8 2BH. Tel: 081 660 8008; fax: 081 660 6243.

Offshore structural design against extreme loads
Conference, 3-4 November, London. Details from: Carol Jopling, Conference Organiser, ERA Technology Ltd, Cleeve Road, Leatherhead, Surrey KT22 7SA. Tel: 0372 374151, ext 2488.; fax: 0372 374496.

Computers for plant safety
Evening meeting and demonstration, Risley, UK. Details from Dawn Butler, IMechE, on 071 973 1226

Flammable and toxic gas detection
One-day tutorial, 4 November, Bromley, Kent. Details from Isobel Smith, Sira Communications, tel: 081 467 2636, ext 215; fax: 081 467 7258.

The fifth oil measurement conference
4 November, London. Details from Caroline Little, Conference Officer, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Tel: 071 636 1004; fax: 071 255 1472.

Flow measurements for the utilities
International conference, 4-5 November, Amsterdam. Details from John Herriot, Conference Organiser, FMU Conference, Meetings Management, Straight Mile House, Tilford Road, Rushmoor, Farnham, Surrey GU10 2EP. Tel: 0252 795414; fax: 0252 792101.

AERION '93
Gas sector exhibition, 4-6 November, Athens, Greece. Details from Ms C Poulon, LDK Consultants, 7 Sp Triantafyllou Str, GR-113 61 Athens. Tel +30 1 862 96 60; fax: +30 1 861 76 81.

10th international symposium on alcohol fuels
7-10 November, Colorado, USA. Details from Jessica White, NREL Conferences Group, 1617 Cole Boulevard, Golden, Colorado 80401-3393 USA. Tel: 303 231 1158; fax: 303 231 7719.

Its a small world
Advanced electricity law seminar, 8-9 November, Hertfordshire. Details from the International Bar Association, 2 Harewood Place, Hanover Square, London W1R 9HB. Tel: 071 629 1206; fax: 071 409 0456.

Energy and the environment
Royal Society Lecture, 9 November, London. Details from The Royal Society, tel: 071 839 5561, ext 219/247.

Energy efficient lighting systems
Seminar, 9 November, London. Details from Courses Secretary, Mid Career College, P O Box 20, Cambridge CB1 5DG. Tel: 0223 880016; fax: 0223 881604.

Monitoring & targeting
Energy management short course, 9 November, Newent, Glos. Details from Vilnis Vesma, tel: 0531 821350.

Commercialising biomass projects: ethanol production
Workshop, 10 November, Colorado, USA. Details from Shirley Ball, EPAC, South Route, Box 206, Nashua, MT 59248. Tel/fax: 406 785 3722.

Fire engineering strategies for complex buildings
Course, 10 November, Manchester. Details from Seminars Secretary, Mid Career College, PO Box 20, Cambridge CB1 5DG. Tel: 0223 88016; fax: 0223 881604.

Operational & environmental implications of CHP
Conference, 11 November, London. Details from Peter Holloway Associates, Allen House, Boltro Road, Haywards Heath, W Sussex RH16 1BP.

Cogeneration — advances in technology
Two-day conference, 16-17 November, London. Details from Jane Worman, IBC Technical Services Ltd, tel: 071 637 4383; fax: 071 631 3214.

Application of expert systems in the power generation industry
Seminar, 17 November, London. Details from Katie Rayner, IMechE, on 071 973 1312.

Clean power 2001
International conference on renewable energy, 17-19 November, London. Details from Conference Services, IEE Savoy Place, London WC2R 0BL. Tel: 071 240 1871, ext 222; fax: 071 497 3633.

The Brunel Memorial Lecture & Luncheon
18 November, Nottingham. Details from the General Secretary, Institution of Mining Electrical & Mining Mechanical Engineers, 60 Silver Street, Doncaster DN1 1HT.

The information centre of the 1990s: changes, challenges & choices
Conference & exhibition, 18 November, London. Details from Caroline Little, Conference Officer, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR.

Power cables & accessories 10 kV-500 kV
3rd international conference, 23-25 November, London. Details from Louise Bousfield, Conference Services, IEE, Savoy Place, London WC2R 0BL. Tel: 071 344 5467; fax: 071 497 3633.

East European Business Fair
Exhibition, 23-25 November, London. Details from East West Business Events Ltd, 26 Danbury Street, London N1 8JU. Tel 071 454 1985; fax: 071 454 1986.

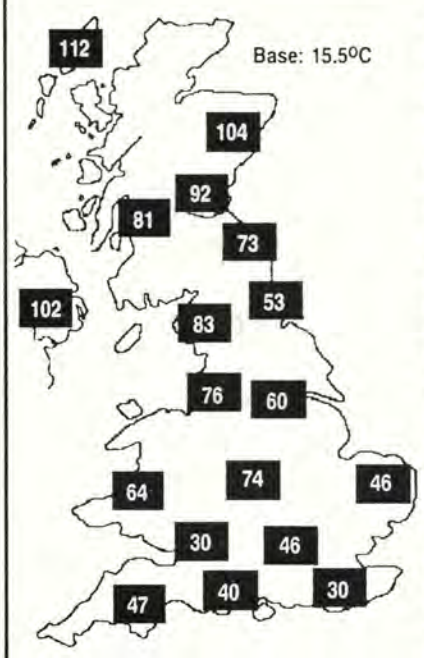
Ohmic heating — a revolutionary approach to the thermal preservation of food products
Royal Society Esso Energy Award Lecture, 25 November, London. All are welcome to attend. Details from The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG. Tel: 071 839 5561, ext 247.

December 1993

Environmental impact assessment & management — BS 7750
Conference, 7 December, London. Details from Courses Secretary, PO Box 20, Cambridge CB1 5DG. Tel: 0223 880016.

DEGREE DAYS: AUGUST 1993

Source: **Degree days direct**



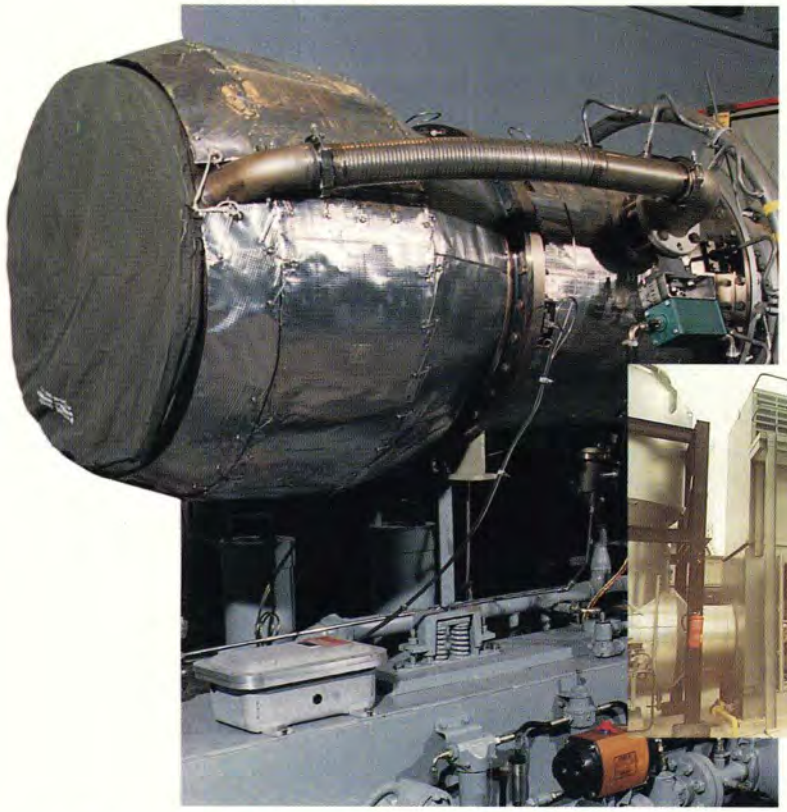
These regional figures, calculated from daily outside air temperatures, provide an index of demand for space heating over the month and thus enable excessive consumption to be detected.

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

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

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

■ 4255kW Dale gas turbine set.



■ 1100kW Dale gas turbine set which now supplies electricity and heat for an Italian brick factory.

■ This 4.2MW Dale gas turbine set is part of a combined cycle CHP system at a Spanish paper mill.

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