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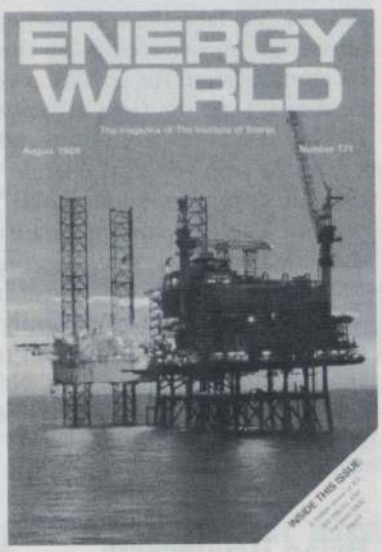
COVER STORY



Our cover photograph shows the accommodation platform on the central offshore complex of Britain's Morecambe gas field which provides catering and leisure facilities for nearly 180 people working on the field. On 11 August, James McHugh, CBE, FEng, British Gas' managing director of production and supply, inaugurated two new drilling/production platforms to mark the completion of the second stage work on the development of the field. Additional wells drilled from these platforms will help ensure the availability of gas to more than 17 million customers, especially in the winter months when peak demand can be six times that of the summer.

The Morecambe gas field was discovered by British Gas in 1974, and is one of the largest to be found on the UK Continental Shelf. British Gas is the sole licensee of the field. Because of its flexibility, the field can be operated as a seasonal supplier, or if other sources of gas decline, as a conventional field.

Photograph by courtesy of British Gas plc.

* See our series of feature articles on the gas industry, beginning page 7.

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TERMS OF CONTROL **Energy World is circulated free of charge to all paid up members of The Institute of Energy. To libraries, organisations and persons not in membership it is available on a single subscription of £60 (UK subscribers only) for 11 issues, £70/$US115 (Overseas). Energy World is also available with The Journal of The Institute of Energy (quarterly) at a combined yearly subscription of £110 (UK) or £115/$US185 (Overseas).**

Energy labelling

Measurements showed high concentrations of lead in the air and on vegetation next to roads, particularly in urban areas. This was attributed to the universal use of tetraethyl leads as an anti-knock additive to motor fuels. It was suspected by some that its presence in the environment would result in lead being incorporated into human tissue. Some supporting evidence was found in blood samples and animal post-mortem examinations.

Lead poisoning, particularly of children by lead paints and toys, was well attested and there were indications that one effect was impairment of mental development. Children's well-being was at risk. Pressure groups formed; parliaments were lobbied; members pressed for action. Eventually, governments legislated to reduce the permitted concentration of lead in fuel and Community-wide Directives were framed. Lead-free fuel appeared in the UK, favoured with a slight reduction in tax. Motor manufacturers were notified that in time all new vehicles would have to be able to use it.

Motorists responded with massive indifference. Over a long period, sales of lead-free fuel remained marginal. Soon, other environmental issues displaced lead from the headlines. Representations about the effects of toxic waste disposal, acid rain, ozone depletion and global warming greatly raised the public consciousness of hazards in the environment. The issues were widely discussed and began to take on political significance. No motorist could have been unaware of implications that the atmosphere was under massive assault. But the use of lead-free fuel remained consistently low.

Then the tax differential in favour of lead-free fuel was increased. At the time, suppliers were attempting to pass on a rise in the oil price and fuel cost was more than usually noticeable. Lead-free fuel sales took off; within months every forecourt had a green pump, quickly followed by substitution of the green option in place of 2-star fuel throughout the land.

What are we to make of this? Is it a perfect illustration of the market-forces argument? Do customers react only when there is a clear monetary advantage in doing so? Or does it show that a major change of attitude can emerge only after a significant gestation period? Perhaps people will eventually feel that they must do something allegedly virtuous when they have been relentlessly bombarded by warnings in the media for a sufficient length of time? Or if they did not believe the argument at first, what made them change their minds?

We need to learn what we can from this occurrence, for there might be others like it in the offing. For instance, we might soon have energy-labelling, the attachment of a prominent notice to domestic appliances showing potential purchasers what the energy utilisation would be in normal use. It seems reasonable that users should be given this information anyway, so that they can weigh energy use among the relative advantages of first cost, size, shape, colour and so on when choosing between one product and another. But the main reason would be to encourage people to be economical in energy use by making them more aware of it.

Powers to require energy labelling in the UK have in fact been available to Ministers since the Energy Conservation Act of 1981. They could have been brought in at any time by statutory instrument, that is, without going back to Parliament for approval of new legislation. Ministers have not taken these powers so far, though energy labelling continues to be advocated (most recently by the European Commission in a recommendation for an action programme on efficient use of electricity). At the time of writing, the Select Committee on Energy is said to be about to endorse it strongly.

Should we support energy labelling? How would you respond in your own household? You decide to buy, say, a dishwasher. These two machines are otherwise much the same, but that one has a lower energy rating. The difference would give a saving of a few pounds a year in electricity costs. Not worth considering? Well, if every family could make a choice like that, it would mean about 3 million tonnes of CO_2 less a year discharged into the environment. Not to mention 60 000 tonnes of acid-forming materials, 800 tonnes of particulates, 800 million tonnes of warm water. . . .

Brian Brinkworth
President

The author

Brian Brinkworth is Professor of Energy Studies at the University of Wales College of Cardiff, head of the department of mechanical engineering and energy studies and dean of the faculty of engineering and environmental design.

Since becoming head of the mechanical engineering and energy studies department in 1983 he has presided over a wide range of energy projects including work on coal, oil, gas, biomass and other renewables.

A graduate in mechanical engineering from Bristol University, Professor Brinkworth began his career with the Ministry of Supply but gained most of his early research experience at the Royal Aircraft Establishment, Farnborough.

At RAE he was appointed Secretary of one of the committees of the Aeronautical Research Council, which led to his becoming a member of several committees of the ARC and other bodies concerned with aviation research for a period of more than 20 years. He retains his membership of the Royal Aeronautical Society and his professional interest in aviation matters.

He has been a member of the academic staff at Cardiff since 1960, having held the posts successively of lecturer, senior lecturer, and reader in mechanical engineering at the university. He became the first holder of the chair in energy studies, established in 1977.

He has also been instrumental in the creation of the university's Solar Energy Unit, which led to the installation of the SERC Solar Simulator, which provides a flux matched in intensity and spectrum to solar radiation, and to the SEU's spin-off operation, the Energy Equipment Testing Service.

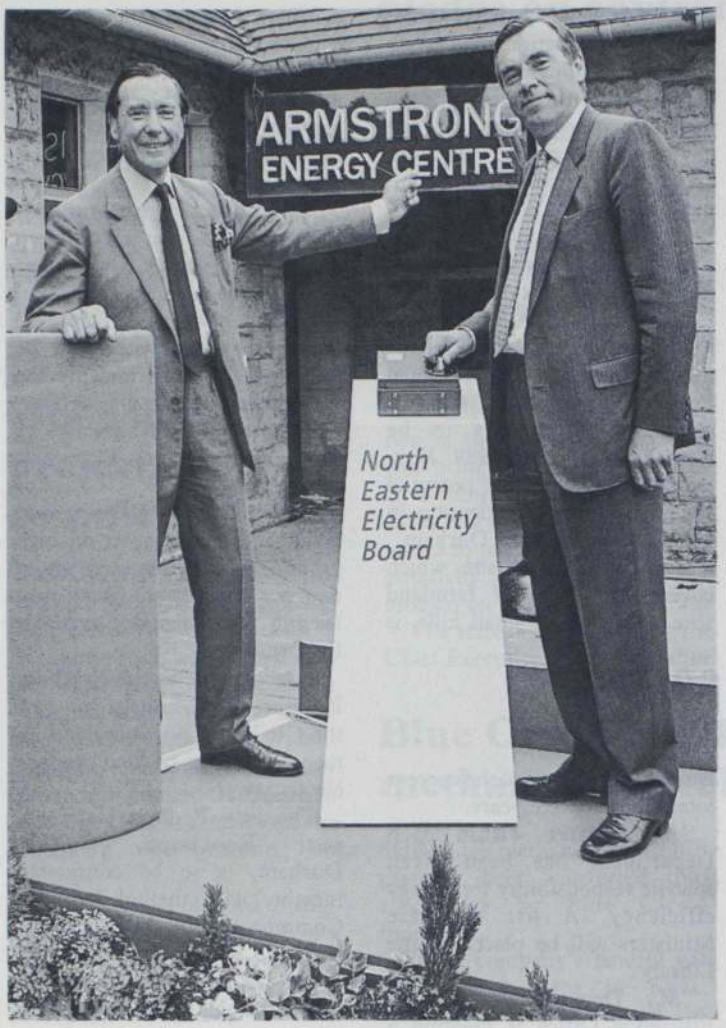
Armstrong Energy Centre opened at Cragside

DAVID MORRIS, the Chairman of the North Eastern Electricity Board formally opened the Armstrong Energy Centre at Cragside, near Rothbury, Northumberland on 21 July. This is the culmination of the £400,000 Cragside Science and Technology Appeal, organised by the National Trust.

NEEB's £100,000 contribution marks that organisation's commitment to the development of the North East and hints that the future of the private electricity industry may once again be synonymous with the engineering excellence demonstrated by Cragside, Lord Armstrong and his contemporaries.

A further £300,000 has been raised by the National Trust from its members, leading British companies, national and local Government organisations under the chairmanship of Lord Vinson LVO who said: "The Armstrong Energy Centre will excite the interest of young people in science and engineering and encourage them to take up a career in this vitally important field.

"Lord Armstrong's pioneering work on alternative energy sources, much of which is featured in the Energy Centre, means that the centre will become a major educational resource for current and future generations."



Pictured at the opening of the Armstrong Energy Centre are Lord Vinson, LVO (left), Chairman of the National Trust's Cragside Science and Technology Appeal, and David Morris, Chairman of the North Eastern Electricity Board.

Wind parks proposed for Western Australia

THE State Energy Commission of Western Australia plans to build a series of "wind parks" along the coast beteen Geraldton and Margaret River in a move that could revolutionise energy production in the state.

Announcing the estimated $16 million project the Minister for Fuel and Energy, Mr Jeff Carr, said SECWA was investigating the possibility of building as many as five parks, which together would generate enough electricity to power a town of 10,000 people. If the project is successful, it could pave the way for some country towns to be powered almost entirely by wind.

The favoured sites for the five parks are at the Greenough River south of Geraldton, at Leeman, Jurien Bay, Leschenault Inlet near Bunbury and Moses Rock near Cowaramup. At peak capacity the parks could generate 12 megawatts of power, which would be fed into Western Australia's main power grid. Much of the wind-generated power would then be used to provide electricity for nearby communities.

Mr Carr said the project was the culmination of six years of research and development by SECWA into grid-connected wind energy generators. It followed the establishment in 1987 of Australia's first commercial wind farm at Esperance, which has six 60-kilowatt aero generators that generate enough electricity for 200 homes in the region.

British Coal's operating profit almost doubled

BRITISH COAL almost doubled their operating profit last year — making it the Corporation's best financial performance for at least 20 years.

This was announced on 26 July by the British Coal Corporation's Chairman, Sir Robert Haslam, when he reported the financial result for 1988/89 of a £498 million operating profit (the industry's prime financial performance indicator). It was achieved "despite the most intense competitive pressures on our business," he said.

With the sharp rise in interest rates, the Corporation's interest burden increased by £64 million to a total for the year of £432 million, paid mainly to the Government — and it will rise further in the current year to over £550 million.

"This again highlights the real and urgent need for a financial reconstruction," Sir Robert said. "Recognising this, the Government are giving the situation active consideration and I am hopeful this pressing issue will be resolved."

Presenting the 1988/89 results (see Table 1), Sir Robert said that higher wage settlements than planned, reflecting rising inflation, added to the Corporation's costs — and the low oil prices last autumn yet again led British Coal to forego any price increase to their biggest customer, the Central Electricity Generating Board.

The last time British Coal increased their prices in line with inflation was as long ago as 1981. Since 1986 alone, the cost of coal to the Corporation's customers has fallen substantially in real terms — with savings to them running at around £900 million in the current year, and the CEGB benefiting by £650 million.

Table 1. Summary of British Coal financial performance in 1987/8 and 1988/9

	1988/9	1987/8
OUTPUT (million tonnes)		
Deep mines	85.0	82.4
Opencast	16.8	15.1
PRODUCTIVITY — deep mines output-per-manshift (tonnes)	4.14	3.62
	1988/9 (£ million)	**1987/8 (£ million)**
TURNOVER	4,297	4,389
Operating costs	(3,799)	(4,128)
OPERATING PROFIT	498	261
Interest charges	(432)	(368)
PROFIT/(LOSS) after interest	66	(107)
Exceptional restructuring costs	(269)	(388)
TOTAL (LOSS)	(203)	(495)

Application made for Britain's first wind farm

AN APPLICATION for consent to build Britain's first wind farm was made to the Secretary of State for Energy on 1 August by the Central Electricity Generating Board (CEGB).

The board is seeking consent to build 25 wind turbines with a combined output of around 8 megawatts on a site at Capel Cynon in Dyfed, West Wales.

Consultation is also taking place with Ceredigion District Council and Dyfed County Council.

It is hoped that construction work can start early next year with the wind farm producing its first electricity during the following autumn and being fully operational in the spring of 1991.

After 10 years of research and investigation, the technology and costs have developed to a stage where demonstration wind farms are planned. These will test the technical performance of the machines, the effects on the environment, public reaction, operational costs and future commercial potential.

Capel Cynon will become the first of three demonstration wind farms proposed for development in a £28 million programme, jointly funded by the Department of Energy, and National Power and PowerGen, the two successor companies to be formed under the 1989 Electricity Act. Two other potential sites are under investigation in Cornwall and County Durham.

The Capel Cynon site, which covers 750 acres of farmland spread over three small hills, is considered a good choice because it has suitably windy conditions, good road access, it is environmentally acceptable and is conveniently located to feed power into the local electricity board supply system.

Each of the 25 wind turbines proposed will have a maximum output of up to 350 kilowatts. They will consist of a cylindrical column between 25 and 30 metres high on which will be mounted a module housing the turbine coupled to a generator. Each machine will have two or three blades about 33 metres across.

The turbines will be spaced about 300 metres apart on high ground, occupying only about one per cent of the land area, leaving the remainder available for farming.

A second site in the Northern Pennines is to be investigated by the CEGB for possible development as a wind park to produce electricity.

The site — Redburn Common, near Rookhope, County Durham, is to be considered together with that of Langdon Common, near Middleton-in-Teesdale, for one of the three proposed demonstration wind parks in England and Wales.

New public sector energy efficiency campaign

IN ONE of his last acts as Secretary of State for Energy before moving on to his new responsibilities at the Department of Transport, Cecil Parkinson announced details of the British Government's campaign to promote energy efficiency in the public sector.

In answer to a Parliamentary Question from Mr John Hannam MP (Exeter) Mr Parkinson said: "The Government is leading a campaign to improve energy efficiency within the public sector.

"The campaign will start with Government Departments and then extend to the public services. The aim for Government Departments is to achieve savings rising to £45 million per annum (15 per cent of the current total bill) over five years.

"A Minister within each Department has been given specific responsibility for energy efficiency. A list of these Ministers will be placed in the Library.

"My Department's Energy Efficiency Office is creating a small team to brief each Minister, enabling them to set targets for their Departments and agree plans for achieving these targets. This team will monitor progress and report to me, and targets and measures of performance will be published.

"Departments will be able to count these new gains towards their targets for efficiency improvements in three year running costs management plans."

Independent power producers consulted on licensing regime

INDEPENDENT generators and suppliers of electricity are being asked for their views on how the proposed licensing regime for the privatised industry might affect them in a consultation document published by the Department of Energy on 7 August.

Under the Electricity Act 1989 anyone who generates or supplies electricity will need a licence, unless exempted. The licences will impose obligations on the electricity companies and may also confer rights. They are designed to achieve a balance between regulation to ensure a secure and reliable supply for consumers and the creation of a flourishing competitive market.

Existing and potential electricity operators are being asked in particular for their views on who should be exempted from the requirement to obtain a licence.

The closing date for submissions is Friday, 8 September 1989.

Watt on waste

AS ONE of a number of new projects launched this year, The Watt Committee on Energy has set up a working group to examine the possible ways of converting low temperature waste heat into electricity. The project, which is sponsored by the Department of Energy, is to be chaired by Prof Jim Crook of Brunel University.

The Watt Committee's intention over the next few months is to review the existing state of knowledge in this field (not to conduct original research). It will examine the various cycles (known as thermodynamic cycles) that are currently available for converting low temperature waste heat into usable power and the cost, availability and reliability of such plant.

A presentation of the working group's findings will be made at a Watt Committee conference in October 1990 and published subsequently as a Watt Committee Report.

Sheffield CHP scheme enters second phase

SHEFFIELD Heat & Power, the joint venture between Sheffield City Council and Ekono Oy of Finland has initiated the £2.5m second stage of their new "heat from waste" distribution system.

Turning the ground to help bring into being a significant new heat distribution network for Sheffield City Centre, Lord Ezra, Sheffield Heat & Power Chairman, commented: "Today marks a new phase in the development of environmentally acceptable energy production in the UK.

"With this new heat distribution network for the city centre we are taking even more of the heat from Sheffield's refuse and putting it to use.

"Building up our heat connections from this system will pave the way for the full combined heat and power system long planned in Sheffield."

Using advanced pipework technology from the i/c Moller division of ASEA Brown Boveri, the new £2.5 million investment is the second phase of Sheffield Heat & Power's work to connect up the city. Already, 18 multi-storey blocks of flats are being supplied with heat, together with 12 public houses and 20 shops and now city centre based local authority and other buildings are to become the first customers for the heat SHP are taking from the city's refuse plant. Finance for the work has been wholly provided from the private sector by the Bank of Tokyo.

Italian contract

BRITISH GAS has won a £3 million contract to work with the gas and water authority of Genoa, Italy, to extend the city's gas system over the next three years.

In the largest contract of its kind to date, British Gas will provide and operate the cost-cutting narrow trenching technology developed by the company and already a familiar sight on Britain's roads. Around 50 km of polyethylene plastic pipe will bring natural gas to several local communes, situated in rugged mountain terrain.

A team from British Gas North Western, where the technology was first developed, leaves to begin work in Genoa on 2 October.

British Gas demonstrates gas making process

BRITISH GAS has successfully completed a two-month trial to demonstrate the production of substitute natural gas (SNG) from coal using a total integrated process route incorporating the commercial-scale British Gas/ Lurgi (BGL) slagging gasifier and the British Gas Hi CoM methanation process.

The trial, at the Westfield Development Centre, Fife, Scotland, is an important milestone in a long-term research and development programme to use coal efficiently and cleanly to supplement natural gas supplies when it becomes necessary and economic.

More than 20,000 tonnes of coal, including coal from the UK and a high-sulphur coal from the United States, were gasified at 375 lb/in^2 pressure (25 bar) in the nominal 8 ft diameter (2.3 m) BGL gasifier. Coal fines were injected through the tuyeres as an aqueous slurry or formed into briquettes and blended with the coal feed. In the gasifier, the coal is reacted with steam and oxygen at high temperature producing a medium calorific value fuel gas and converting the coal ash to an inert slag. Sulphur in the coal, which is converted to mainly hydrogen sulphide in the crude gas, is readily removed and recovered as elemental sulphur. At Westfield, the crude gas was purified to a sulphur content of less than one part per million by washing with methanol and the purified gas was upgraded in the British Gas Hi CoM process. In this process the carbon monoxide and hydrogen in the purified gas are converted to methane using a British Gas methanation catalyst.

The performance of the gasifier and the integration with the downstream gas processing system was entirely satisfactory throughout the trial. An overall process efficiency greater than 70 per cent for converting coal to SNG can be achieved with this process route. The demonstration, which was financially supported by the Gas and Electric Power Research Institutes of the United States and the EEC, has proved the technical viability of this coal to the SNG process route.

As well as SNG, the gasifier can be used to produce fuel gas, synthesis gas for chemical production or clean electric power generation.

There is a great deal of interest in this advanced gasification technology. A number of large-scale demonstration plants are planned or are under construction in the EEC and in the USA and several independent studies show the BGL gasification process to produce cheaper electricity than its competitors.

Woodside LNG project nears completion

WOODSIDE Offshore Petroleum in Western Australia has declared that the construction of its giant liquefied natural gas project is now "in the home straight". Major sections of the Burrup Peninsular LNG plant are complete with the power generation unit and fractionation train one commissioned and the remaining work running on schedule.

Woodside had planned to ship out what would be Australia's first LNG exports from the plant in early October but might now be capable of sending the first container load to Japan as early as August. Eight Japanese electricity and gas companies have contracted with the six North-West Shelf joint venturers to buy all of the North Rankin A LNG for the next 19 years.

Production is expected to peak at just under 6m tonnes a year by 1994, which will be worth an estimated $2bn a year.

New power companies give pledge on environment

A COMMITMENT to continue safeguarding the environment was given on 17 May by the three successor companies to emerge from the Central Electricity Generating Board under the Government's electricity privatisation proposals.

A joint statement of environmental policy has been published by National Power, PowerGen and The National Grid Company. It says that privatisation of the successor companies will bring no lessening of their environmental obligations. Standards and practices will be maintained to minimise the impact of electricity generation and transmission on the environment.

The statement is issued by the Chief Executives designate of the three successor companies, Mr John Baker of National Power, Mr Ed Wallis of PowerGen and Mr Bill Kerss of The National Grid Company.

Each company commits itself to take environmental care as a guiding principle to cover all operations, planning and construction programmes.

The statement says National Power, PowerGen and The National Grid Company all recognise the need to reconcile the provision of a secure, efficient and economic electricity supply for the public with the obligation to reduce, to a practical minimum, adverse effects from transmission and from nuclear, fossil or renewable forms of generation.

Blue Circle converts methane gas to electricity

SURPLUS methane lean landfill gas has been converted into electricity by Blue Circle Industries.

At the company's landfill gas utilisation scheme in Kent, between 45-50 per cent of the methane gas generated at the landfill site is utilised in the nearby cement works and sold to local industrial users. The balance of the gas which would otherwise be flared off has now been harnessed to generate electricity.

Approximately two thirds of the one megawatt of power generated is fed directly into the Seeboard grid and the balance is meeting the electrical needs to run the landfill station. The power generation scheme, installed at a cost of only £700,000, is now fully on line and the electricity being supplied into the grid is sufficient to meet the demands of some 2000 houses per year.

The two 500 kilowatt gas engines generating the electricity are able to operate on low-quality methane and low-pressure gas. As a result, BCI Landfill Division sees scope for implementing the system at other landfill sites.

British public favour wind power generators

THE first-ever survey into public perception of wind power in the UK has produced some surprising results as delegates at the recent European Wind Energy Conference, in Glasgow, heard that the British public would prefer the use of wind power to other forms of electricity generation.

As many as 52 per cent of those interviewed actually wanted to see an increase in production and use of wind energy and it emerged that people who are well informed about wind power are more in favour of it than those who know little or nothing.

Sponsored by the Department of Energy (DEn) and the CEGB, the Robens Institute and the Department of Psychology at Surrey University interviewed members of the public in various places around Britain. Some had no experience of living near a wind turbine, some had at least one wind turbine operating in the locality while others lived in the vicinity of one of the three wind-farm sites proposed by the CEGB and DEn. Yet another group were interviewed as work was starting in Kent on a large MW-rated wind turbine in their area. Further studies will involve measuring the changes in attitude, in the last group, after construction is completed.

Eighty-six per cent of those familiar with the workings of a wind turbine were very positive about the safety aspects of wind energy. Although the majority thought that wind turbines were conspicuous, 45 per cent saw them as being attractive.

Dr Ian Page, chairman of the British Wind Energy Association, says: "The results of this public opinion survey are very encouraging. The British public appear to be prepared to accept small groups of wind turbines in their locality in order to see electricity generated without pollution."

South Coast symposium on NO_x control

THE LATEST annual symposium organised by the Institute's South Coast Branch was on the subject: *NO_x generation and control in boiler and furnace plant.*

Held in Portsmouth, the event was organised in conjunction with the Combustion Institute and was attended by more than 80 guests, predominantly Institute of Energy members.

Words of welcome from John Hardman, Chairman-elect of the South Coast Branch were followed by an introductory address by the then President, Ted Pugh CBE, who called for prudent, informed action on NO_x control, a subject on which emotions sometimes outrun logic and commonsense.

The morning session which was chaired by Prof Derek Bradley FRS (Leeds University), began in a very logical manner with three papers considering the mechanism of NO_x formation during the combustion of coal, NO_x chemistry in dispersing plumes and the effect of NO_x on plants.

In the first paper, Prof Alan Williams and his co-workers at Leeds University reviewed the complex and incompletely understood mechanisms and kinetics of NO_x formation from nitrogen present in coal.

The second paper, by Alan Cocks of CERL, considered the continuing relations of NO_x in the atmosphere and the dispersion of the exhaust plume.

J A Lee of Manchester University discussed the effects of NO_x on plants. He noted that the overall complexity of this subject and the timescale over which ecological events occur suggests that a full evaluation of the importance of NO_x pollution may not be possible in the near future.

The paper on NO_x legislation and its implications for fuel firing practice by M P Cabot of HM Inspectorate of Pollution (HMIP), was presented by his colleague, Mr Barnett. He pointed out that existing UK legislation had evolved to protect UK citizens and took little account of possible effects caused elsewhere by 'exported' pollutants. EEC legislation so far enacted was intended to provide for a harmonised approach to industrial air pollution control in the various EEC countries and inevitably took a broader view, although its main regulatory theme of adopting BATNEEC (best available technology not entailing excessive cost) does equate fairly well with the requirement for BPM (best practicable means) used in the UK.

The remaining six papers were of a more practical nature.

The task of summarising the day's presentations and discussions fell to Dr C Lawn, Secretary of the British Branch of the Combustion Institute. He summarised the main points covered by the day's proceedings with the following opinions:

- The universities' claim that NO_x is as great a menace as "smog" is an overstatement — possibly meant to encourage grants for research work! The current programme on NO_x reduction from UK power stations was costing £170m and this seemed a reasonable response in relation to the problem.
- The practical approach to legislation represented by BATNIEC (Best available technology not incurring excessive cost) was welcome, but harsher measures will be likely after 1992.
- Atmospheric fbc can meet limits presently required with careful operation, while pfbc can do so more easily. However pfbc will lose out to pf firing on a cost basis.
- Selective catalytic reduction with ammonia appears to involve excessive cost, but may be necessary as emission limits become more stringent.
- Effort should be concentrated upon modifying the combustion process to control NO_x formation.

Double awards for Napier Polytechnic students

TWO Napier Polytechnic students not only gained BEng honours degrees in Energy Engineering this year, but they also received special awards from The Institute of Energy.

Steven Marshall (pictured above, far left) gained the John Rayner Shield from the Scottish Branch of the Institute for being the author of the best student paper presented during the year. Robert Stafford (far right) was awarded the Roscoe Prize, a national award for the best paper presented by a student anywhere in the UK.

Their prizes were presented at the annual dinner of the Scottish Branch where the guests included Prof Brian Brinkworth, then President Elect of the Institute (pictured 2nd left), Gavin Laird, the General Secretary of the Amalgamated Engineering Union (AEU) (2nd right). John Hoyle, Chairman of the Scottish Branch, is pictured in the centre of the group.

Obituary

D H Johns

We regret to announce the death on 7 July of Daniel Howe Johns, who had been a Member of The Institute of Energy and its predecessor body, The Institute of Fuel, for more than 30 years. Mr Johns was aged 66.

As a young graduate chemist, Dan Johns worked for a short period in the steel industry before joining the Birmingham Electricity Authority in the Nechells laboratory. He went on to become station chemist at, in turn, Carlisle, Nottingham, Castle Donington, and Hams Hall power stations before joining the headquarters staff in what became the Midlands Region of the CEGB.

D G Kingerley

Revolution — the *Ofgas* way

by James McKinnon, Director General of Gas Supply

The Office of Gas Supply (OFGAS) has been operating as Britain's official regulator and consumer watchdog over the gas supply industry since June 1986. In the following article, James McKinnon, who heads OFGAS as the country's first Director General of Gas Supply, looks back at the problems and constraints on competition that existed in the then newly-privatised gas supply industry and assesses the progress made in dealing with these problems during the past three years.

WHEN the history of the gas supply industry in Britain comes to be written, 1989 will surely go down as one of its most historic years.

In the same year as the French celebrate their bicentennial, with talk of revolution in the air, there is also a revolution going on in gas.

But unlike some revolutions, the benefits accruing from the gas revolution are more likely to be shared by all, because for the first time in Britain competition has been introduced into the gas supply market.

And with that competition will come lower prices for industrial customers, exports should become more competitive and the ordinary man and woman in the street should benefit from the keener prices obtained by industry for its fuel costs.

Why is 1989 so important, I hear you ask? Well to begin at the beginning, it has been possible for some years now for potential customers to use the existing British Gas pipeline system to transport gas either to their own premises or to their own customers.

A combination of factors meant that such competitors were unwilling to take what for them would have been a giant leap into the unknown. They had no indication of the costs of transporting gas through the pipeline system, no information as to what British Gas was charging its customers for the gas and, of fundamental importance, they had no access to new gas. Such a range of formidable obstacles was good reason not to take that leap.

All that has now changed and the door to competitiveness has been opened as all three outstanding issues have been addressed and resolved.

First, the Monopolies and Mergers Commission report on Gas, published last autumn, concluded that British Gas has been guilty of discrimination in the way it operated its pricing policy towards its industrial customers. As a result, the company was required to publish schedules showing prices for firm and interruptible gas thereby introducing a transparency which would provide a guide to competitors and fairness to gas users.

Secondly, and a further result of the MMC report, at least ten per cent of all new gas will be made available to purchasers other than British Gas.

Thirdly, OFGAS has for the first time intervened on behalf of a competitor and issued a direction to British Gas to allow the use of its pipeline system for the carriage of the competitor's gas to its own customers.

Other competitors are now anxious to take advantage of the new situation and are currently engaged in discussions with British Gas. OFGAS will remain on the sidelines unless negotiations fail and we are once more called upon to adjudicate.

Customers contracting with these emerging competitors can be confident that their interests will be safeguarded. For example if, for an operational reason, a shipper has a difficulty in obtaining supplies British Gas will be called upon to provide a back-up supply. Such a back-up supply will be determined by OFGAS at the start of a contract as to price and the conditions under which it will be supplied.

If for any reason, a customer, having commenced to deal with a competitor to British Gas has a change of mind it must be emphasised strongly that such a customer would be entitled to revert to dealing with British Gas. He will be able to do so in accordance with the published price schedules and will be treated no differently from any other British Gas customer.

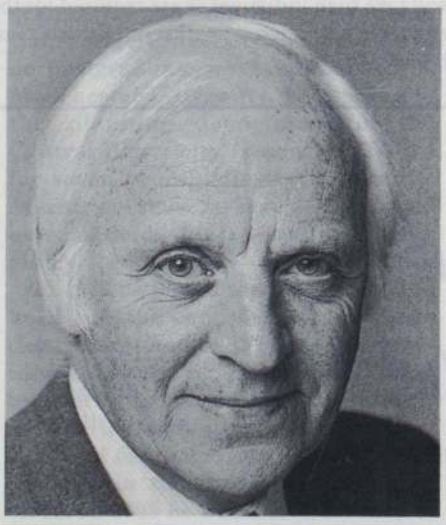
Common carriage

OFGAS is attempting by its involvement in the "common carriage" discussions to level the playing field to give new players a reasonable change of success. The terms and conditions of carriage will ensure that the quality of gas will be as before, the level of service will be identical and that only the price will be different.

Competitors will seek customers among existing British Gas customers as well as the rapidly expanding power generation market.

The publication by British Gas of its price schedules provides transparency and allows the potential competitor to assess the size of his target market place. The emergence of the 90/10 rule and the reality of competitors being

The author



James McKinnon was appointed to the newly-created position of Director General of Gas Supply by the then Secretary of State for Energy on 24 June 1986. He has recently been re-appointed to the position for a further five years from 18 August this year.

Mr McKinnon, 58, is an accountant with over 30 years experience in commerce and was previously Group Finance Director of the Imperial Group plc.

Educated at Camphill School, Paisley, Scotland, Mr McKinnon then served articles with a Glasgow firm of accountants. He has held a number of accountancy appointments with firms in the private sector and is a member of both the Institute of Chartered Accountants of Scotland and the Institute of Cost and Management Accountants.

He was a member of the Council of the Institute of Chartered Accountants of Scotland from 1978-83 and was President of the Institute in 1985-86. He served as deputy chairman of the CCAB Accounting Standards Committee between 1982-84 and is currently external adviser to the Ministry of Defence's Management Audit Committee.

Before leaving Scotland, Mr McKinnon lectured (part-time) to students studying for ICMA and ICAS final examinations. He has written several publications, including a series of books on management accounting for the Institute of Cost and Management Accountants examination students.

able to use the British Gas pipeline system have combined with the schedules to provide all the elements required for the development of competition in the gas supply market.

It is now up to competitors to take advantage of these conditions and enter the market place. OFGAS seeks to assure end users of gas that the competitive system will operate satisfactorily and that the terms and conditions affecting the competitor will ensure continuity of supply to the customer.

Overseas suppliers of gas will doubtless be monitoring events in Britain with great interest. If the market opportunities in Britain appear to offer satisfactory earning levels it is possible that an entrepreneur could build a pipeline linking Britain to the European grid but that is something for the future.

Price schedules

Of more immediate concern to OFGAS are the British Gas price schedules published earlier this year. We have received a number of representations from gas users which assert that there are a number of undesirable features emanating from the introduction of the price schedules which took effect on 1 May. These include:

—the lack of aggregation in interruptible contracts;
—the non-recognition of accredited buying groups;
—the impact of price band cut-offs on the efficient use of gas.

We are required to monitor the impact of the price schedules and following an analysis of complaints from British Gas customers, we put a seven-point set of proposals to the company recently and they have agreed to come back with an answer by September.

The seven specific areas are:

- The number of bands in the price schedule should be expanded in firm and interrupted contract categories to cater for higher levels of volume, with aggregation available in both categories. The number of premises for which firm supplies can be aggregated should be increased to cover all customers' circumstances.
- All legitimate trading affinity groups and energy management companies or other agents offering centralised contracts should be permitted to aggregate for the purpose of price qualification in both the firm and interrupted sectors.
- Load factors should be introduced without delay as a further determinant of the prices charged to customers.
- Arrangements should be made to buffer the impact of changing from one band to another.
- The existing matrix of choice should be expanded to provide a further range of options. An understanding should be given that interruptions under contract should, if possible, be pre-arranged with customers.
- A review should be carried out as to the choices which are presently offered in terms of an inflator or indices.
- For those customers who have experienced very heavy increases in price the transition period should be extended from one to three years.

Ofgas — the watchdog with teeth

According to a statement issued by the Office of Gas Supply, the regulatory body's efforts on behalf of the consumer have met with some success by:

—persuading British Gas to adopt more sensitive policies when dealing with customers who suffer severe financial hardship particularly those who are unable to handle credit payments.
—reconstructing the system for setting the maximum resale price at which gas can be sold by a landlord to a tenant — down from 67 pence to 39.8 pence per therm.
—questioning the British Gas policy which made the customer liable to repay the company for money stolen from a prepayment meter by a third party and contending that if the customer had already paid for the gas and had taken all reasonable precautions to secure the premises, he could not be held liable for the loss.
—intervening on behalf of people who wanted a gas supply but refused the British Gas estimate.

I believe that these proposals, taken together, will help us to achieve one of the objectives set out in the MMC report, namely, to ensure fairness among all gas users. It is for British Gas to respond to the aspirations of its customers and I hope that response will be positive.

The schedules must be as fair as possible since the full benefit from gas-to-gas competition will not be obtained before 1991 or 1992.

Competition assured

I regret the need for any form of regulation in the industrial gas market and in a competitive world regulation would be unnecessary. There is a temporary need for the artificial aids of price schedules and the 90/10 rule and so an element of regulation is necessary if competition is to thrive.

British Gas has long enjoyed a *de jure* and *de facto* monopoly in this country. The industry was not, however, at first centralised. A number of local monopolies of various sorts existed until full nationalisation in 1948. In 1964 as LNG imports were developed, and then under the 1972 Gas Act, the industry became increasingly centralised.

The Gas Act 1986 established OFGAS as the watchdog for the gas industry and part of its role was defined thus:

1) to enforce the Gas Act 1986 and British Gas' Authorisation; and
2) enable competition to develop in the gas market.

The Authorisation is largely concerned with the tariff market which includes domestic customers. The basis of that regulation is to control prices and to ensure that the obligations and responsibilities undertaken by British Gas are observed.

In the contract market the approach was that inter-fuel competition existed and that direct gas-to-gas competition would develop out of the regulations but it has been necessary to supplement the original concept. Competition in gas supply will begin and British Gas has welcomed the challenge. This is encouraging. Companies which hope for and achieve international success normally do so on the basis of success in a truly competitive home market. We will watch developments with interest and will take such initiatives as are required for the emergence of such a market in British Gas' home territory. □

The Institute of Energy

BENEFITS OF MEMBERSHIP

Various benefits of membership were advertised in the **February 1989** issue of *Energy World*. One such benefit referred to discounts available to members on car hire from Hertz. The Institute has now received a supply of Hertz Business Partners Club cards and any member wishing to obtain a card should write to: The Membership Office (Ref MB), The Institute of Energy, 18 Devonshire Street, London W1N 2AU (Tel: 01-580 0077).

Contract Gas after the MMC Report

*by Ivan Whitting**

At the beginning of May this year British Gas implemented a number of changes to its policy and practices in relation to its supply of gas to the industrial and commercial markets, following recommendations made in the October 1988 MMC Report on Contract Gas Pricing. In the following article, Ivan Whitting of British Gas reviews the background to the MMC Report, describes the new system of contract supplies and assesses the effects on consumers.

FOLLOWING the discovery of natural gas in the 1960s, British Gas rapidly built up sales of gas from small beginnings, to reach leading positions in both the industrial and commercial markets. Contract sales were largely built up by offering highly competitive prices in relation to other fuels.

Gas contracts were individually negotiated with customers, in the same way that other energy suppliers conducted their business. Essentially British Gas developed two types of contract market, or three if we include feedstocks where there were very large sales to a small number of chemical plants.

One market, expanded from the traditional uses of gas and taking advantage of its premium qualities, was supplied on a firm contract basis with prices mainly related to gas oil, the main competitor.

However, it takes time to increase gas sales significantly in these specialist markets for the customers often need to invest in new equipment. So, the British Gas industry created volume sales in the non-premium market to large industrial boiler plants, mainly in competition with heavy fuel oil. These sales were made on an interruptible contract basis thereby avoiding investment in a corresponding amount of gas storage capacity.

In 1986, the Government privatised British Gas as an integrated industry. A regulator, the Director General of Gas Supplies, was appointed to oversee the tariff market for sales up to 25,000 therms, with prices controlled by a tariff formula. But for the contract market it was felt that competition from other fuels, and other potential suppliers of gas, together with general competition law would provide a competitive market. The British Gas pricing policy of relating prices to those of the competing fuels in individually negotiated contracts had been endorsed by successive Governments over the previous 20 years.

It so happened that privatisation took place at a time of rapidly falling oil prices. As gas prices had been constrained well below competing oil prices in the early 1980s, when oil prices fell in 1986, there was not a corresponding sharp fall in gas prices. Some did move, however, and as a result at that stage there was quite a wide spread of gas prices across the 20,000 contract customers.

Most of the contract customers of British Gas remained constant with their gas prices as these were steady or falling but a few complained strongly. Some of these complaints were taken up and in November 1987 the Director General of Fair Trading referred aspects of contract pricing to the MMC.

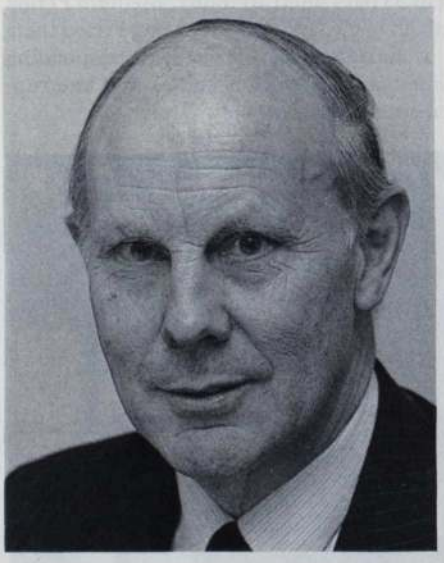
The MMC Report

British Gas co-operated with the Commission during its inquiry and put forward its case that there were many good features underlying its practices which had seen the successful development of the contract market. Nevertheless, the MMC decided it was important to open up competition in the supply of gas to contract customers and to facilitate this by introducing transparency of pricing and terms of supply. To achieve these objectives their main recommendations were that British Gas should be required to:

- Publish a schedule of prices at which it is prepared to supply firm and interruptible gas to contract customers and not to discriminate in prices or supply.
- Not refuse to supply interruptible gas to any user on the basis of the use made of the gas or the alternative fuel available.
- Publish further information on common carriage terms in sufficient detail to put a potential customer in a position to make a reasonable estimate of the charges that would be sought by British Gas.
- Contract initially for no more than 90 per cent of any new gas field.

**HQ Director of Corporate Affairs, British Gas plc*

The author



Ivan Whitting has been installed in the newly-created post of Director of Corporate Affairs at British Gas headquarters since 1 May this year. His directorate incorporates the public relations department and covers business strategy and public affairs.

Mr Whitting was educated at Torquay Grammar School and, after graduating in mathematics from Cambridge University, he went on to do postgraduate work in statistics at Manchester University. He worked in the planning department of the Central Electricity Generating Board for seven years, going on to join the Ministry of Power where he developed new methods for evaluating energy policy.

In 1970 he joined the Gas Council as head of the operational research department and in 1976 became planning manager at British Gas headquarters, responsible for development of the industry's annual corporate plan and for matching gas supply and demand in the medium and longer term. In 1985 he became controller of efficiency studies at British Gas headquarters.

In 1986 he was seconded to work on privatisation and during this period he was particularly concerned with relations with brokers, financial institutions and the investment community generally.

From 1987 until his latest appointment Mr Whitting was head of investor relations.

Table 1: Firm gas supply scheduled reference price (pence/therm)

Volume Band		1	2	3	4	5	6	7	8	9	10	11
Nominated consumption therms/annum		25,001 to 50,000	50,001 to 100,000	100,001 to 150,000	150,001 to 250,000	250,001 to 500,000	500,001 to 1,000,000	1,000,001 to 2,000,000	2,000,001 to 5,000,000	5,000,001 to 10,000,000	10,000,001 to 25,000,000	Greater than 25 mill +
Number of Premises (see note 2)	1	34.0	33.5	33.0	32.0	31.0	30.0	29.0	27.5	26.0	24.5	—
	2	—	33.8	33.4	32.5	31.5	30.5	29.5	28.0	26.5	25.0	23.0
	3	—	33.9	33.6	33.0	32.0	31.0	30.0	28.5	27.0	25.5	23.5
	4-5	—	—	33.7	33.3	32.5	31.5	30.5	29.0	27.5	26.0	24.0
	6-10	—	—	—	33.5	32.9	32.0	31.0	29.5	28.0	26.5	24.5
	11-20	—	—	—	—	33.2	32.5	31.5	30.0	28.5	27.0	25.0
	21-50	—	—	—	—	—	32.8	32.0	30.5	29.0	27.5	25.5
	51-100	—	—	—	—	—	—	32.4	31.0	29.5	28.0	26.0
	101-400	—	—	—	—	—	—	—	31.5	30.0	28.5	26.5

The MMC acknowledged that its recommendations would mean that the profitability of British Gas "is likely to suffer in the short term." They also recognised that among British Gas' customers "some will lose and some will gain."

The MMC report was published in October 1988. There followed a period of detailed discussions with the Director General of Gas Supply on the implementation of the recommendations. Then, after a period of public consultation, it was announced on 16 March that the necessary changes to the British Gas Authorisation under the 1986 Gas Act had been agreed.

New contracts system

British Gas schedule prices — the corporation published its first schedules of contract prices on 20 March 1989 to come into effect from 1 May. One covers the supply of firm gas, the other the supply of interruptible gas.

In designing the new schedules and terms of supply British Gas attempted to provide a wide range of options for customers in both the firm and interruptible markets covering one and two year contracts, and fixed price, index-linked or contract prices moving in line with the published schedules.

Additionally, firm contract customers can aggregate some or all of their premises into one contract to obtain better terms, and in the interruptible market three different choices of short, medium and longer period interruptions are offered. In all cases prices are linked to the volume of gas consumed.

Table 1 sets out the prices for firm gas supplies on standard terms as they appeared in the initial schedule.

The contract terms are described in the schedules. As noted above, there are also options — for extending the contract to two years, for taking a fixed price contract for one year or two years or for indexing the contract for one year or two years with 50% PPI and 50% Gas Oil.

There is a corresponding schedule of prices for interruptible gas supplies with initial prices ranging from 29.5p/therm for customers taking above 250,000 therms to 16.0p/therm for customers taking more than 10m therms at individual premises. Contracts with different periods of maximum interruption may be selected by the customer — Short Period with up to 35 days interruptibility, Medium Period with up to 63 days, while for Long Period there is a maximum of 90 days; corresponding minimum periods of 3, 7 and 21 days interruption are applicable.

Typical of the contract gas supply customers of British Gas is the metal plate manufacturing company, Spartan Redheugh of Gateshead. The company have won one of this year's Gas Energy Management (GEM) Awards and have achieved energy savings of 43 per cent with the help of the company's new lift-off furnace, the first of its kind in the world. Heated by gas-fired recuperative burners, the furnace can be used for reheating ingots, slabs and part-rolled plates.

Effect on gas customers — the effect of the initial price schedules from 1 May 1989 on the contract customers of British Gas is that about 12,000 out of the 20,000 received a decrease in price. For a further 4,000 customers the price rise will be below the rate of inflation, while about 4,000 other customers will face increases above that level.

The increases in charges arise because prices in the schedule are now volume related and are not matched against alternative types of fuel to meet each customer's situation; and, by reason of the MMC recommendations and the amended Authorisation, individual terms cannot be negotiated to reflect special circumstances.

Although the MMC anticipated that some customers would lose, they expected the majority of these customers would have alternative fuel supplies and could exercise their options to change fuels.

In order to ease the transfer to the new arrangements, British Gas proposed to the Director General, who agreed, that there should be special transitional arrangements. These help customers facing increases by providing options to spread the increase over a period or to freeze their current price until their contract expires. Customers receiving reductions could benefit straight away.

British Gas customers now have a wide range of options from which to choose and while the representatives of British Gas are happy to explain the options, the final choice and responsibility lie with the customers. By the terms of the amended Authorisation British Gas can no longer negotiate individual arrangements.

While customers are seeing themselves affected by the price schedules in various ways, there is a cost to British Gas related to the new schedules. British Gas has estimated that the combined effect of various factors may reduce pre-tax profits by about £75m in 1989/90 with a possible full year effect up to a third higher.

Revised purchasing arrangements — on 27 April the Corporate Affairs Minister announced that the MMC's "90%" recommendation would be implemented in a modified way. The Government has set as a target that 10 per cent of the gas coming forward from new gas fields should be supplied to market by suppliers other than British Gas. This is an overall target, including imports, and is not set on a field by field basis. The Government has also indicated that for the first two years from 31 May 1989 the position

would be monitored, particularly as to the level of sales contracted into the general industrial and commercial markets.

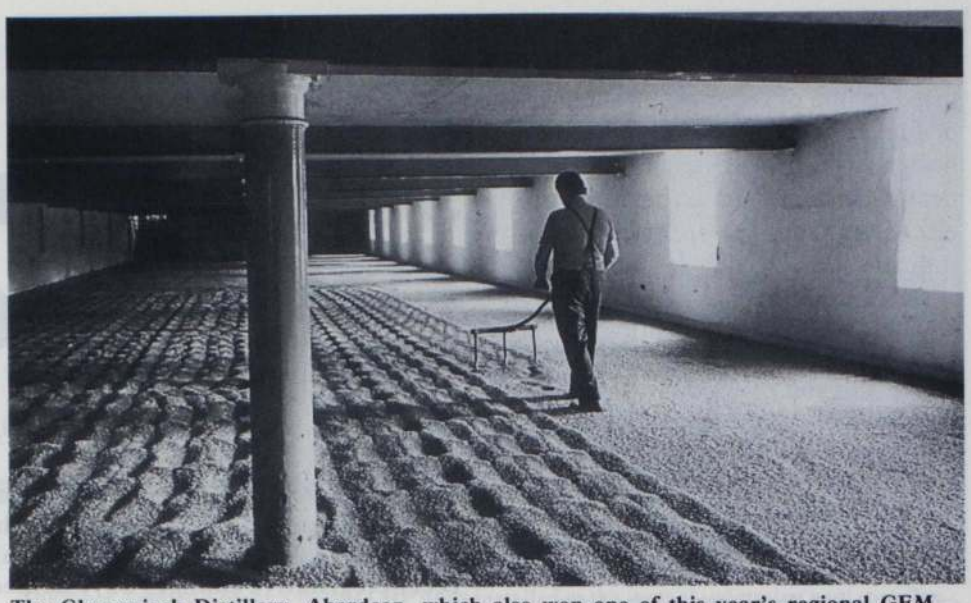
Clearly the Government is expecting gas producers to achieve an early build up of contracted sales into the industrial and commercial markets.

Stemming from the 90/10 recommendations, British Gas has been asked for an undertaking actively to facilitate the efforts of gas producers towards achievement of the 10 per cent target.

Common Carriage — the other major thrust towards implementation of the MMC's recommendations is on conveyance of gas for others, better known as Common Carriage. British Gas was required by the modified Authorisation to publish further details of its Common Carriage charges. This was done on 15 June.

British Gas has now also established a separate Gas Transportation Services Department in keeping with the "Chinese Wall" requirement of the modified Authorisation. This new department is responsible for negotiating and administering commercial agreements for conveying gas on behalf of suppliers and gas purchasers who wish to do business directly with each other.

By their nature, transportation agreements are complex and there is not space to summarise meaningfully the terms offered in the statement. Nevertheless, it may be noted that the published typical charges allow for distance from receiving terminals, load factor and the parts of the transmission and distribution used in supplying premises of varying sizes.



The Glengarioch Distillery, Aberdeen, which also won one of this year's regional GEM Awards for its energy saving measures. These measures involved installing regenerative burners on one of its direct-fired stills and modifying the refractory setting to give longer dwell time for the products. The new system is saving over 200,000 therms a year.

Looking ahead

Following the MMC recommendations, the new British Gas stalls are set up for business. As regards competition the next steps are now largely up to competing suppliers.

The first British Gas contract price schedules came into effect from 1 May 1989. British Gas may alter its published prices at intervals of no less than 28 days to take account of market conditions. Many contract customers have already objected to their loss of negotiating freedom with British Gas, especially as the schedules now reveal their gas prices to the oil companies. However, the MMC saw this arrangement as a means towards building up gas-to-gas competition.

Before the publication by British Gas of the new statement on transportation charges, one new competitor, Agas had entered the Common Carriage market by means of a determination made by Ofgas. The Gas Transportation Services Department set up by British Gas has already received a number of enquiries from gas suppliers and buyers. Assessment of the build up of common carriage sales will therefore be clearer within the next few months.

Whatever complications the operation of the 90/10 rule place on the development of new gas fields, the new arrangements, too, are planned to give a stimulus to the sale of gas by producers to final users and/or the direct purchase of gas by industrial or commercial customers.

The contract gas market in Britain had evolved in a pattern over a period of 20 years. That pattern is now changing with an outcome that cannot really be predicted at this stage.

The scene is therefore set, but whatever the future holds, British Gas will go ahead in the spirit of the statement by Robert Evans, the new Chairman of British Gas, in his foreword to a brochure* on *Contract Gas after the Monopolies and Mergers Commission*: "We shall discharge our responsibilities as a leader in our chosen trading areas by continuing to provide to all our customers the highest standards of service — an approach we believe is fundamental to our success." □

* *Available on request from Corporate Affairs Directorate, British Gas plc, Rivermill House, London, or from Regional Public Relations Departments.*

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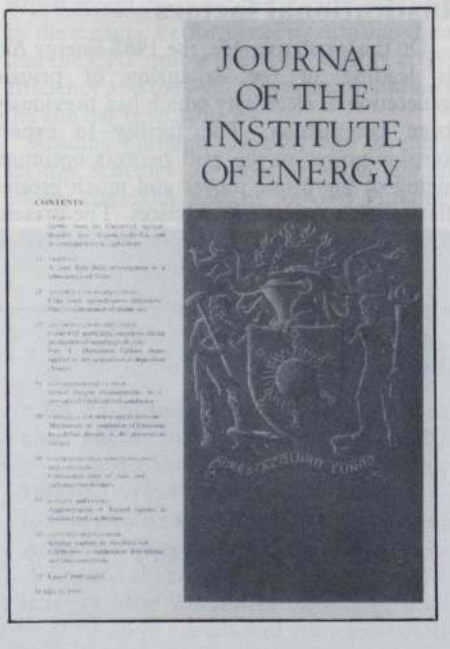


The *Journal of the Institute of Energy* is the technical journal of record for the Institute. Published quarterly, it carries refereed technical papers on a wide range of subjects and it is available to members of the Institute who register their wish to receive it. To put yourself on the mailing list,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

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

Examples of papers recently published include: *A comparison of the combustibility of chars in fixed-bed and fluidised-bed reactors* (M Rashid Khan and YY Lee); *Laminar flame propagation in mixtures of fuel droplets, fuel vapour and air* (JED Gouthier and MF Bardon); *Steady-state heat transfers from vertical fins protruding upwards from horizontal bases* (CW Leung and SD Probert); and *A comparative study of engine-driven heat pumps* (YSH Najjar and MN Nahas).

Gas as a fuel source in CHP systems

*by Peter Chester, CEng, BSc (Tech), MInstE, MIGasE**

The use of natural gas in combined heat and power (CHP) systems has been increasing steadily in many industrialised countries in the past few years, and recent legislative changes have helped to create a growing UK market for this fuel in CHP applications. In the following article, Peter Chester describes the factors that have assisted this trend and he reviews a number of installations which are perhaps typical of the technology requirements for a range of heat and power outputs.

THE COMBINED generation of heat and power (CHP) has long been recognised as one of the most efficient uses of fuel, providing a ready alternative both to the use of boilers and other heating systems and to the purchase of electricity from the electricity supply industry.

In the right circumstances and using natural gas as the fuel, significant savings can be made on total energy bills, not only on the unit cost of electricity, but also by reduction of maximum demand on the incoming electrical supply and by the sale of electricity back to the grid. As a consequence, there are already numerous natural gas fired installations in both industry and commerce, with new applications being developed all the time.

In recent years, substantial reductions in the heat-to-power ratios required by industry, legislative initiatives and on-going technical developments have notably improved the viability of gas-fuelled CHP systems in particular, offering major market opportunities for the gas supply industry.

The environment

Environmental matters are now attracting an ever increasing amount of interest both in the UK and in Europe. Natural gas produces neither sulphur nor particulates in its products of combustion, and in all types of plant has long been justifiably regarded as an environmentally friendly fuel.

In addition, because the carbon content of natural gas is little more than half that of coal, from which most electricity is produced in the UK, gas fired power generation is intrinsically a highly effective route towards reducing the emissions of carbon dioxide which, among the 'greenhouse gases' is much the largest contributor to global warming. The potentially very high efficiencies of CHP systems also contribute significantly in this respect. Thus where the power generation is accompanied by the production of heat in a CHP system, and especially where electric or solid fuel heating has been used previously, even greater reductions in carbon dioxide emissions will occur.

For both engines and turbines the cleanliness of natural gas gives considerable advantages over alternatives such as heavy fuel oil and diesel. Not only are delivery and storage problems eliminated, but maintenance is significantly reduced, leading to longer life and more efficient and reliable operation of plant.

Institutional factors

On the legislative side, the 1983 Energy Act is leading to the expansion of private generation of electricity which had previously been languishing. The facility to export surplus power to the grid permits optimum sizing of the prime mover and much greater flexibility in operating practices. The present high level of interest and activity for CHP in the UK would not have been possible in the absence of this legislation. Similarly, while there are still many uncertainties regarding the forthcoming privatisation of the electricity supply industry, one apparent effect should be further encouragement for the independent generation of electricity.

Technical developments

Improvements in gas turbines have increased shaft efficiency remarkably in recent years for mid-range units (3.6 MWe), partly due to advances in aeroturbine technology. Power generation efficiencies are now around 28 to 30%, with potential for 35% shaft efficiency in the near future. With appropriate heat recovery, overall plant efficiency of a thermally integrated turbine system can be of the order of 90%.

The use of gas turbines in combined cycle systems with steam turbines markedly raises the efficiency of producing electricity to around 45%, a major advance on conventional generating equipment. This alone indicates a cost reduction of about 20%, but there are other benefits such as reduced capital and maintenance costs and improved environmental conditions.

For small scale CHP applications British Gas has been active in marketing the small spark ignition gas engines. Modern engine control techniques with improved heat recovery have raised system efficiencies to over 80%.

In the longer term, fuel cells offer increased potential for high efficiency generation and both Japan and the USA have considerable research and development programmes.

The author

Peter Chester is currently industrial and commercial contracts manager at British Gas headquarters. A graduate in fuel technology and chemical engineering at the University of Sheffield, Mr Chester is a Member of the Institute of Energy and of the Institution of Gas Engineers.

He has spent some 30 years in the gas industry, the early years in research. During several years in the East Midlands he carried out industrial development work and was concerned with the conversion of industry from town to natural gas. He then became involved in industrial contract sales; the industrial CHP scheme at John Player's at Nottingham being one project undertaken at that time.

During 1975 and 1976 Mr Chester took part in the market exploitation of the gas-fired recuperative burner, which has made a significant contribution to energy efficiency with several thousand now installed.

Since then he has held a number of posts in British Gas concerned with the marketing of gas to industry and commerce. He has a keen interest in CHP and he represents British Gas on various committees of the CHP Association.

**Industrial and Commercial Contracts Manager, British Gas plc*

Small scale gas engine CHP

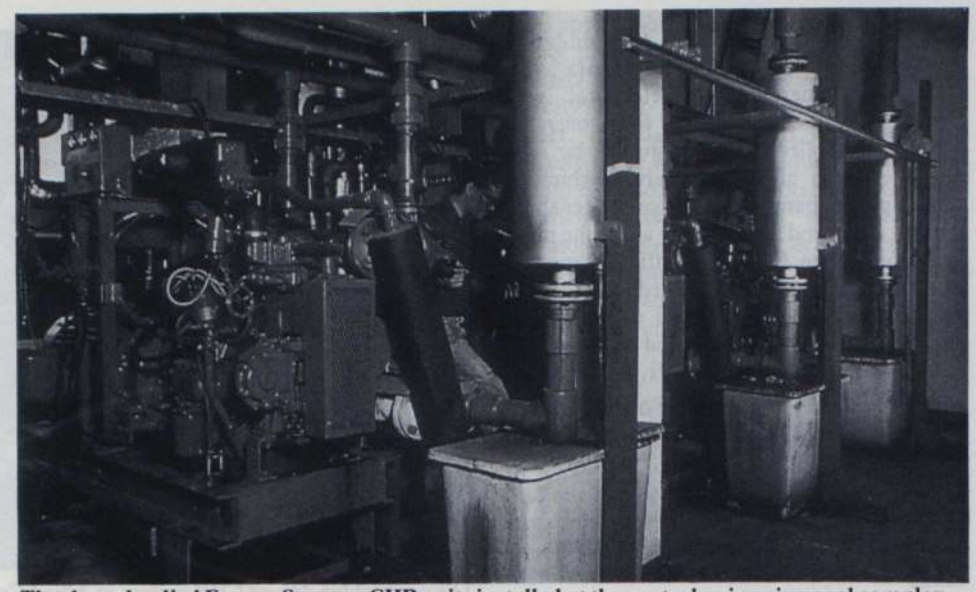
For CHP applications with electrical outputs from about 20 kW to 1 MW, reciprocating engines are commonly chosen. Spark ignition, automotive engines are used for small scale applications while heavy duty industrial gas and dual fuel engines are employed for larger power outputs.

Small scale CHP, typically having electrical outputs from about 20 kW up to 200 kW from a single packaged unit, is widely accepted as a cost-effective means of reducing site energy usage and costs. Over 300 units have been installed up to the present time. They have a typical heat-to-power output ratio of 2:1, heat being recovered from both the gas engine cooling jacket and the exhaust system as hot water, at a temperature of 80°C and suitable for use in a normal heating installation. The overall efficiency of such units is typically around 85%.

A large number of these small scale CHP units have now been installed in commercial premises. The majority are designed to provide base load rather than peak load running, the topping up of heat and electrical power being provided from boilers and the grid electricity supply. Recovered heat can alternatively be used in an absorption chiller to produce chilled water. This opens up the potential for CHP as a source of air conditioning for offices, retail stores and computer suites. Currently, small scale CHP has been used with great success in sheltered housing, swimming pools and leisure centres, hotels and hospitals.

Small scale CHP — examples

In an application having great potential, the London Borough of Waltham Forest installed a small gas fired CHP group heating scheme to provide electricity, heating and hot water to 52 houses, predominantly occupied by the elderly at the Bakers Almshouses, Leyton. The services from two boiler houses are connected by an underground main so that the heat produced in either can be used anywhere on site. At the same time one of the boilers was removed and replaced with a CHP unit.



The three Applied Energy Systems CHP units installed at the central swimming pool complex run by Reading District Council are typical of small scale CHP applications. They are helping to reduce energy use by 34 per cent and sales of electricity have helped towards annual cash savings of £29,000.

Manufactured by Applied Energy Systems Ltd, the unit produces 26 kW of electricity and 54 kW of hot water. Base load electrical demand is met by the CHP system, with additional demand topped up from the public supply. The engine runs 17 hours a day and the heat recovered from the engine cooling systems is used to heat the Almshouses. The CHP unit therefore acts as the 'lead heat generator', and a central control unit cuts in the three existing boilers as needed, to meet additional demand.

The Council assumed responsibility for the electricity supply to the Almshouses and recharges the tenants.

The original consumer electricity meters have been replaced by Council supplied meters which accept magnetic credit cards purchased by the tenants. Performance monitoring shows that the CHP unit is operating reliably at 85% efficiency and the total energy consumption of the site has been reduced.

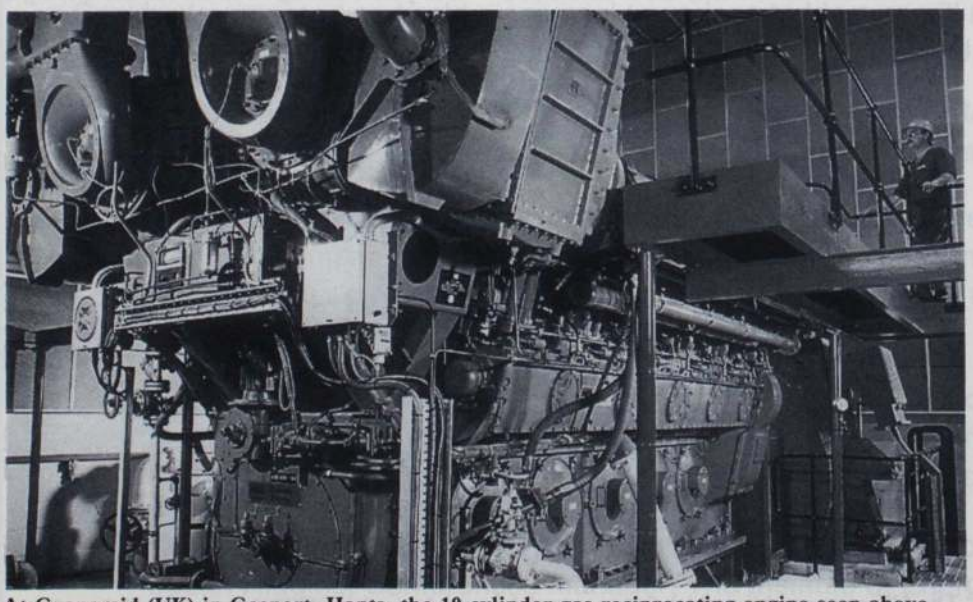
Reading Borough Council, with its energy savings schemes for existing buildings and energy conscious designs for new buildings, has demonstrated the important cost saving advantages of CHP. Working closely with British Gas engineers, the borough council have completely refurbished their central swimming pool complex. The heart of the new facility is a CHP installation comprising three Applied Energy Systems units, each rated at 40 kWe. These units reduce the cost of electrical energy used in the building and provide supplementary heat to the pool water, space heating and domestic hot water. The CHP units, which take priority in operation, work in conjunction with new modular boilers.

The new CHP based heating system, improvements in the air handling unit and the use of run-around-coils have reduced energy consumption by 34%.

The success of CHP at the central swimming pool pointed the way forward for the borough council and at Caversham, four CHP units are now providing power in the largest leisure pool in the south of England. In addition to the electrical energy, this new installation by Applied Energy Systems provides the heat source for the space heating, hot water services and pool heating, offering very considerable savings in energy costs.

Large hotels have substantial electricity and hot water demands throughout the year and can be prime sites for CHP. This was clearly demonstrated by a Trusthouse Forte survey which showed that substantial savings would result from the installation of a gas fired CHP system. It was, therefore, decided to install a unit manufactured by Combined Power Systems Ltd (CPS) under the Energy Efficiency Demonstration Scheme sponsored by the Department of Energy.

The installation at the 200 bedroom Post House Hotel, Manchester, has a gas engine driving a synchronous generator which provides 36 kW of base load electricity at 415 V. The engine also produces 70 kW of hot water at 80°C which is fed into the hotel heating system. The electrical grid supply and existing boiler plant provide additional power and heat as required.



At Cyanamid (UK) in Gosport, Hants, the 10-cylinder gas reciprocating engine seen above generates 3.5MWe and heat is recovered from the exhaust gases by a waste heat boiler. Gas after-burners supplement steam generation when necessary.

A novel feature of the unit is an on-board mini computer which monitors the mechanical, thermal and electrical performance of the unit. Data from over 30 sensors is collected and stored by the computer. If a signal is received which is outside pre-set parameters, the computer shuts the unit down and immediately alerts the main computer at the CPS head office. Action is then taken to identify and remedy the fault so that the unit can be restarted as quickly as possible. Each day the collected data is transmitted to the central computer, which scans the information to pick up any gradual deterioration in performance which may need attention. The unit operates 17 hours a day at around 80% efficiency.

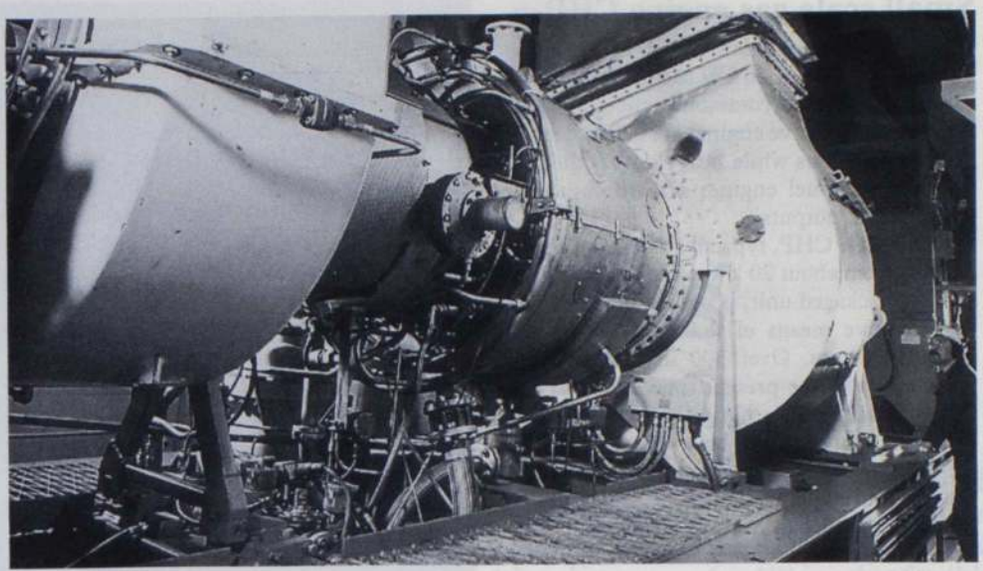
Larger reciprocating engine CHP

For higher power ratings from around 200 kWe upwards, heavy duty spark ignition gas engines may be selected. Their heat-to-power ratio is around 1.3:1 and, as with the smaller automotive engines, heat is recovered as hot water at 80°C. Dual fuel engines, where the gas supply is supplemented by approximately 7% pilot oil to allow compressioin ignition, are often used for outputs of around 500 kWe to 1 MWe. They offer a higher shaft efficiency than spark ignition engines and are used up to the point where gas turbines begin to be competitive. Some of these engines have sufficient oxygen in the exhaust gases to allow auxiliary fuel firing, if required, to supplement the heat production.

A recent example employing this principle is the 3.5 MWe Crossley Pielstick engine at Cyanamid of Great Britain Ltd. At the company's factory in Gosport, the 10 cylinder dual fuel engine is driving a Brush 3.5 MW alternator. Heat is recovered from the engine cooling system and transferred to the boiler feed water. The exhaust gases are ducted to an NEI-Cochran waste heat boiler where they are used with a supplementary John Zink boost burner. This project is the first application in the UK that uses a boost burner firing natural gas, utilising the free oxygen in the exhaust gases of a dual fuel engine. Because of this, the installation qualified for a grant under the Energy Efficiency Demonstration Scheme operated by the Department of Energy.

Large reciprocating engines can also play their part in the commercial sector. At British Gas North Western Region headquarters, Altrincham, there was a simultaneous need for electricity, space heating for the offices and cooling for the computer suite. A wide range of options was considered and the proposal to install a CHP system emerged as the clear winner on economic and energy efficiency grounds.

The new CHP scheme is based on a 1,000 hp Brons MAN reciprocating engine which has a well proven reliability record. The engine drives an alternator producing 750 kW at 415 V, which is stepped up to 11 kV to interface with the grid supply. Most of the power produced goes to the computer which requires 500 kWe day and night for most of the year. The computer suite also needed cooling and this is provided by a combination of electric and absorption chiller units.



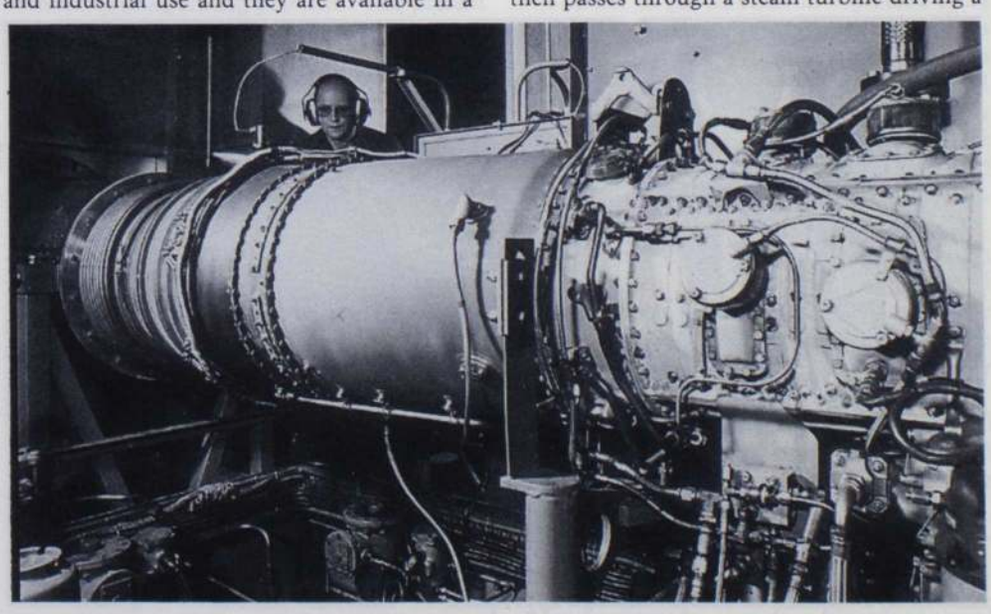
The gas turbine driven CHP system at Allied Colloids, Bradford, is a good example of a large scale industrial process application of CHP. The 5.8MWe Ruston gas turbine set covers the site base electrical load, can export 0.5MWe to the local grid, provides steam at 250psi to power a 1MWe steam turbine alternator and a steam supply at 60psi to cover most of the process plant requirements.

First call on the heat recovered from the engine is for space heating and any surplus heat is used by the absorption chiller to remove heat from the computer suite. During periods of high space heating demand, in the offices, cooling in the computer suite is provided by the electric chillers. As heating demand falls, the absorption chiller is brought on line. Maintenance of the heat-to-power balance is achieved by varying the number and type of chillers in use at any time. A computer controller ensures optimum performance of the system. Designed to give the highest performance at the lowest operating cost, the CHP unit has an overall efficiency of 90%.

Gas turbine CHP

Gas turbines are cost effective and flexible prime movers for larger scale CHP systems. They have proven reliability in both aircraft and industrial use and they are available in a wide range of sizes. As already mentioned, developments in turbine systems can be expected to raise shaft efficiencies which, with recuperation, could reach 35%. With several manufacturers also developing smaller turbines with improved efficiencies, the use of turbines as CHP prime movers will undoubtedly increase.

The wide use of steam for process heating applications has led to the turbine exhaust gases in most applications being used to fire waste heat boilers. A recent example incorporating steam generation is the installation at Allied Colloids in Bradford. This firm produces speciality chemicals and has a high demand for both electricity and steam. In 1987 a Ruston Tornado 5.9 MWe gas turbine was installed together with a Senior Green waste heat boiler rated at 35,000 kg/h. Heat from the turbine is used to produce the base steam load which can be boosted to 70,000 lb/h using an after burner with a 40:1 turn-down. The heat recovery unit produces steam at 250 psi which then passes through a steam turbine driving a



The Allison gas turbine which forms part of the award-winning CHP scheme at the University of Liverpool. The scheme is providing heat and power for the whole of the 82 acre university campus, plus heat to some neighbouring sites and electricity exports to the local grid.

1 MWe alternator. This reduces the pressure to 60 psi, sufficient for much of the process plant requirements.

British Gas was asked to provide a specification for the complete gas installation at Allied Colloids. This included the high pressure internal pipework, fuel gas compression and the safety systems on the turbine and the heat recovery unit. British Gas were also involved in the hazard assessment required by the Health and Safety Executive to conform with Control of Industrial Major Accidents and Hazards site regulations.

The virtual absence of sulphur in natural gas means that it is possible to utilise exhaust waste heat directly as well as for generating steam. The cogeneration plant at Scottish Grain Distillers Limited, Glasgow, illustrates this variation, where the waste heat from a 5.9 MWe Ruston Tornado turbine is used for both steam raising and drying. The animal feed drying circuit at the distillery makes an important contribution to the economic operation of the site and matching of the turbine exhaust heat with the drier demand is an essential feature of the CHP application. (Details of the installation are shown in the EEO Project Profile Sheet 208).

Although gas turbines are particularly suited for industrial process applications, they are now beginning to be accepted for large commercial premises. The University of Liverpool is successfully operating the UK's first gas turbine CHP district heating scheme in an educational establishment. This is providing the entire power and heating requirements for the 9,000 students and staff throughout the 87 acre campus.

The Centrax gas turbine and alternator set can provide 3.65 MWe to meet peak periods of electrical demand. Waste heat from the exhaust generates 8.2 MW of high temperature hot water which can be increased by a supplementary gas burner to 15 MW. Overall efficiency is more than 80% and even when electrical output is turned down to 2 MW for the night time load, very little efficiency is lost.

Since September 1987, turbine availability has exceeded expectations with the system operating for almost 98% of the time available. The down-time has been primarily for routine washing of the turbine blades. This pioneering installation won the national British Gas GEM Award in the New Technology category earlier this year.

Although not yet seen in Britain, gas turbines are in use in the USA in conjunction with steam-fired absorption chillers. An attractive feature of absorption systems is that, unlike compression systems, they do not rely on chlorofluorocarbons, now recognised as heavily implicated in the erosion of the ozone layer and the atmospheric greenhouse effect. The lighting and small power electricity to cooling load ratio in offices is such that a lower cost single-effect absorption chiller is capable of delivering more than sufficient chilled water from the steam available from the waste heat. Using a single-effect chiller also permits a combined cycle gas turbine-steam turbine configuration to be used, supplying back-pressure steam to the chiller.

In applications where the cooling load is a higher proportion, the steam turbine may be omitted and the high pressure steam fed directly to a high-efficiency double-effect chiller. Installations of this complexity are unlikely to be found in buildings of less than 50,000 m^3, and may incorporate conventional electrically-driven chillers to enable the operator to select the most economical plant operating regime. This would take account of hourly, daily and seasonal variations in loads, as well as fuel and electricity purchase and sell-back rates.

Conclusions

Combined heat and power is by no means a new concept, but there is growing evidence that due to a combination of factors including environmental pressures, efficient use of energy and institutional changes, it is increasingly capable of economic application in a great variety of applications.

The various case studies prove natural gas CHP to be a practical option, ranging from the provision of heat and power to individual hotels, leisure centres or blocks of flats, through industrial site CHP using larger reciprocating engines and gas turbines to combined cycle gas and steam turbine systems for power generation only in power station schemes. In all these markets British Gas has the wide ranging experience and technical expertise to assess the technical and economic feasibility of such schemes and to compete for and win a substantial share of a major new business opportunity. □

THE INSTITUTE OF ENERGY

a seminar

'BRITISH COAL PRIVATISATION — FISSION OR FUSION'

12 September 1989, The Conference Forum, Aldgate, London

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

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

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

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

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

Improving efficiency and plant performance

*by Richard Pugh BSc, MSc, PhD and Roger Webb BSc, CEng, MInstE, MIGasE**

The need of industry to constantly improve the energy efficiency of its plant and processes has been with us for at least two decades now as it has become widely recognised that this factor plays an important part in maintaining and improving the competitiveness of industrial companies. The following article reviews some of the technology that has resulted from the work of British Gas in the energy efficiency sector and considers its impact, especially in the industrial process market.

OVER the past two decades great emphasis has been placed on improving the energy efficiency of industrial processes and plant. This requirement initially stemmed from the rapid escalation of energy prices which occurred during the 1970s and more recently has been continued by an increasing awareness of the opportunities to reduce operational costs that can result from good energy management.

Technological advances, for example in materials and electronics, have also stimulated improvements in plant design and performance.

In addition there is a continuing background of competition between energy suppliers which also leads to better and more efficient equipment.

British Gas has become established as a world leader in the development of technology for the industrial and commercial markets, this work being undertaken primarily at its Midlands Research Station in Solihull. Its objective is to ensure that gas continues to be competitive in the market place.

Whilst energy efficiency continues to be a major feature of much of the new utilisation technology, it has become increasingly important to take account of other key considerations in helping customers to produce the right product with the right quality at the right price. Important factors include high plant productivity, high product quality and low reject rates. These objectives take their rightful place alongside energy efficiency in the British Gas R&D programme on industrial and commercial gas utilisation.

Suppliers of gas fired equipment for industry and commerce differ greatly in size, resources and company culture and whilst many are highly regarded specialists in particular areas, few have been able to undertake the extensive independent research and development (R&D) programmes required to produce significant advances in utilisation technology. Such programmes carry a degree of technical and commercial risk and there can be no doubt that the strong partnership created between British Gas and manufacturers is responsible for important advances which would not otherwise have occurred.

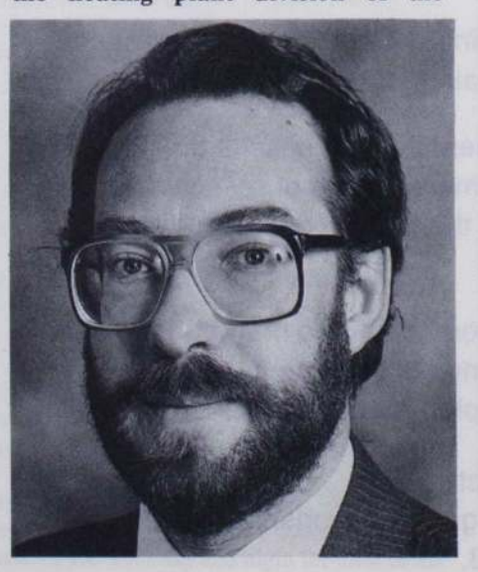
These advances benefit gas users, equipment manufacturers and British Gas. The ultimate user can produce more efficiently, while the manufacturer has a new product to sell since it is through licensed manufactures that BG developments are brought to the market.

Most industrial low temperature heating, involving processes such as liquid heating, drying and curing, has traditionally been based on centrally generated steam. This approach is indeed deserving of the term "traditional",

**Midlands Research Station, British Gas plc*

The authors

Richard Pugh is a senior scientist in the heating plant division of the British Gas Midlands Research Station.



A mechanical engineer with an MSc in thermodynamics and a PhD gained through a study of the flow properties of fluidised beds, he joined the staff of the research station in 1974 and worked for some years on low temperature process heating, in particular industrial liquid heating.

In his current position he is responsible for various aspects of the commercialisation of Midlands Research Station (MRS) developments.

Roger Webb joined the MRS in 1970 and is now assistant manager, heating plant division. He has a degree in chemical engineering and has worked on many aspects of high temperature heat recovery. In 1983 he was awarded, jointly with Jeff Masters of MRS, the Royal Society Esso Award for work on recuperative burners.

He is currently responsible for co-ordinating a wide ranging programme on low temperature process heating and building energy services.

being rooted in times when coal was the only widely available fuel and the most convenient way of using its energy was by distributing steam through an often lengthy and complex system of pipework.

Steam heating still has much to commend it, but it can yield low overall thermal efficiencies. British Gas studies, carried out some years ago, showed that a value of 50% was typical and this led to the recognition of an opportunity for improvement through replacing steam heating with dedicated gas fired plant located at the point of use.

A development programme on liquid heating was established which has changed user perception of their energy requirements. The first product of the programme was a high intensity immersion tube for heating industrial vats and tanks. This system, which has been available through licensees for some years, uses a purpose-designed burner and small bore tubular heat exchanger. It has an overall thermal efficiency of more than 80%, and its application has produced fuel cost savings of up to 50%.

A further development of this concept has led to the introduction of two multitubular heat exchangers, one of which is a particularly compact form which lends itself to packaging as a self-contained heater for industrial or commercial applications. These systems are available through British and US licensees.

To increase efficiency beyond 80-85% it is necessary to recover the latent heat stored in the water vapour produced by combustion. Further investigation by British Gas confirmed that the use of conventional heat exchangers at such low temperature differentials was precluded by their size and cost and that therefore the most convenient means of heat transfer was through direct contact between the combustion products and the liquid to be heated.

Existing direct contact heaters had efficiencies which declined significantly as water temperature increased and British Gas therefore began a development programme aimed at overcoming this limitation. The resulting heater combines a direct contact tower with an indirectly heated base section to produce gross efficiencies of around 90-95% at water temperatures exceeding 90°C. It requires a cold water feed for optimum performance and is therefore ideal for such industries as food, textiles and leather where large quantities of heated water are required for washing machinery or the product.

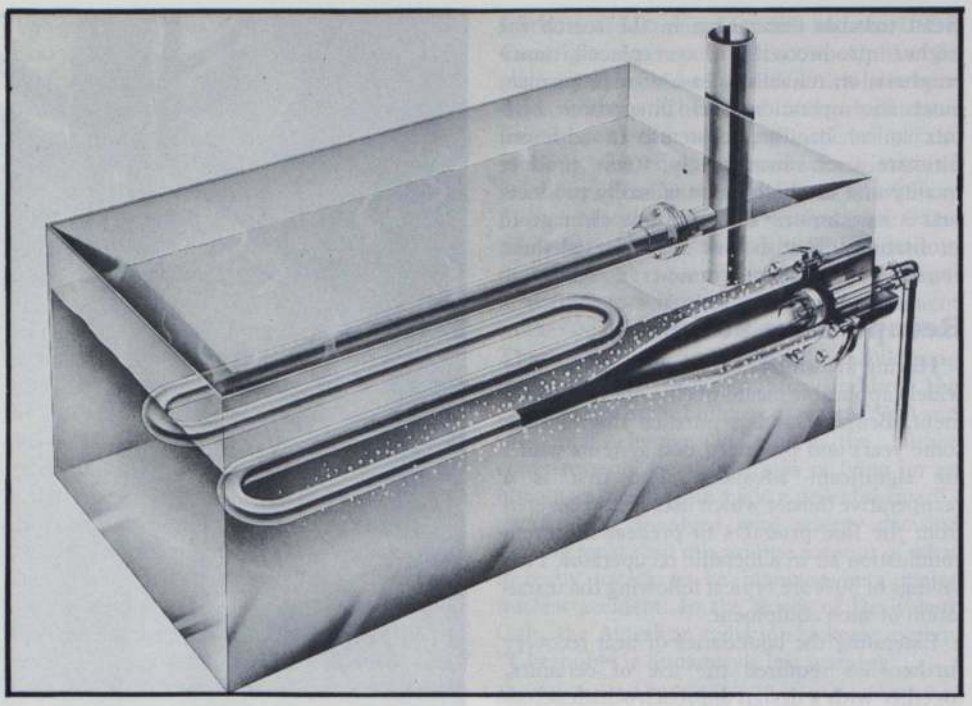


Fig. 1: high intensity immersion tube system for industrial liquid heating

British Gas has shown that, in the area of industrial liquid heating, the key to efficient operation is decentralisation. The equipment described has established a new standard for the process; when 80-95% efficiency is readily achievable, less than 50% can no longer be viewed as best practice.

High temperature process heating

From the technical viewpoint, the goal of the work on liquid heating was the simple one of improving efficiency. For British Gas programmes on high temperature process heating the goals are more complex.

Such processes normally operate at between 400 and 1300°C and in some cases temperatures exceed 1600°C. At exhaust gas temperatures of 1300°C, 70% of the heat input is lost through the flue. This will be increased even further by poor air/gas ratio control. Overall efficiencies of 10% or less have been observed on some operating furnaces. High temperature plant therefore presents a clear opportunity for development of energy saving measures and British Gas has responded to this need by producing a range of equipment which has set new standards of specific energy consumption.

Other factors have, however, also played a significant part in shaping this equipment. For example, reductions in the number of maintenance personnel, together with a general

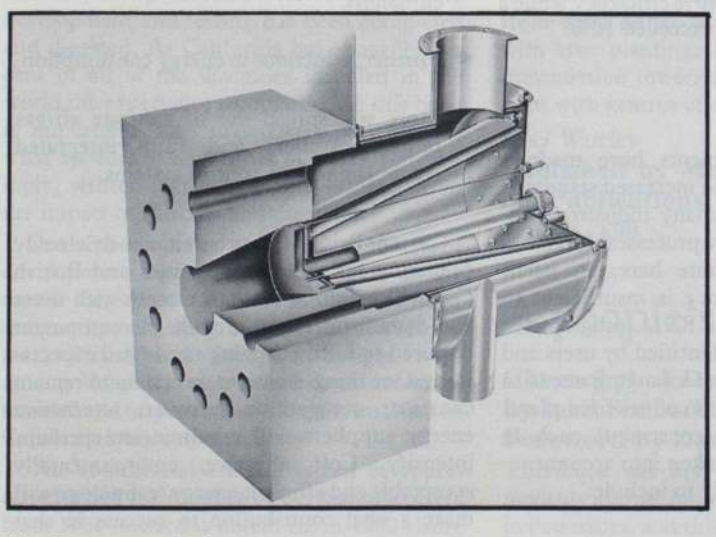


Fig. 2: recuperative burner

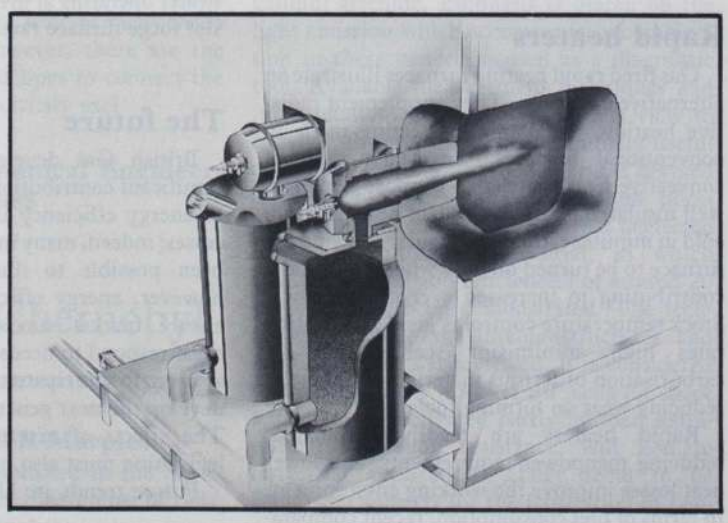


Fig. 3: regenerative burner system

trend towards demanning in the search for higher productivity, have placed more emphasis on reliability, ease of maintenance, automatic operation and integration with mechanical handling systems. In addition, ultimate users increasingly stress product quality and the high value of many products makes reject rates an important element in profitability. British Gas has reflected these requirements in its programmes.

Recuperative burners

Having identified heat recovery as the most widely applicable means of efficiency improvement, British Gas has pursued this line for some years and produced two systems which are significant advances. The first is a recuperative burner which uses heat recovered from the flue products to preheat incoming combustion air in a metallic recuperator. Fuel savings of 30% are typical following the installation of such equipment.

Extending the boundaries of heat recovery further has required the use of ceramics, together with a design approach which recognises the strengths and limitations of these materials. The British Gas regenerative burner system comprises two burners, each with an associated packed bed heat store of alumina balls which is alternately heated by flue products and cooled by incoming air as the burners fire in sequence. The system reduces fuel consumption by up to 60% and has the particular advantage that it can be applied to dirty processes such as aluminium melting where flue gas contamination would produce corrosion and blockage in metallic recuperators. A heat recovery effectiveness (ratio of heat recovered to maximum theoretically recoverable) of almost 90% is achieved by such systems.

Recuperative burners are now specified by many users and manufacturers as standard equipment on new and refurbished furnaces and the regenerative burner is rapidly approaching the same degree of market acceptance. This equipment has therefore established new efficiency baselines for many processes. The heat recovery techniques described above are also applicable to a wide range of existing plant and offer a retrofit approach to efficiency improvement.

Rapid heaters

Gas fired rapid heating furnaces illustrate an alternative approach. They supplement radiative heating, the dominant heating mode in conventional furnaces, with high rates of convective heat transfer in purpose-designed, well insulated plant. Such plant heats up from cold in minutes rather than hours, allowing the furnace to be turned on only when needed and contributing to increased average efficiency. Stock temperature control is good and heating rates high, minimising scaling and decarburisation of ferrous materials and thereby reducing wear on forming tools.

Rapid heaters are readily automated, reducing manpower requirements, and lower heat losses improve the working environment. In terms of fuel consumption, recent comparative measurements on two furnaces with the same duty on the same site showed a rapid heater operating at over 40% efficiency while a slot forge furnace rarely exceeded 10%.

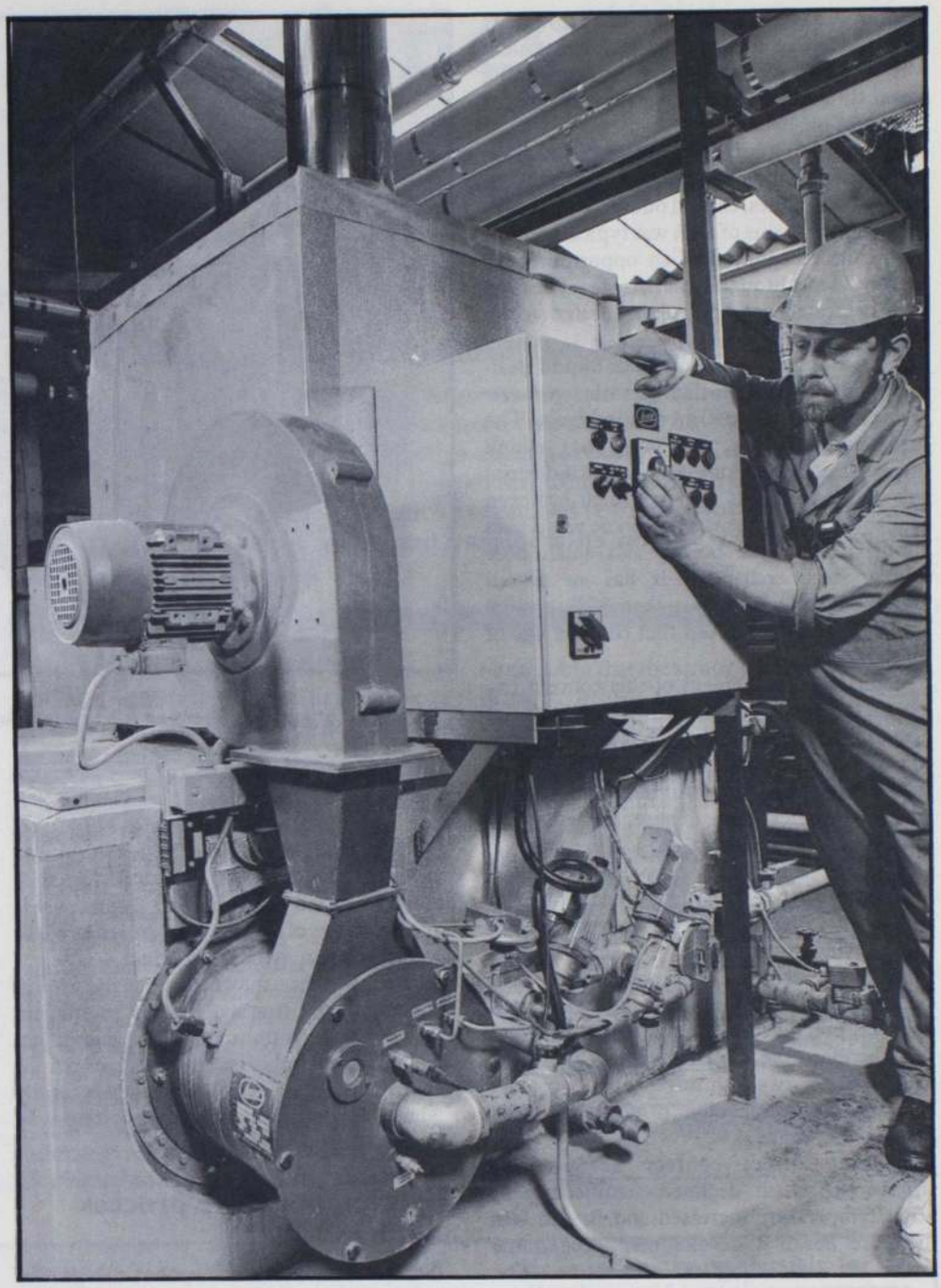


Fig. 4: direct contact water heater application for the food industry

The future

British Gas developments have made a significant contribution to increased standards of energy efficiency in many industrial processes; indeed, many more processes than it has been possible to illustrate here. In itself, however, energy efficiency is insufficient to ensure market success. R&D programmes must respond to needs identified by users and also try to anticipate these changing needs to develop the next generation of gas fired plant. The effects of external constraints such as legislation must also be taken into account.

Future trends are likely to include:

- Increased emphasis on environmental issues including noise and atmospheric emissions.
- Further reductions in energy consumption.
- More widespread use of accurate air/gas ratio controllers and fully integrated combustion/plant control systems.

Current British Gas programmes are already preparing for these eventualities and British Gas will continue to work closely with users and manufacturers to provide the equipment required to fulfil changing needs and expectations. One thing, however, is certain to remain constant; competition between alternative energy suppliers will continue and perhaps intensify. Cost effective, environmentally acceptable and efficient energy technology will make a vital contribution to success in that competition. □

Valuable work on wind generators

'Wind Energy Conversion' — proceedings of the 10th British Wind Energy Association Conference, March 1988

Apart from some hydropower in Scotland, and limited resources south of the border, wind is the only renewable energy source which is both technically and economically ready for exploitation for electricity generation in Britain. The proceedings of the British Wind Energy Association annual conference are therefore of considerable interest to members of The Institute of Energy as an up-to-date appraisal of the state of the art and the technical areas which are still the subject of research and development. The scale of the material covered by the 1988 conference is considerable — running to over 60 papers and nearly 500 A4 pages. Even so, the cover price of £90 is likely to deter many engineers and, indeed, libraries too!

To the non-specialist engineer the main interest will be in the papers covering the performance of plant already running and plans for new installations and developments over the next few years. These papers are in the first 50 pages of the book. The other section of general interest is the economic appraisals which are at the end of the book. Most of the papers are therefore on specialist topics and assessments on controls, blade design for the difficult conditions of operation with the rapidly varying winds driving the machine, measurement and prediction of wind levels for power output estimation, coping with gusts and high winds etc.

Most of the material is from British sources with a high proportion from British universities. The British programme of prototype testing will lead to a number of relatively small wind "farms" in the early 1990s.

Both in performance and reliability the British designed prototype wind generators have performed well. The paper outlining the experience in California is in many ways the most interesting and gives an indication of the problems that can arise if large scale installation of plant proceeds before comprehensive development and testing has been completed and digested. As California has about 90 per cent of all of the machines installed in the world the experience summarised in this book is important. This material is presented in what appears to be a series of slides. Surprisingly, written text would only subtract from the impact of the data and diagrams.

One of the diagrams suggests that the state of development now is about the same as the motor car about 1900 or so! Most British designers would disagree with this view. However, British and European designs were among those whose performances are summarised and 60 per cent of the units installed in California were imported.

The commercial difficulties can be appreciated when the number of US manufacturers from 1980 onward is noted: six in 1980 rising to 13 in 1983 and dropping again to five in 1986 and 1987. It is worth outlining the main reasons for the poor performance of the Californian machines because these identify the main areas where British wind parks and designs require special research and testing.

It is noted that the wind velocities have not been up to the levels of the site surveys. On average the wind speeds have been sufficient for only 86 per cent of the predicted power levels. As the power varies to the cube of the wind speed this is in fact only equivalent to a shortfall of about 93 per cent of the time averaged speed prediction. This shows how important a good wind survey of the site is to the output and economic performance of the site and also how year to year variations in wind speed can be important.

Part of the output shortfall in California was also due to poor location of wind generators in the site — another 5 per cent of energy loss was due to this cause. On average the performance was 75 per cent of prediction — the worst was less than 60 per cent and the best was 93 per cent! The latter are the outputs when the units were working. The proceedings reveal that plant availability was poor (just over 50 per cent) and much of the plant had to be shut down for repairs due to problems such as blade fatigue. Many manufacturers were unable to meet their maintenance and repair schedules due to their poor financial situation and this must have been an important contributing factor to the poor availability. There were also significant output losses due to blade soiling — labelled "bugs" and "dirt" in the American slide.

Although the Californian experience appears to have been unsatisfactory, it has apparently provided data to confirm that wind power could provide, under British conditions, cheaper electricity than coal or nuclear (about 2p per unit) even with average wind speeds of 8 m/s which are available at a large number of locations. In these circumstances wind power must now be considered to be a serious contender as a source of electricity for the next century.

Finally the comparison of wind farms in remote sites with tree planting raises interesting points. The report does not list the bad points but the advantages are attractive — 10 times the local employment, minimal effect on wildlife and an immediate financial return from wind rather than a wait of many years with tree planting. However, there are the transmission towers and lines to connect the farm with centres of electricity use!

N G Worley

Published by Mechanical Engineering Publications, 1988
476 pp. £90

A people's Chernobyl

Chernobyl: A Documentary Story by Iurii Shcherbak
Foreword by David R Marples

This book was first published in the Soviet monthly journal *Iunost* in the summer of 1987, in two issues, and this English version appears by an agreement between the Canadian Institute of Ukrainian Studies and the USSR Copyright Agency in Moscow. Unlike the majority of books and articles which have been written about Chernobyl and which have focused on the technical aspects of the incident, this book represents the views and reactions of ordinary people from all walks of life. As Marples puts it in his foreword: "The immediacy of the disaster is illuminated in these pages by those who lived through it: firemen, doctors, scientists, party and government workers, helicopter pilots and journalists. There is the contrast between those collapsing from radiation sickness after fighting the graphite fire in the building of reactor No 4 and the final chapter in which the author comments on the simple joys of lying on an uncontaminated bank aside a peaceful river".

All those involved with energy decision making must read this unique account of what it really means to be involved in a major nuclear accident. In the words of Dr Robert Gale, the American radiation sickness expert, "Chernobyl is humanity's last warning".

Dr Cleland McVeigh

Published by Macmillan Press, in association with the Canadian Institute of Ukrainian Studies, 1989
168 pp. £25.00 H/B; £6.99 P/B

Photovoltaics — research and development

'Current Topics in Photovoltaics', Vol 3
Edited by T J Coutts and J D Meakin

Following the pattern of earlier volumes in the series, this volume comprises four review chapters on recent advances in research and development in solar photovoltaic devices and systems. Each chapter is essentially a monograph, with no deliberate connection with the others.

The first chapter is a review of factors determining the lifetime of the minority charge carriers in III-V compound semiconductors of relevance to solar cell applications, such as gallium arsenide. Emphasis is placed on the light emission which accompanies recombination in these materials, used as a diagnostic tool. Available measurement techniques and interpretations are reviewed, with a view to assisting the study of other potentially useful compounds in this class. Chapter 2 is devoted to another III-V compound, indium phosphide, considered to be a somewhat neglected but rather promising material, in which standard conversion efficiencies of around 20 per cent have been demonstrated. The technology of growing suitable structures and forming contacts is reviewed. It is considered that development work on InP cells for space applications, motivated partly by their extraordinary radiation resistance, will lead to terrestrial applications. They seem to be promising subjects for the fabrication of two-cell or even three-cell cascades. In chapter 3, a similar study is made of the prospects for

cadmium telluride, a II-VI compound. Although standard efficiencies of around 15 per cent are thought to be possible, it is indicated that considerable development would be required to enable this material to reach its potential.

The final chapter examines the requirements for the measurement of solar cell and module performance. The lack of agreement between various national and international standard test conditions is highlighted. A useful review follows of the technology for testing and of the instrumentation required.

Though undoubtedly a book mainly for specialists, it shows also that steady progress continues to be made to establish a solid basis for the understanding of solar cell behaviour, during a period when industrial and governmental support in this area has been rather weak.

Prof B J Brinkworth

Published by Academic Press, London, 1988
359 pp. £45.00

Photovoltaics — equipment for applications

'Solar Photovoltaic Products'
(A guide for development workers)
by A Derrick, C Francis and V Bokalders

This book should be mandatory reading for all development workers. It is clearly aimed to help select the best equipment for each application. Requiring no previous knowledge, it leads the specifier through the technical and economic appraisal of his problem towards an optimum solution. Particularly helpful are sizing monographs and tables, and examples of products available.

Many books of this type shy away from the specific information for which the vendor thirsts — that is, supplier lists and price guides. This book jumps straight in with these, which I am sure will make it the specifiers' Bible. It is hoped that regular reprints will be made with updated information.

There is an introduction to the theory of PV cells and systems, also a tender document format, both of which will help to give confidence to the novice specifier.

The book is divided into chapters on battery charging, water pumping, vaccine refrigeration, lighting, rural telecommunications and miscellaneous. Each section summarises field experience of the various types of equipment on the market, costs, sizing and implementation and gives a list of examples. There are photographs, performance data and some prices for each product.

An excellent publication which covers all the Third World applications of photovoltaics.

B M Cross

Published by Intermediate Technology Publications, London, 1988
127 pp. £12.50

R & D progresses in Europe

'Energy from Biomass 4'
Edited by G Grassi, D Pirrwitz and H Zibetta for the Commission of the European Communities

This book contains the proceedings of the Third Contractors Meeting, which took place at Paestum in May 1988. The Commission of the European Communities had implemented a four-year non-nuclear energy research and development programme for the expansion of the use of renewable energy sources and, in particular, biomass.

There had been two previous meetings of the CEC Directorate for R & D: in Brussels in 1986 and in Orleans in May 1987. Papers presented at these two meetings were never published and so this book contains an updated overview of the Commission's activity in this area.

The book is for the specialist rather than for the interested lay person. It contains some 87 papers and can be divided into four specific parts:

(*a*) production of biomass for energy and improvement of productivity;

(*b*) harvesting, transport, storage and drying of biomass;

(*c*) biochemical conversion of biomass (ethanol fuels, basic studies on biological conversion);

(*d*) thermochemical conversion of biomass (liquefaction, gasification, pyrolysis).

The book informs the reader on virtually all the most important research taking place on bio-energy and the technologies which are at present in the collaborative programme. At the conclusion of the book is a general discussion on the state of six particular fields of interest: forestry, agricultural crops, harvesting, biological conversion, pyrolysis, and gasification.

F John L Bindon

Published by Elsevier Applied Science Publishers, Barking, England, 1989
627 pp. £72.00

A comprehensive study

'Natural Gas — Basic science and technology'
by Dr A Melvin

This is a book for the physical scientist. It aims to give an appreciation of the application of physical techniques over the whole range of natural gas operations, from discovery to utilisation. The lay person, with some science background and with an interest in energy topics, will certainly find some useful material in this excellent and readable book.

Dr Melvin is manager of the Physics Division of the British Gas London Research Station. He has had much experience in the gas industry and it does appear to be appropriate that such an appraisal of one of the UK's most important energy topics should be viewed critically. The book covers a wide range of topics from resource to exploration through to the end product, combustion.

Chapter 1 deals with the sources and origins of natural gas deposits and is followed by a short survey of the gas industry's operations across the whole spectrum. This second chapter forms the basis of the book by identifying important matters, later discussed.

Chapter 3 deals with seismic exploration, although this most technical subject is dealt with in a more simplified form than the rest of the contents. Chapter 4 covers thermodynamic properties and methods of gas operations, with a following chapter on the basic physics of gas metering. Then comes precision calorimetry, leaving the final section of the book to outline some of the basic physics specifically relevant to the combustion of natural gas.

Some useful tables and empirical equations are given in the two appendices and the reader will find the diagrams and general layout very clear.

This is one of the British Gas Technical Monographs, which have been based on the expertise and knowledge of its staff. The main use is for readers outside the industry. It does do what is claimed as an objective, and that is to fill perceived gaps in current literature.

F John L Bindon

Published by Adam Hilger, Bristol, England, and Philadelphia, USA, in association with British Gas, 1989
221 pp. £27.50

Recently published

'Guidance notes on the installation of industrial gas turbines, associated gas compressors and supplementary firing burners'

British Gas. Price: £25.00 (inclusive of postage).
Available from: British Gas plc, Marketing Division, 326 High Holborn, London WC1V 7PT, Tel: 01-242 0789, or from Industrial Departments of British Gas regions.

'Industrial Energy Markets'
Energy Efficiency Series No 9

Department of Energy. Price: £40.
Available from: HMSO Publications Centre, PO Box 276, London SW8 5DT.

'Electricity Distribution Network Design'
by E Lakervi and E J Holmes

Available from: The Institution of Electrical Engineers, Michael Faraday House, Six Hills Way, Stevenage, Herts SG1 2AY, Tel: (0438) 313311. Price: £48.

'Applications Manual: Condensing Boilers'

The Chartered Institution of Building Services Engineers in collaboration with the Building Research Energy Conservation Support Unit. Price: £13 for members of CIBSE; £26 for non-members.
Available from: Publications Department, CIBSE, Delta House, 222 Balham High Road, London SW12 9BS, Tel: 01-675 5211.

New examination route to CEng status

A CAMPAIGN to help industrial companies facing skills shortages was launched by The Engineering Council on 6 July.

The campaign is aimed at men and women working in industry who did not have the opportunity to study for a degree on leaving school. It offers an alternative route to achieving Chartered Engineer status through the Council's Examination which is of degree standard.

This examination can be taken by those whose circumstances prevent them from qualifying through the normal route of an accredited degree, and for those who have non-accredited degrees and wish to undertake further qualification to meet the required standard.

"Tapping this hidden pool of talent will help industrial companies to improve the profile of their technological workforce," Professor Jack Levy, the Council's Director — Engineering Profession, said today.

The campaign, backed by an explanatory leaflet and poster, encourages men and women of ability to take this route to qualify as Chartered Engineers through The Engineering Council Examinatioin while continuing their employment.

Professor Levy said: "We are aware that many good, young people go into industry every year with very few academic qualifications.

"Because of our education system they often think of themselves as failures. Most of them are far from failures and have a lot to give their companies and the country. We want to help them to study to try to achieve our qualification."

While stressing that young people are still advised to take degrees on full-time courses at universities, polytechnics and colleges, the Council says it believes that at the moment many able school-leavers realise too late that they can become professional qualified engineers.

"We want to widen their horizons and at the same time help industrial companies to lessen the effect of the dwindling labour pool on their future competitiveness," said Professor Levy. "Both employers and employees will benefit greatly, particularly after 1992 when the qualifications profile of companies will become increasingly important.

"Nowadays young people thinking about their careers are looking much closer at what companies can offer them, too. If a potential employer can show that the company has a firm policy of professional development it will be better placed in the recruitment market."

*The Council has 40 recognised examination centres thoughout the world and a parallel campaign will be offering similar advice through them.

Six pilot schemes announced for integrated engineering degree

THE GO-AHEAD has been given for six pilot schemes for a new Integrated Engineering Degree Programme (IEDP), The Engineering Council and the Department of Trade and Industry (DTI) announced on 21 July.

The universities of Durham, Southampton and Cardiff (Wales) and the polytechnics of Portsmouth, Nottingham (Trent) and Sheffield City have been picked to receive DTI funding in support of The Engineering Council's initiative. Two of the courses — Nottingham and Durham — will begin this year.

The new courses are designed:

- to emphasise the interdisciplinary nature of engineering;
- to make a career in engineering more accessible — through better course design — to those without traditional qualifications while still maintaining the highest of standards;
- to reflect the fact that graduates often have an unclear idea of their first job, and job opportunities may change considerably between the start of a course and graduation, as may students' aspirations.

Welcoming the development, Industry Minister Mr Eric Forth said: "This is a timely initiative from The Engineering Council, and the DTI is pleased to support it. It will undoubtedly make a positive contribution to helping industry obtain engineers with the broader based skills needed to ensure future success.

"It is an excellent example of what we are trying to achieve through the Enterprise and Engineering Initiative, with business and education working together to solve a common problem with DTI support."

Professor Jack Levy, FEng, The Engineering Council's Director (Engineering Profession), said: "There has been strong competition in the universities and polytechnics to qualify for the pilot schemes.

"There has, too, been a very positive response to the IEDP scheme by our industry affiliates and other industrial organisations," he said. "Industrial support for the IEDP courses includes cash donation, secondees, student sponsorship, industrial lectures, supervision of industrially-based projects, donation of equipment, membership of steering committees, donation of computer aided design equipment and software.

"This rigorous and challenging honours degree is intended to complement rather than replace existing accredited courses in engineering. It also is expected that it will in time significantly widen access to engineering without lowering standards."

New opportunities for engineers in Europe

THE BRITISH Government needs to reaffirm its determination and enthusiasm to lead in the European Community, the Chairman of The Engineering Council, Sir William Barlow FEng, told the Engineering Assembly in Huddersfield on 18 July.

"For professional engineers Europe is a new opportunity to increase our influence and standing," he said at the Assembly, which comprises more than 100 members elected by the 300,000 Chartered Engineers, Incorporated Engineers and Engineering Technicians registered with The Engineering Council. There had been a great response by applications from British engineers for the new qualification and title of European Engineer and there would be more interchange of engineers within European countries, especially younger ones.

"It is a great pity that the British Government, having spent enormous time and effort in increasing the awareness of the Single Market all through 1988, has somehow created the impression in 1989 that it has lost its enthusiasm for the market.

"Britain leads in a lot of its practices, including many aspects of the Social Charter and it is, therefore, rather unfair that we are currently looking as though we do not want to be a member.

"That is not the wish of the majority of British people nor of the Government but we need the British Government to reaffirm its determination and enthusiasm to lead in the European Community," he added.

Brave start on meeting aims of Finniston Report

THE ENGINEERING COUNCIL had made a brave start on the tasks outlined in the Finniston Report nine years ago, its author, Sir Monty Finniston, FEng told the Assembly, meeting at Huddersfield. But much remained to be done.

The academic institutions had done basically what the report recommended but industrialists, even if increasingly aware of the problems of lack of modern skills, have been much slower in matching education needs which are ultimately their needs.

"Continuing education in mid-career training and development is a must in the changing working lifetime of our present engineering management. We lag for example behind the Japanese who spend nearly ten times as much on average as do British companies!

"Real progress will only come when the need for it is recognised in every boardroom in the land," he said.

Information technology helps British Gas

*Thirty years ago British Gas became the first utility in Britain to send out a computerised bill.

*Today the company is one of the largest data processors in Europe, with one computer terminal for every two office staff, carrying out eight million transactions a day.

*IT tells us what appliances or spare parts are in stock and when they can be delivered, speeds emergency teams to gas leaks and allows engineers who formerly did six jobs a day to complete ten.

*Service engineers using digital radio keep crowded air waves free, while a printout facility in vans further ensures clear and fast communication.

*On-screen digital mapping, now being introduced, means that all underground services can be quickly and accurately loaded, cutting down road-digging and improving safety.

*Some 30 expert system programs are in use or under development in British Gas, allowing instant access to expertise on everything from designing gas burner systems to the best herbicide to use.

*Software written and exported by British Gas is helping run gas networks or tap gas and oil reservoirs in a dozen countries overseas.

*Today the sophisticated use of information technology helps 80,000 gas people serve 17 million customers — seven years ago 106,000 served 15 million.

For further information contact British Gas plc, Marketing Division, 326 High Holborn, London WC1V 7PT.

Plastic heat exchangers are cleaner for power stations

Soon to be launched in the UK is a new all-plastic heat exchanger system for power stations, which is claimed to be safer, more effective and cleaner for the environment than present conventional regenerative exchangers.

Manufactured by GEA, the process technology group of West Germany, the new recuperating Ecogavo system for high performance flue gas desulphurisation plants is corrosive free. Thus its heat exchanger, made from Teflon plastic, will not leak, a common and serious problem of conventional heat exchangers, claims GEA.

Five power stations in West Germany are using the system, some of which have already operated for 12,000 hours. A further six power plants in other Mainland Europe countries are installing the system.

GEA claims that the new system allows a "leak-proof transfer of heat" from the crude gas to pure gas. It also prevents the transmission of sulphuric, hydrochloric and fluohydric acids into the pure gas flow as can happen with conventional systems. Any danger of the acids, fly ash and dusts reacting together is therefore avoided.

GEA estimates that the system's plastic tubes will only need to be cleaned one to three times a year. The anti-adhesive quality of the tubes means that they are in effect self-cleaning and will require the minimum of maintenance.

It is claimed that the Ecogavo is suitable for nearly all types of flue gas desulphurisation plants. Because of its modular design it is easy to install, and its plastic tubes exert a stable controller action over a high degree of load changes.

For further information contact GEA Luftkuhlergesellschaft Heppel GmbH & Co, Dorstener Strasse 18-29, D-4690 Herne 2, Federal Republic of Germany.

Sequence control leads to improved efficiency

Sequence control of pairs of gas direct water fired storage heaters in commercial applications leads to greater improved efficiency, when the PP Controls JBT 23 two-stage temperature sequencer is utilised in conjunction with the existing time switch and lead-lag selector switch. Use of the sequencer in this way ensures that the selected second heater only fires during periods of peak demand. This intermittent use of the second heater and the more precise control of combined flow water temperature leads directly to considerable fuel savings.

This accurate, yet basic sequencer is, it is claimed, simple to install, flexible in application and easily adapted to both new and existing control systems, all of this at a modest cost. For applications involving 3 to 8 sets of such heaters, or any modular boiler systems, PP Controls offer individual 4/6 and 8 stage JBT temperature sequencers.

For further information contact Industrial Acoustics Company, Walton House, Central Trading Estate, Staines, Middlesex TW18 4XB.

Automatic degree day system has two software variants

Vilnis Vesma's automatic degree day system, JACKDAW, is now available in two software variants. JACKDAW-123 works from the Lotus 1-2-3 spreadsheet environment while JACKDAW-EXE runs directly under DOS. The hardware pack, which logs daily temperatures and passes them to the user's PC for degree-day calculations, remains the same in both cases.

The main software product, however, will remain spreadsheet based. This is the "XS-DETECT" M&T system. By exploiting the power of Lotus 1-2-3, it achieves a high degree of functionality, and its ease of development is reflected in a "lifetime free upgrades" policy. Spreadsheet programs can be distributed in a machine-independent form requiring no on-site tuning, even though they make extensive use of screen graphics. As a result the product is keenly priced, and conversion to a stand-alone variant would destroy that advantage.

XS-DETECT, JACKDAW, and Vilnis Vesma's other energy spreadsheet software should all work with versions 2.2 and 3 of Lotus 1-2-3. But, with the possible exception of specially commissioned projects, future developments will be designed to run under the existing release 2.01 as well, avoiding the need for existing 1-2-3 users to upgrade their programs or computers.

For further information contact Vilnis Vesma, 50-52 Culver Street, Newent, Glos GL18 1DA.

Range of oil, gas and dual fuel burners extended with new model

G.P. Burners, specialists in dual fuel burners for industrial applications, have extended their 'F' burner range with the addition of a 720 model. This range now covers 3000 kW to 12,300 kW in four models: F16 3000 to 5600 kW, F18 4100 to 7300 kW, F20 6500 to 10,500 kW, and F22 8200 to 12,300 kW.

All models are available in single, dual or triple fuel versions, and can be supplied with a complete range of accessories including gas trains, pumping and heating sets and control cabinets.

Typical applications for the 'F' range include: firetube boilers; watertube boilers; airheaters, dryers and incinerators. These turbo-ring forced draft burners use a patented refractory steel combustion head which, it is claimed, assures stable, pulsation-free operation with high heat release in confined combustion chambers.

A main air damper is multi bladed driven from a modulation controller which also drives the primary air sleeve in the combustion head. This gives accurate air control and enables the air velocity to be maintained across the burner's head at reduced firing rates. It also enables the burners to be adapted for different flame configurations.

For further information contact G.P. Burners Limited, 3 EPH Industrial Estate, Faraday Road, Dorcan, Swindon SN3 5HQ.

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Title: **Electron microscopy**
Location: University of Surrey, Guildford
Duration: 5 days.
Starting: 25 September 1989.
Content: The theory of scanning and transmission electron microscopy and the collection and interpretation of both images and diffraction patterns.
Contact: Prof P J Goodhew on 0483 571281.

Title: **Chemical engineering for scientists**
Location: The Norfolk Gardens Hotel, Bradford
Duration: 5 days.
Starting: 25 September 1989.
Content: What is chemical engineering? Material balances. Energy balances. Basic concepts of fluid flow. Simple fluid transfer systems. Liquid mixing. Safety and loss analysis. Process heat transfer. Heat loss calculations. Heat transfer equipment. Basic mass transfer. Gas absorption. Solvent extraction. Binary distillation. Liquid-solid systems. Solid liquid separation. Reactor design. Powder technology. Process economics. Instrumentation and control.
Contact: Conference Section, IChemE on 0788 78214.

Title: **Plant layout**
Location: The Albany Hotel, Nottingham
Duration: 5 days.
Starting: 25 September 1989.
Content: Layout principles. Batch and housed plants. Modular construction. Solids handling/packaging. Site layout. Noise control. Area classification. Explosion and fire effects. Safety and emergency considerations. CAD exercise. Release and dispersion calculations. Layout organisation. Role of CAD and expert systems.
Contact: Dr J K Walters on 0602 484848×2419/2952/2417.

Title: **Industrial emission and air quality monitoring**
Location: Crest Hotel, Amsterdam
Duration: 5 days.
Starting: 25 September 1989.
Content: Introduction to stack sampling. Sampling for stack gases. Stack site set-up and test preparation. Isokinetic sampling for dusty gases. In-stack permanent and continuous monitoring. In situ particle size assessment. Extractive particle size assessment. Air quality sampling techniques. Air quality modelling. Environmental air and government regulations. Gas chromatography — field and laboratory techniques. Sampling for solvent vapours and organic aerosols. Standardisation and calibration procedures. Sampling of difficult systems. Calculation of data. Sampling of airborne radioactive materials. Special sampling in the high technology and specialised industries.
Contact: The Centre for Professional Advancement in The Netherlands 20 662 30 50.

Title: **Good design parameters for laboratories**
Location: Caransa Crest Hotel, Amsterdam
Duration: 3 days.
Starting: 26 September 1989.
Content: Furniture systems and fume hoods. Laboratory design. HVAC. Programming laboratory facilities. Upgrading existing laboratories. Safety and hygiene. Energy conservation.
Contact: The Centre for Professional Advancement in The Netherlands 20 662 30 50.

Title: **The implementation of control projects in the process industries**
Location: St Ermins Hotel, London SW1
Duration: 2 days.
Starting: 28 September 1989.
Content: Analysis specification. Tendering. Design, procurement. Fabrication. Testing, installation. Commissioning, acceptance. Operation, maintenance. Modification, enhancement. Replacement. Training.
Contact: Conference Section, IChemE on 0788 78214.

Title: **Briquetting, pelletising, extrusion and fluid bed/spray granulation**
Location: Novotel Alpha Hotel, Amsterdam
Duration: 3 days.
Starting: 2 October 1989.
Content: Glossary and terminology of particle size enlargement. Review of methods and equipment. Exploration of participants' fields of interest and application. Bonding and strength of agglomerates, fundamentals of agglomeration. Selection of the proper agglomeration process. Professional organisations, association and references of particle size enlargement. Methods and equipment details. Case histories, scale-up of equipment, research and test methods. Discussion of participant applications, problem solving approach. Examples from industry. Binders for agglomeration. Ancillary equipment, agglomeration systems. Cost of agglomeration. Suppliers of equipment, systems and services.
Contact: The Centre for Professional Advancement in The Netherlands 20 662 30 50.

Title: **An appreciation of aviation fuel and its quality**
Location: Egham, Surrey, England
Duration: 2 days.
Starting: 16 November 1989.
Content: Tracing the history of the development of aviation fuel as a guide to current practices, the course covers engine performance and fuel hydrocarbons, fuel requirements of the airlines, the role of the specification, measurement of specified properties, aviation fuel production, distribution and quality control, additives, and a number of other fuel related topics.
Contact: Dr E M Goodger FInstE, 78 Church Road, Woburn Sands, Milton Keynes MK17 8TA, England. Tel: 0908 582120.

September 1989

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

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

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

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

CIPE '89
Conference, 25–28 September, Leeds, England.
Details from Conference Section, Institution of Chemical Engineers, 165 Railway Terrace, Rugby CV21 3HQ, England. Tel: 0788 78214, Fax: 0788 60833, tlx: 311780.

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

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

October 1989

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

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

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

Combustion and Furnaces
Conference, 5-6 October, Stuttgart, FRG.
Details from Dipl-Ing H Webner, VDI-Gesellschaft Energietechnik, Postfach 1139, 4000 Düsseldorf 1, FR Germany. +49 6214 329/216.

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

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

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

CoalTrans '89
International conference and exhibition, 16–18 October, London.
Details from Conference Manager, CS Publications Ltd, McMillan House, 54 Cheam Common Road, Worcester Park, Surrey KT4 8RJ, England. Tel: 01-330 3911, tlx: 8953141.

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

Human Reliability in Nuclear Power
Conference, 19–20 October, Cafe Royal, London.
Details from Sara Mountford, IBC Technical Services Ltd, Bath House, 56 Holborn Viaduct, London EC1A 2AX.

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

Trends in World Natural Gas Trade
Conference, 25 October, London.
Details from The Institute of Petroleum, 61 New Cavendish Street, London W1.

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

November 1989

International Solar Hydrogen Symposium
Symposium, 1 November, Zürich, Switzerland.
Details from WCTC, PO Box 238, CH-8055 Zürich, Switzerland.

PWR — the present and future of Europe's Nuclear Energy
Conference, 6-7 November, London.
Details from IBC Technical Services Ltd, Bath House, 56 High Holborn, London EC1A 2EX.

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

NEMEX '89
Conference and exhibition, 21–22 November 1989, NEC, Birmingham, England.
Details from Energy Systems Trade Association (ESTA), PO Box 16, Stroud, Glos GL5 5EB. Tel: 045 387 3568.

3rd Conference on Tidal Power
Conference, 28-29 November, London.
Details from Conference Office, Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA. Tel: 01-222 7722, Fax: 01-222 7500.

October 1990

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