ENERGY WORLD

The magazine of The Institute of Energy

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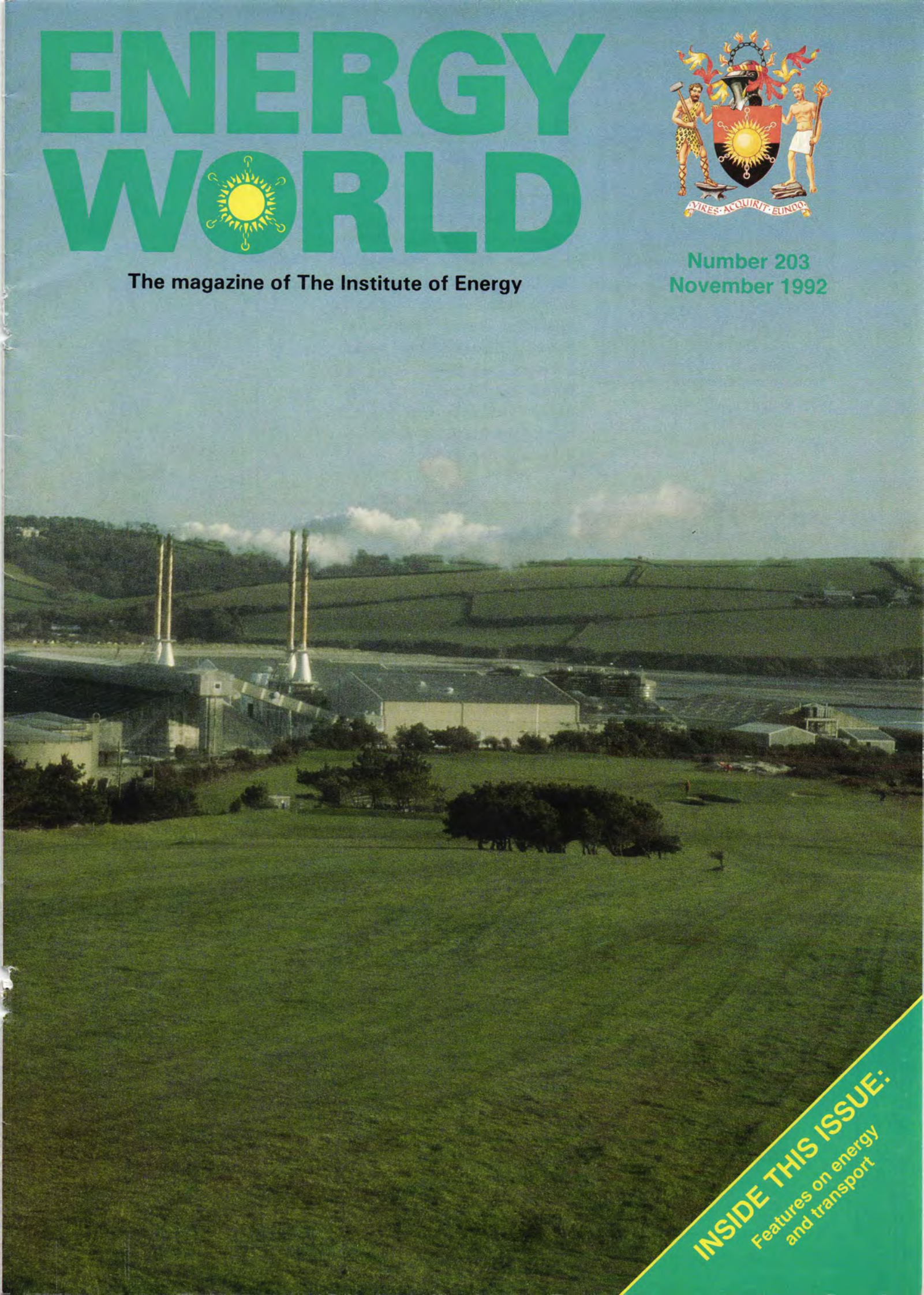

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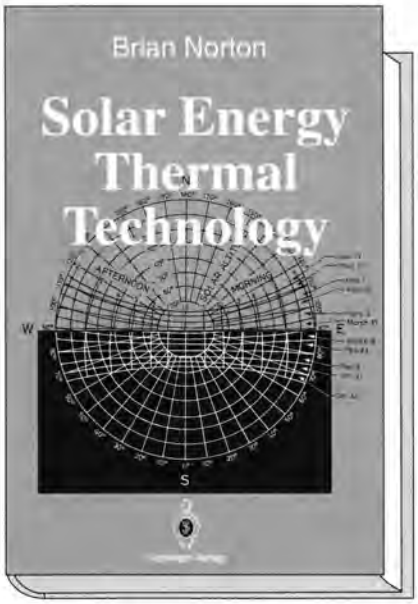

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However, if you are not a member, but would like to receive a copy, write to us, the publishers,

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Johanna Fender

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CONTENTS

COVER

ECC plc, formerly English China Clays, opened a £4 million combined heat and power plant at their Par harbour site, St Austell in Cornwall, in October, pictured on the front cover of this issue.

In 1989 the ECC International energy department commissioned a feasibility study to look at CHP schemes for the site, having already established that gas turbine generators could provide on-site power generation with the turbine exhaust ducted to their industrial Buell type dryers to provide direct drying heat. Energy cost savings alone justified the scheme.

Photograph by courtesy of BP Energy.

Ignorance and tears

WE HAVE recently witnessed a Government decision to close some thirty UK coal mines. Luckily this has since been deferred, because at best it was based on ignorance of energy, its implications, opportunities and above all, its real costs.

It is equally true to state that the power generation sector in the UK is heading for unbelievable overcapacity of mechanically and economically sound generating equipment, not always in the correct geographical location, with the scene being compounded by additional imported electricity.

On top of all this we have a Regulator in office, but we must question both his understanding of the scene and the purpose of his role.

Over a year ago now I forecast all this would end in tears. Then the only uncertainty was whose tears. That too is now becoming clearer, and it looks like being nearly everybody involved in this almost unbelievable situation, as well as the consumer, both as a consumer direct, and as a tax payer.

At Vesting Day for electricity, UK Ltd already possessed more than enough modern and efficient electrical generating capacity. Indeed some of this was mothballed in a new or nearly new state. Since then we have:

- significantly increased the operating utilisations of our nuclear stations, and rightly so;
- continued with the programme of extending the normal operating lives of our many existing 500 MW and 660 MW turbo-alternators, from nearly 30 running years to almost 40, again rightly so;
- introduced some FGD in the larger and most efficient coal stations, the cost of which will only be worthwhile if these are used to their full extent;
- expanded the use of very high sulphur imported bitumen derivatives, the polluting effect of which is substantial;
- witnessed this unbelievable 'dash for gas', which appears to have committed UK Ltd already to a further 50%-60% surplus electricity generating capacity.

It is quite clear that market forces, as an energy policy, are not working. In isolation they are not enough. Neither is the statutorily backed Regulation working. That role was established to safeguard the consumer, and look what has happened!

It is a fact that currently coal stocks are increasing at a rate of 1 million tonnes per month, so Government offers £1 billion to create up to 100 000 redundancies in total, which will then cost the tax payer around £600 million a year in social security payments, and further subsidies in job creation schemes. All this when our coal mines are now technically amongst the potentially most productive and efficient in the world. Indeed, some of those scheduled for closure have total production costs less than the subsidy paid in some other countries. Our common market colleagues in Germany being an example. This is scandalous in itself and even more so, if this subsidised coal were ever to be imported into the UK.

Let us not overlook, also, that every coal mine has a finite life. We must not become emotionally carried away, and defer facing up to just that issue either.

It seems that both the current Government and British Coal need some sound commercial and factually-based advice. Particularly Government, and it could be argued that because they are still the largest shareholders in the electricity supply industry, they have a vested interest in enhancing the profitability of that industry, prior to the final sell off. That would turn out to be a very expensive route in the longer term. Government must obtain all the facts, listen, and follow a sound economic and patriotic route, that also helps to restore order to the scene in a logical and secure manner.

The facts are as follows: the biggest cost item of nuclear power is building of plant in the first place, Hence the true cost is largely dictated by the level of interest rates, and very little else. Once built they should be operated for a maximum number of years. Any other policy is unfair to those who put up the money in the first place. To claim nuclear power is subsidised is ridiculous. It has the lowest marginal cost of any large scale power generation system, and its use should be maximised. Whether or not nuclear fuel should be reprocessed or 'flogged to death' first and then dry stored is debatable too.

Coal is best used in large plant. It has long start up and shut down cycles, so use it continuously or nearly so, and that means for baseload generation. In this way, plant use is maximised, with maintenance and fuel costs minimised. Overall coal is far cheaper than gas on large and fully depreciated plant, of which the UK has an abundance.

Gas/oil is the most versatile fuel, with rapid start up and shut down cycles. It lends itself to peak lopping. Additionally the plant is smaller and cheaper to build so it is best introduced where the system needs re-inforcing, but not for just baseload.

Imports of electricity. Why? For mutual peak lopping, yes, as originally intended. But why has it been allowed to become one way traffic into the UK, at a cost in excess of the marginal cost of our own surplus capacity, some of which is within a few miles of the import receiving and distribution station?

Imports of coal. Again one must ask the question, why? In the UK we make the world's best mining equipment, and have geological conditions in deep mines equal to the world's best. Furthermore, we know our miners are at least equal to or better than the opposition. The USA is evidence of that, where deep-mined coal is largely extracted by UK manufactured mining equipment, managed by former British Coal managers.

It really is quite obvious how UK Ltd should be proceeding with power generation. That the recent debacle is going to end in tears is equally obvious. Hopefully, and this is where it may not happen, these tears will be limited to those who have failed to regulate (not necessarily just the Regulator); those who have got their sums wrong; those who have interferred politically in an area where logic, commonsense and proper economics should be allowed to take their natural course; those who have made decisions to invest in new plant, in a non-commercial manner, because of political, emotional or other non-commercial reasons.

Neither UK Ltd nor those mines with a perfectly viable future, should be allowed to suffer.

Michael Roberts
IoE President & Chairman, MCR Energy

Thermie to finance IGCC project

THE DIRECTOR General for Energy in the EC has signed a financing contract to design, construct and demonstrate a generating installation for the gasification of coal through combined cycles (IGCC).

IGCC technology is currently regarded as representing the future of electricity production from coal, as it drastically reduces CO_2, NO_x and SO_x emissions to levels far below the limits set out by the EC directive.

IGCC technology reduces CO_2 emissions by 20% compared to traditional coal-fired power stations.

Under the Thermie programme, a specially created Spanish company, Elcogas, Electricite de France and Electricidade of Portugal will implement the project on the site of Puertollano in Castilla-the Mancha in south-east Spain.

A broad range of coal will be tested during the period of demonstration, after which the IGCC plant will run on bituminous coal from the Puertollano opencast mine.

EC action needed to unlock CHP potential

THE EC could play a central role in the future large-scale development of CHP in Europe if it were to take the appropriate policy action in the energy sector, according to CHPA's European director, Michael Brown.

Speaking at the *Cogeneracion 92* conference in Madrid in October, he spelled out the great potential for CHP development in the EC and the new economies in central and eastern Europe.

EC output from CHP is currently only 6%. But if its full potential is realised, CHP could make a major contribution to reducing emissions to EC target levels by 2000.

Nat Power to invest in Malaysian power project

A NEW project company has been set up to build Malaysia's first two privately owned and funded power stations. UK company, National Power, are investing in the new company, as well as being responsible for the operation and maintenance of the new plant.

The two gas-fired power stations will have an output of 1500 MW, and will be built in two phases. Under the first, due for completion by 1995, 1000 MW of open cycle gas turbine plant will be built at two sites: Paka, Terengganu and Pasir Gudang, Jahore. Phase two will see the conversion of the plants to combined cycle gas turbines.

National Power will own 70% of the joint venture company. The remaining 30% will be owned by by YTL Corporation Berhad, a major Malaysian construction company. The deal provides National Power with the possibility of participating in future power generation projects in Malaysia.

Practical assistance needed on nuclear safety

THE FRENCH and UK energy ministers meet in London in October to discuss, amongst other things, nuclear safety in central and eastern Europe and the former Soviet Union.

Tim Eggar and Dominique Strauss-Kahn confirmed their governments' support for the multilateral programme of action proposed by the Munich summit to provide assistance in nuclear safety to the new commonwealth. They stressed the importance of coordination of activities of all potential donors.

The European Council has made clear their desire to play a full part in the programme, including setting up a multilateral fund to deal with actions not covered by bilateral measures. The UK and France are working together to create the necessary mechanisms for this fund, as well as in a number of specific projects.

Progress so far has been made within the framework of the Phare and Tacis programmes. Rapid movement from the study phase in order to deliver practical assistance at the plants concerned was also stressed, giving priority to operational safety and near-term technical improvements, as agreed at the Munich summit.

BG make progress in Yemen

A MEMORANDUM of Understanding (MoU) has been signed by British Gas Exploration and Production and the Petroleum Exploration Production Board of Yemen.

The MoU forms the basis for negotiation of a production sharing agreement, and relates to the offshore Socotra block, southwest of Socotra Island in the Gulf of Aden, covering an area of 17 500 sq km.

Fuel cells down under by 2000

FUEL CELLS could be in use for power generation in Australia by the turn of the century, according to researcher Wal James of the Murdoch University Energy Research Institute in Western Australia.

Fuel cell systems are being developed for a variety of uses, including urban power requirements, remote areas and heavy transport vehicles.

The institute is using its expertise on the power electronic aspect to convert the fuel-cell produced DC power to usable AC power which can be integrated into the existing grid system.

By the end of the institute's three-year project, they should have produced a prototype of a power conversion and integration system.

Fuel cells have the advantage of high efficiency in comparison to conventional systems, and produce less CO_2 and no noxious fumes.

In addition, they operate efficiently on a part-load, allowing large cells to be used efficiently at low load levels.

A comprehensive investment programme by the state authority of Java includes the modernisation of seven of the Island's hydroelectric plants, such as the one above left. The programme order has gone to Sulzer-Escher Wyss, who estimate that the modernisation should increase output by 20 630 kW to a total of 92 980 kW, and ensure safe, cost-effective operation for the next 25 years. Computer-aided runner design methods (above right) will be used in revamping the old power stations.

Future of UK coal industry under threat from the 'dash for gas'

ON 13 October it was announced that production was to cease at 31 of British Coal's 50 deep mine collieries. 27 of those would close, with the remaining four to be kept on a care and maintenance basis to maintain access.

The decision was taken when it became clear that the new coal contracts with the generators would not justify current levels of production. As a result over 30 000 miners would lose their jobs, with the jobless figure rising when taken to include associated job losses in related sectors, such as rail freight.

Within a week of the announcement, however, the pressure of public opinion had forced the President of the Board of Trade, Michael Heseltine, to announce a moratorium on the closures, until at least the statutory review procedure was concluded, in order to avoid an embarrassing Government defeat.

Most of the rebel Tory MPs were brought into line by assurances that the all-party DTI Commons Select Committee would carry out the review.

Scarcely more than a week before the closures were announced, the Coalfields Communities Campaign had published a prophetic report, titled *The end of coal?* Authors Stephen Fothergill and Nigel Guy predicted that if the gas-fired power stations currently committed or with grid connection agreements went ahead, there would be no market at all for UK coal by the end of the century. They identified two actions which they consider essential if the coal industry is to have any future whatsoever.

First, a halt to the issue of licences for further gas-fired power stations. Second, intervention by OFFER to require the RECs to suspend their preferential contracts with gas-fired power stations (in which several RECs have a stake) to allow cheaper coal-fired plant to compete on equal terms.

These calls for action were echoed again and again following the closure announcement, when increasing numbers of people, both in and out of the industry, demanded a level playing field for coal.

However, many in the industry fear that without a highly unlikely absolute reversal of the Government's energy policy, little can be achieved to change the situation between now and the new year.

British Coal estimate they will need to reduce their output by a minimum of 25 million tonnes, which would mean the end of deep mining in Lancashire, North Staffordshire, North Wales and North Derbyshire. The four collieries to stay on care and maintenance are Maltby, Wearmouth, Prince of Wales and Hatfield-Thorne.

Maximum redundancy payments of £37 000 were offered to mineworkers at the affected pits, dependant on length of service and weekly earnings. Chairman Neil Clarke later told a Select Committee hearing that British Coal had wanted to improve on this offer, but had been prevented from doing so by the DTI.

Generators announce over 2700 MW of plant closures

AT THE end of September, two weeks before the furore over the pit closures, both PowerGen and National Power announced the closure of 'uneconomic' plant, in the light of the continuing and projected surplus of capacity.

Not surprisingly all the plant to be withdrawn by National Power is coal-fired, with the exception of the 110 MW gas-fired plant at St Helens in Merseyside, and two auxiliary gas turbines at Eggborough in North Yorkshire.

PowerGen announced that four out of the six 100 MW units at Castle Donnington, near Derby, will close. The two remaining units will stay to support the grid system. Drakelow B (coal-fired), and Bulls Bridge in Middlesex and Leicester (gas-oil stations) will close.

Simultaneously, PowerGen began commercial generation at their 900 MW gas-fired plant at Killingholme. Production from the first 450 MW of the CCGT has been achieved just over two years after construction work on the plant began.

Prof Stephen Littlechild, Director General of Electricity Supply has announced his intention to examine the closure programmes. He has also brought forward his review into electricity purchasing strategies of the RECs.

DoE sets up Energy Saving Trust

THE DEPARTMENT of the Environment announced in October that Lord Moore is to be the Chairman of the new Energy Saving Trust.

The Trust is a private sector independent body, set up by the Government, British Gas, the RECs of England and Wales and the Scottish electricity companies to stimulate energy savings and so protect the environment.

Lord Moore, an MP since 1974 until his peerage in June this year, was Parliamentary Under-Secretary for Energy from 1979 to 1983, during which time he held responsibility for energy efficiency. He was instrumental in setting up the National Energy Foundation, chaired by Dr Mary Archer, and the Neighbourhood Energy Action programme.

Challenge to 'gas is cheaper' claim

A REPORT published in the Financial Times newsletter *International Coal Report* on 16 October challenges the DTI's claim that gas-fired power generation is cheaper than coal.

According to the report, not only is gas more expensive than coal on the proposed new contract price levels — £1.50/GJ — but it is also more expensive than the existing, much higher, prices currently being paid to British Coal of £1.85/GJ. The most expensive gas generation — and this accounts for the bulk of the new gas plant — is 70% more expensive than the proposed new coal contract price.

No estimate of gas generation prices has been presented by the DTI to justify the closure of coal mines.

The 'dash for gas' has pushed up the price of gas for power generation from around 16p per therm to 21p. In additional, most of the new gas contracts are on a long-term interruptible basis: no coal is contracted on an interruptible basis.

International Coal Report also forecasts the likely impact on fuel supplies to PowerGen and National Power. While cheap imported coal, from countries such as South Africa and America will flood in until 1994/5, in the following years this coal, allowing cheaper electricity generation, will be replaced by yet more high-cost gas-fired plant.

BC deputy chairman dies

DR KENNETH MOSES CBE, who was appointed joint Chairman of British Coal in April of this year, died on 2 October after suffering a stroke.

Dr Moses joined the coal industry in 1957, working underground at Bold colliery. Between 1964 and 1970 he held a number of managerial positions, becoming Chief Mining Engineer of the North Yorkshire area in 1974. He went on to be Director of Planning at Hobart House, then Director of the North Derbyshire area before being appointed a Board Member and Technical Director in 1986.

He became President of the Institute of Mining Engineers and was awarded the CBE in 1988. He received his doctorate in 1990, his thesis being on strategic decision making in the UK coal industry.

Mammoth task for HSE

THE SHIFT of responsibility for offshore safety from the Department of Energy has created a massive task for the Health and Saftey Executive (HSE), and will lead to difficulties in bringing together the mass of legislation needed for the new regulatory regime, according to law firm Nabarro Nathanson.

The Cullen Report, produced as a result of the Piper Alpha disaster has attracted widespread publicity, and the final chapter contains no less than 106 recommendations, all of which were accepted by the Government.

A major change is the shift in responsibility for offshore safety from the Department of Energy to the HSE, who now face the task of implementing these proposals. The sheer mass of legislation necessary makes this a daunting prospect.

Top Anglo-Dutch award for large UK company

FKI Babcock Robey have been awarded the highly coveted Anglo Dutch Award for Enterprise, in a ceremony organised by the Netherlands Chamber of Commerce, held at Whitbread the Brewery, London, in October. FKI Babcock Robey of Oldbury, West Midlands was awarded the Unilever Trophy, a category open to large UK companies for commercial and industrial cooperation between Holland and the UK.

Managing Director, Andrew Michel (pictured centre) received the Trophy from Sir Michael Angus, President of the CBI (left) and Michael S Perry CBE, Chairman of Unilever (right).

The judges proclaimed FKI Babcock Robey the winners for their part in the design and manufature of three large Euronox boilers which now service a district heating scheme in Den Haag, Holland.

Prize for Leicester's eco-house

FOR THE second year running a project from Leicester has been chosen as the Conservation Engineering winner in the British Conservation Awards, organised by the Conservatuion Foundation with support of the Ford Motor Company, and could represent the UK in the European finals.

Eco-house, sited in Western Park on the outskirts of Leicester, has been modified by the Leicester Ecology Trust to demonstrate a wide variety of ways in which householders can increase the conservation efficiency of their homes.

Representatives from the Leicester Ecology Trust received their trophy and a cash prize of £3000 from Environment Minister, David McLean, and David Bellamy at a ceremony in London earlier this month.

Runners up in the Conservation Engineering Category included Iceland Frozen Food's Portable CFC Reclaim Plant.

Reactor restart at Bradwell

THE NUCLEAR Installations Inspectorate of the HSE has given consent to Nuclear Electric to restart operations at Reactor 1 at Bradwell nuclear power in Essex. NII granted consent in August for Reactor 2 to restart.

The consent follows completion of Reactor 1's biennial statutory outage, together with a comprehensive safety review which included a programme of reactor pressure vessel inspections.

Agreement to continued operation is subject to Nuclear Electric demonstrating continuing satisfactory results from the regular test and inspection programme that underpins the normal regulatory control of the station. It is also subject to satisfactory completion of an agreed programme of improvements and further analytical work.

Both reactors had been shut down since March 1992, pending NII's assessment of the comprehensive safety review and completion of the inspection programme on each reactor. NII's decision to allow both Bradwell reactors to operate beyond 30 years is based on its assessment of Nuclear Electric's further safety review and the successful outcome of an extensive reactor pressure vessel inspection programme.

The principle objectives of the further safety review were to update the previous long-term safety review (LTSR) in the light of current standards and working practices, and to implement any further necessary or worthwhile safety improvements. These objectives are similar to those established for the LTSR, which formed the basis for the NII agreeing to the station operating to 30 years.

Kelt doubles production

FULL production from two new onshore oil fields began in October. Caythorpe and Singleton double production for the company involved, Kelt UK Ltd.

The two new fields will contribute 450 barrels of oil equivalent, helping Kelt to achieve a net total of 850 bopd.

The Caythorpe field is the first in the UK to be developed as a direct response to the new independent gas market. It is also the first onshore field producing from the Rotliegendes formation which is prolific in the southern North Sea. The company is pursuing similar exploration prospects in nearby on and offshore areas.

At Singleton the completion of permanent production facilities has resulted in all four wells being in production simultaneously.

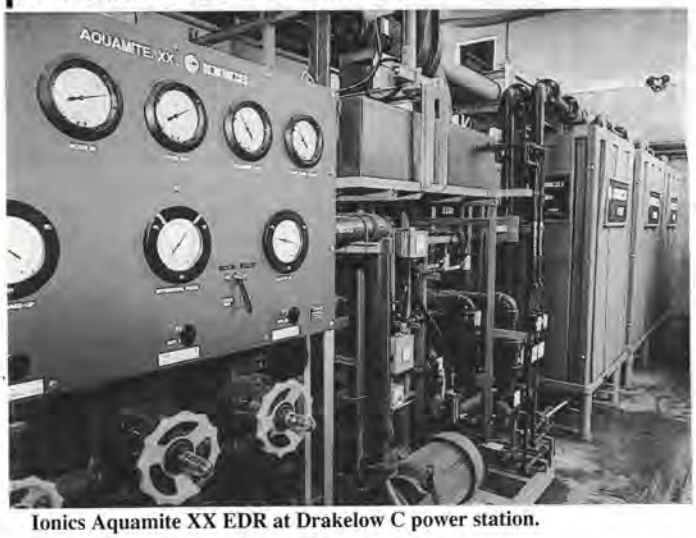
Electricity from sewage gas

UK-BASED engineering company Peter Brotherhood Ltd has won a contract valued at more than £60 000 for equipment which will help to provide 'green' energy by generating electricity from sewage gas.

Peter Brotherhood will supply a waste heat recovery steam turbine, generator, condenser and associated control and instrumentation equipment to Beckton sewage treatment works in Essex. The order was placed on behalf of Thames Water Utilities.

The steam turbine will be used to enhance the efficiency of a recently installed £10 million combined heat and power system, incorporating two gas turbines to generate electrical power, utilising methane gas produced as a by product of sewage treatment. The steam turbine will use steam raised from the waste heat in the exhaust gases of the gas turbines. The turbine generator is capable of generating 2 600kW of power, which can be sold to the local grid.

Substantial water savings from pre-demineralisation



Ionics Aquamite XX EDR at Drakelow C power station.

AN ELECTRODIALYSIS reversal (EDR) pre-demineralisation unit at the steam powered Drakelow C power station in Burton-on-Trent has taken a substantial load off the station's main ion exchange plant, and has enabled PowerGen to switch from mains to raw river supply, with a substantial reduction in its water costs.

With an output of 6 million pounds of steam per hour (at 2 400 psi) the steam generators at Drakelow need 60 m^3 of demineralisation water each hour to replace blowdown losses. A 100m^3/hr ion exchange plant provides this make-up water to the boilers at the required rate.

Until recently water was taken from the town's mainswater, as Drakelow has no cheap source of clean water, such as a borehole available on their site.

Over a year ago PowerGen installed an Ionics Aquamite XX EDR system to act as a roughing, pre-demin system ahead of ion exchange. EDR systems can remove most of the minerals from a water source, are relatively compact compared to traditional ion exchange systems, and, most importantly, can tolerate far higher conductivity and greater organic contamination in the feedwater.

During the initial year of use, the EDR has been operational for 94% of the time. PowerGen run the EDR unit throughout the day and the main ion exchange plant about 50% of the time.

Full details are available from Ionics (UK) Ltd, 16 Endeavour Way, Wimbledon, London SW19 8UH.

New micro-CHP range launched

New 147kWe CHP unit from Petbow Cogeneration is first in a range from 20 to 5000kW. ENVIROGEN 147 (pictured above) on show at Electrotech '92 attracted a high level of enquiries

THE FIRST of a new range of CHP units, ranging from 20 to 500kW has been launched by Petbow Cogeneration.

Envirogen 147 has an electricity output of 147 kW and a heat output of 240kW. The unit is powered by the well proven Perkins 30008SI Natural Gas Vee Eight engine driving a two bearing Newage Brushless Synchronous alternator.

Utilising both coolant and exhaust heat through shell and tube and plate heat exchangers, the packaged unit incorporates both primary and secondary electrically driven pumps for circulation.

The Envirogen 147 is completely automatic in operation with an auto mains paralleling AP800 system designed by Petbow and facilities for separate remote condition monitoring through the Petbow 'Sigmus' system.

The range of CHP units will be available for running on a choice of fuels including natural gas, biogas, LPG, 35 second oil and landfill gas.

For further information contact: John Ridout, PGI Manufacturing Ltd, Sandwich, Kent CT13 9NE. Tel: 0304 613311.

Consulting the energy Oracle

A NEW document management product should enable organisations in the utility sectors to manage textual documents within the Oracle database structure.

Energy companies will be able to store, retrieve and update complex documents and practices such as plant equipment, safety regulatory procedures, product information and environmental issues, as if they were part of a traditional database.

Text documents can be stored and managed in native Microsoft Word and WordPerfect formats as other industry standard forms. Also, data and documents can be retrieved from Oracle databases or other applications across a network so the system is suited to large sites and geographically dispersed computing environments.

SQL*TextRetrieval is available on Sun Sparc under Unix and Dec VAX under VMS, and porting to other platforms is scheduled for the coming months. It will be released as part of the ORACLE7 developers programme. The product is compatible with both ORACLE Version 6 and ORACLE7 and will be sold both direct and through Oracle's VAR channels.

Although suitable for a wide range of large-scale document tasks, Oracle expects initial application areas to include the management and maintenance of company-wide records. In the long term it will enable simultaneous multi-user processing.

Bright idea wins schoolboy McAndrew award

Midlands branch Chairman, Mr Les Green (left) makes a presentation to Jonathan Stanier of Royal Grammar School Worcester (right), the Junior McAndrew Award winner for 1992, with his design of a solar torch. The presentation was made at the Midlands Regional finals of the Young Engineer for Britain competition, which were held in July.

The Midland branch of The Institute of Energy has awarded this prize for two years running. Winners receive a cheque for £50 and a trophy is presented to the participating school. The Award is funded by the McAndrew Trust, which is held by the Midlands branch, and is intended to encourage young people in their energy-related studies.

Call for papers

PAPERS are invited for a major international conference to be held in Leeds in July 1993. Entitled 'Facing the European challenge: the role of the professions in a wider Europe', the conference will provide an opportunity for academics, researchers and members of professional institutions to discuss the changes brought about by the single market.

Abstracts, of not more than 250 words, should be sent to Professions in Europe Conference Committee, Dept of Continuing Professional Education, University of Leeds, Springfield Mount, Leeds LS2 9NG. Papers must be received by 30 November 1992.

... and projects

THE EC has published the 1993 call for projects for the THERMIE programme.

In its first two years THERMIE was allocated 150mECU for more than 200 projects.

Particular emphasis will be given to projects in the areas of energy savings and CO_2 reduction in buildings, and integrated systems for urban traffic management. Brochure available from DG XVII, fax: 32 2 235 0577.

New Secretary for Institute

FOLLOWING the resignation earlier this year of Colin Rigg, Council has approved the appointment of Jim Leach (right) to succeed him as Secretary of the Institute as from 1 November 1992.

Jim probably needs no introduction to many members, having joined the Institute staff in April 1978. Since that time he has served as Membership Secretary, Membership Officer, Membership and Education Officer, Deputy Secretary, and for the last six months, Acting Secretary.

He sees the immediate future as a period of expansion for the Institute and is happy that he is able to play a full part in its future development.

A partnership that works

by Eur Ing F John L Bindon and Nicholas Proctor

Year by year since 1986 the Year in Industry scheme has increased its intake of school leavers who are going on to further education in the engineering disciplines. The scheme has proved remarkably successful, as the results of the 1992 Young Engineer for Britain competition demonstrated, with many of their categories being won by Year In Industry students. Eur Ing Bindon introduces the scheme, which is illustrated with the example of Nicholas Proctor's prize-winning project.

THE YEAR In Industry scheme began as a single region pilot project in 1986 (Industry Year). Over the six years since then it has achieved unrivalled success and today is available across the length and breadth of England and Wales.

The scheme is controlled by 12 university based regional directors, whose job it is to match the bright young men and women from schools with companies, in order to undertake useful work on a selected project before starting their university degree courses.

In order for the scheme to suceed, companies must be willing to participate by taking students into their organisations in such a way as to provide a first hand insight into modern industry. One prime advantage for industrial companies is by engaging students in related disciplines the employer is provided with an opportunity to influence pre-graduates in a positive way to choose an industrial career.

Companies which have participated so far have observed that it makes sound commercial sense to involve students. The students themselves have also benefitted enormously. Those selected undertake project work with a company for a year before embarking on their degree courses.

Employers are expected to pay a salary to those selected as well as an administrative fee in order to support the running of the scheme. In return they benefit from the resulting project work, as well as being in a position to conduct continual assessment of the student's work to decide about possible future employment.

The benefits are on both sides. To put it simply: it is a partnership that works.

The Year In Industry scheme began in the South West of England with a handful of students six years ago. By 1991, the numbers has grown to 153 students being placed in 102 companies, large and small.

The scheme aims to produce future managers and engineers capable of meeting the highest standards of excellence in order to compete with other countries on the international market place. The scheme is seen as a vehicle to help stem the tide of business liquidations, which has threatened to sweep away the UK's industrial base, the very bedrock of our prosperity.

The work of 18 selected students was presented at the Dinorwig power station in North Wales in July this year, by courtesy of the National Grid Company. One of these is set out here. It is the work of Nicholas Proctor from Manchester Grammar School, who won a prize in the Industrial Entries category (age 16-19) of The Engineering Council's Young Engineers for Britain 1992 competition.

Nicholas's project 'Steam leaks' was carried out during his Year In Industry at BP Chemicals in Baglan Bay. Another student, Sam Wardill from Alleynes School, was also taken on by BP, to work on the topic of 'Fugitive emissions on a petrochemical plant'. Clearly these are important subjects, work on which is a major factor in safety terms as well as in improving overall plant efficiency. Both students are currently reading Chemical Engineering at the University of Cambridge.

The following is Nicholas Proctor's written account of his project work.

Steam leaks

The BP Chemicals site at Baglan Bay produces the raw materials that are used in the plastics, textiles and pharmaceuticals industries. Naphtha, a light petroleum distillate is cracked to produce mainly ethene, ethanol, propanol and styrene.

All plant on the site require steam for its operation. The steam is used to maintain reaction vessels and distillation columns at the correct temperatures, and the process conditions required enable steam to be used to drive pumps and turbines.

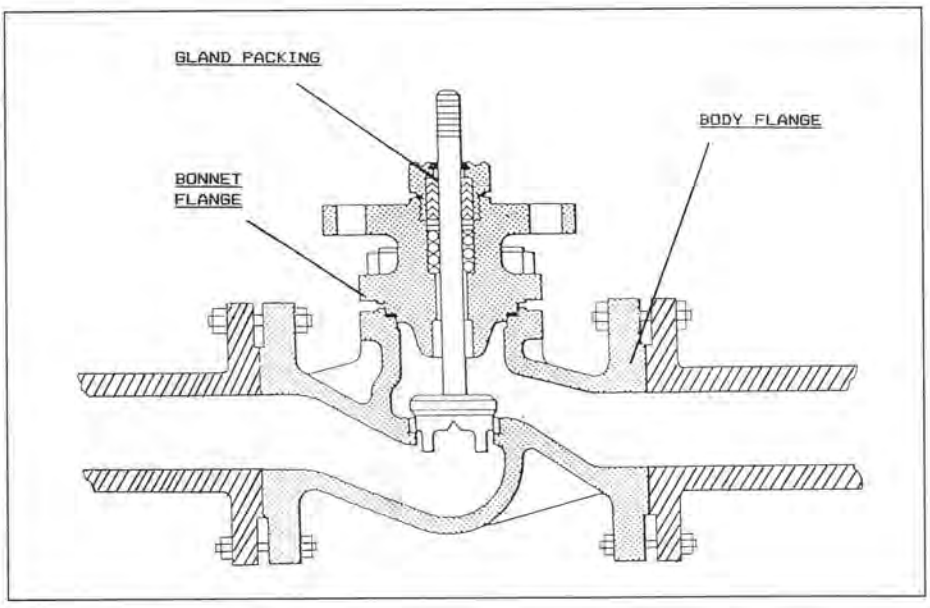


Figure 1: Valve leaks.

This report concerns the measurement of steam leaks on one plant at the Baglan Bay site. Lost steam is lost energy, and this investigation is one of many that are carried out to improve energy utilisation across the site. The main problem is quantifying steam loss, which is vital if the cost of steam leak repair is to be justified.

This particular investigation was ideal for a student with 'A' level knowledge, bringing a new approach and greater inquisitiveness to the problem. However, a good knowledge of plant processes was required, together with knowledge of how steam is inadvertently lost to atmosphere.

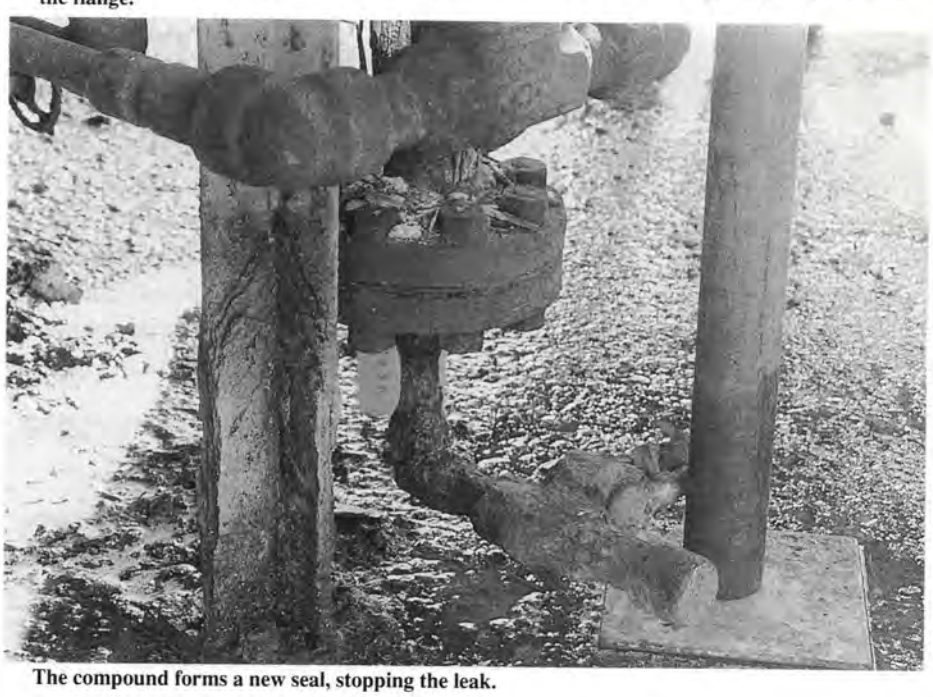
The initial step was to identify the different types of leak and to catalogue the leaks on the plant to discover which type occurred most frequently. Leaks from valves are most common. Some 65% of those catalogued were from valves. The most frequent type of valve leak is a cloud of steam from the base of the stem, caused by loose gland nuts or by worn gland packing. The bonnet flange and the body flange of a valve can also leak, but this occurs far less frequently (as in figure 1).

Leaks also occur from lengths of pipework. These tend to be in lines of less than 2" diameter. The most common source of these leaks is the open end of a pipe. These may be discharge lines from faulty steam traps, lines to drains, or vent lines. The latter two are typically caused by a passing valve.

Flanges, joints and tee-pieces can also leak, if a weld fails or a flange cracks (as in figure 2).

A typical steam leak. Here a flange weld has failed.

This type of leak can be repaired whilst the plant is on-line. A sealant compound is injected into the flange.



The compound forms a new seal, stopping the leak.

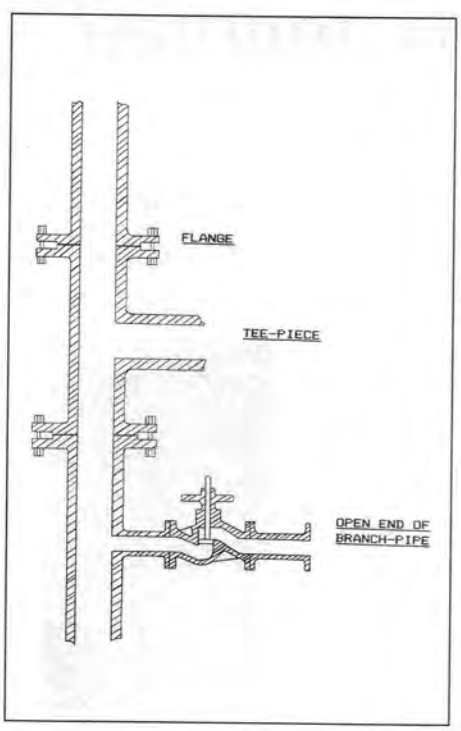


Figure 2: Pipework leaks.

Measurement of leaks

Once the different types of leak had been defined, leaks on the plant were catalogued. Each leak was listed with information about its location, type and size. The catalogue was designed to enable any particular leak to be located for repair quickly and easily. The 'size' of the leak was a qualitative estimate based on the speed and volume of the emission, each leak being classified as large, medium or small.

These qualitative sizes had to be converted into figures, so an investigation of methods of measuring leaks was carried out. This involved examining methods already in operation and assessing the viability of the alternatives. This part of the investigation did required some help from engineers. The advantage of the student is to be able to look at each different method objectively, without bias or preconceptions.

Traditionally steam loss is calculated indirectly, by taking readings from the flow meters in the steam lines. These show the amount of steam flowing into the plant and the amount being used by the various reactors and vessels. Equating the two gives the steam loss.

This method has several drawbacks: any unmetered lines will create an artificially high steam loss. As a percentage of total import, the loss is often fairly low. This means that any errors or inaccuracies in the meter readings will have a comparatively large effect on the steam loss. So this method was rejected.

There are figures available for calculating steam loss from the blow length of a leak. However most leaks do not blow free, but impinge on the ground or on neighbouring supports and pipes. Also the plant had steam at different pressures which would affect the blow lengths.

It was decided that it would be better to use a direct method; some form of portable meter which could be used to measure individual leaks.

Direct methods

One possibility was to condense the leaking steam in a large volume of water and record the mass change over a period of time. But this requires leaks on ground level with the steam directed towards the ground, for it to be possible to collect it. This occurs so infrequently as to make this method impractical.

If the velocity of a steam leak can be measured at a known cross-sectional area of the leak, then volumetric flow rate can be found. To this end commercial velocity meters were investigated. The main problems with measuring a steam leak directly are the high temperatures involved and the large amount of condensation that occurs on any apparatus placed in the steam.

A pitot tube, connected to a manometer can be used to measure the velocity of a fluid. It measures the difference between the impact and static pressures of the flow, seen as a head difference on the manometer. This head is proportional to the square of the velocity of the flow.

A pitot tube was built to measure a sample of steam leaks. It's simplicity and lack of moving parts meant it could still function even in wet steam. It was calibrated using compressed air, against a vane anemometer.

Leaks were measured by placing the tube in the steam as close to the source as possible and recording the maximum head difference seen on the manometer. This gave the velocity of the leak. The diameter of the leak at the point of measurement was found using a precut circular templates, allowing a volumetric flow rate to be calculated for each leak measured.

The sample of leaks was chosen to include a number of each different size of leak, so that the qualitative sizes from the catalogue (large, medium, small, and so on) could now be quantified. Knowing how many of each size of leak were in the catalogue, a total volumetric flow rate for all the leaks on the plant could be found.

The project identified and economically quantified an area where substantial savings could be made, showed that steam leak repair is justifiable financially, and brought a new approach to the problem of measuring steam loss. □

Motoring and the environment

The motor car, as a fast and convenient form of transport has become an indispensable part of modern living. But increasing concerns about its environmental impact have led to renewed interest in alternative fuels such as natural gas, methanol, ethanol and hydrogen. The following article is based on Shell Briefing Service, number two, published earlier this year, and describes the emissions from cars run on traditional fuels, and how they are being reduced through improvements in engine technology and fuel quality. It goes on to outline the principal alternative fuels in terms of their technical feasibility and their likely environmental performance compared with oil-based fuels.

THE MOTOR car has become an indispensable part of modern life and ownership is closely linked to economic growth and prosperity. It is a high technology product, built to perform well even under extreme temperatures and driving conditions. Remarkably, though, its method of propulsion, the internal combustion engine, remains basically similar to that used 100 years ago.

The development of the motor car towards the end of the last century ushered in a new era of transportation. In the first phase of development, cars — thanks to their speed, range and ease of use — fast replaced horse-drawn carriages and by the 1930s were competing with rail transport. The late 1950s heralded a new growth phase with the beginning of the era of mass motorisation in OECD countries.

In the first half of this century, car production was dominated by the US, which in 1946 produced more than 80% of the world's cars. By the mid 1980s, that share had fallen to just over a quarter. In the past 40 years, world car production has increased from more than eight million a year in 1950 to more than 35 million today.

There are currently around 430 million cars registered worldwide: by the year 2000 this is likely to exceed 500 million. There are wide disparities in levels of ownership. In the US, there are more than 570 cars per 1000 inhabitants. In Nigeria, India and China, there are fewer than 10. Overall OECD countries, with about 15% of the world's population account for more than 80% of registrations.

Demand is forecast to increase sharply in non-OECD countries, which by the year 2010 are expected to account for more than a third of estimated total world sales of 74 million vehicles. Demand is expected to be especially high in Eastern Europe and the Asian economies, particularly South Korea.

However, there is increasing concern about the effects of vehicle emissions on the environment. Worldwide, almost half of the carbon monoxide (CO), hydrocarbons (HC) and nitrogen oxides (NO_x) given off by the burning of fossil fuels are emitted by gasoline and diesel engines. In addition, there are the sulphur dioxide (SO_2) and particulate emissions associated with diesel engines. HC, CO and particulates result from incomplete combustion of the fuel. NO_x arise from the 'fixing' of atmospheric nitrogen due to the high temperatures involved in combustion within the engine. SO_2 is the direct result of burning fuels which contain sulphur. Thus, vehicle emissions are derived either directly from the fuel or from an interaction between fuel and engine.

These pollutants from so called 'ground level' vehicle emissions affect local air quality. Efforts to reduce air pollution by controlling such emissions began in the US in the 1960s in reaction to the problem of photochemical smogs in Los Angeles. Since then US legislation to reduce vehicle emissions has focussed solely on local air quality.

More recently, however, attention has also turned to global air quality and the effect of carbon dioxide (CO_2) emissions, leading to an augmented greenhouse effect and possible global warming.

Between 70% and 80% of anthropogenic CO_2 emissions are estimated to come from the burning of fossil fuels, more than half of which is oil. Since about half of the world's oil is used in transport, about a fifth of the world's anthropogenic CO_2 emissions can be attributed to the transportation sector.

Conventional fuels

Since cars have to carry their fuel on board and must be able to refuel safely, conveniently and rapidly, they generally require a high density liquid fuel. Most cars run on either gasoline or diesel, which can be stored and handled easily and yield good vehicle range and performance. Gasoline and diesel together account for almost 80% of world demand for transportation fuels.

Improvements in vehicle technology and fuel quality have reduced emissions from gasoline and diesel cars, whilst maintaining performance and containing operating costs. Such improvements are likely to meet increasingly stringent local air quality standards. When changes are being proposed for environmental reasons, emission levels must be considered throughout the whole energy chain — from recovering and transporting feedstock through to manufacture and delivery to the end user. This 'well to wheels' or 'cradle to grave' approach can be used to assess whether improvements in one area will be cancelled out by increased emissions in another. For example, most changes in fuel quality (eg, phasing out lead in gasoline or reducing the sulphur content of diesel) result in increased energy consumption and CO_2 emissions at the refinery. Thus, although changes may improve local air quality, they will have an impact on global air quality.

Gasoline is a mixture of between 200 and 300 hydrocarbons which evaporate between ambient temperature and 220°C. It is a complex mixture, produced by blending the output from several refinery processes. To meet the stringent demands of modern motoring, a gasoline must:

have a volatility which is neither too high nor too low throughout the boiling range;
have an octane quality high enough to burn smoothly and efficiently.

These characteristics are largely a function of the bulk fuel properties. Additives are also included to maintain, and in some cases improve, fuel performance. For instance, detergent additives control deposits, thus maintaining emission performance of the engine throughout its service life, while spark aiding additives reduce CO and HC emissions.

Emissions from gasoline cars comprise:
exhaust emissions and
evaporative emissions.

The main exhaust emissions are HC NO_x and CO, which affect local air quality, and CO_2, which affects global air quality. The composition of the HC species emitted is as important as the total quality emitted, since the extent to which hydrocarbons form ozone is related to their structure and reactivity.

Volatile organic compounds (VOC) — mainly hydrocarbons — are emitted into the atmosphere as a result of evaporation from fuel tanks and carburettors and during refuelling and delivery.

Exhaust emissions can be reduced by fitting a three-way catalytic converter which uses a catalyst containing platinum, palladium and/or rhodium to convert exhaust components into less reactive products. Since such catalysts are deactivated by lead, cars with catalytic converters have been mandatory on all new cars in the US and Japan since 1975. As a result, almost all cars in Japan and more than 90% in the US are fitted with catalytic converters. By contrast, less than 10% of cars in Europe have catalytic converters, since they have been a requirement in only a few countries and only since the mid 1980s. However, this percentage will increase, following EC legislation which requires catalytic converters to be fitted to all new cars sold in Europe from 1993.

Such improvements in engine technology are the most effective means of reducing emissions. Dramatic reductions can be obtained in exhaust emissions when a three-way catalyst is fitted to a gasoline car.

The introduction of catalysts and concern about the effect of lead on public health led to the development of unleaded gasoline. Lead was traditionally added to gasoline to boost octane quality so as to meet the high standards of performance and fuel economy required by modern car engines. When lead is reduced or removed, the octane number of gasoline must be raised by other means, for example, by changing refining processes or blending in certain alcohols or ethers known as oxygenates — eg, methyl tertiary butyl ether (MTBE).

Unleaded gasoline is mandatory in many countries, such as the US, Canada, Japan, Australia and Brazil and is widely available in many others, accounting for around two-thirds of the world gasoline sales (excluding former Communist areas). More than half of world sales of unleaded are in the US alone. In most European countries, unleaded is taxed at a lower rate than leaded to encourage sales.

Evaporative emissions can be reduced by means of 'carbon canisters' containing activated charcoal. These absorb any vapours emitted and are regenerated by drawing air through them and into the engine as the car is driven. These devices have been fitted to all cars in the US and Japan since the mid 1970s. They are required in Australia, Scandinavia, Switzerland and Austria, and will be mandatory throughout the EC from 1993.

Evaporative emissions can be controlled not only from the car, but also at all stages in the manufacturing and distribution system (stage 1 recovery). At refineries and depots, improved tank seals and, in some cases, double tank roofs are required, together with complex vapour recovery units to recover vapours which are returned from service stations in empty road tankers. To control refuelling emissions, the options are either so-called 'stage 2' systems to recover vapours in the service station or else enlarged carbon canisters to capture vapours onboard the vehicle. These options are summarised in Table 1.

The effect of fuel quality on emissions is small compared to the impact of advances in engine technology, but becomes significant as emission limits get tougher. This is the case in the US where concern about local air quality, especially in certain major cities, resulted in a new US Clean Air Act in November 1990. This major piece of legislation covers a wide range of emissions sources and air quality issues. Included in the section on 'mobile sources' — fuels and vehicles — are tough new limits on exhaust emissions and a 'reformulated' gasoline programme.

From 1995 onwards, only gasolines which meet certain defined fuel quality standards will be permitted to be sold in cities with the most severe air quality problems. Since other cities and states may opt in to the programme, as much as a third of US gasoline may have to be reformulated. These gasolines must have a minimum oxygen content, reduced vapour pressure, a low benzene content and must not contain lead or any other heavy metals. When compared to average US gasolines in 1990, they will also be required to meet certain emissions targets which include no increase in NO_x emissions and specified reductions in 'air toxics' emissions (eg, benzene, formaldehyde) and volatile organic compounds (VOC) emissions.

Against the background of this legislation, a number of oil companies and motor manufacturers in the US embarked on a major study, the auto/oil programme, to investigate the effect of fuel properties on emissions. The initial findings of the study have shown that the quality changes required for 'reformulated' gasoline may not be the best way of reducing emissions.

The results of the auto/oil programme are being studied closely elsewhere in the world. In Europe, some changes in gasoline quality may be needed to meet future more stringent emission limits. The widespread introduction of catalysts and carbon canisters in 1993 is, however, likely to be more effective in reducing exhaust emissions than any changes to fuel quality.

Diesel fuels are made mainly from 'straight run' refinery components — hydrocarbons derived directly from the distillation of crude oil (the middle distillates or gas oils which boil between 150 and 400°C) with the addition of small quantities of components from other refining processes. The properties of these 'straight run' materials are highly dependent on the type of crude oil used to produce them. Refineries must therefore select crude oils with care to satisfy current

Table 1: Reducing VOC emissions — 'closing the gasoline system'

Source	Manufacturing	Distribution	Refuelling	Evaporative	Exhaust
Contribution (uncontrolled)	2%	3%	2%	10%	25%
The remainder is from non-automotive sources					
Control technology	Control of all fugitive emissions	Stage 1 systems (vapour balance and vapour recovery units at depots)	a) Stage 2 systems or b) large carbon canister	Small carbon canister	Three-way catalyst
Reduction achievable	90%	95%	a) 75% b) 95+%	90%	90%

diesel fuel quality demands, especially with regard to the sulphur content of the final product.

To perform well, a diesel car requires a fuel with good ignition quality, expressed as the 'cetane number'. This is measured by running a standard test engine on the fuel and comparing performance to two reference fuels — the shorter the ignition quality delay period, the higher the cetane number. The cold weather performance of a diesel car is especially critical. In severe cold, a diesel car must be able to start and also operate without wax forming on the filters and fuel lines. In many parts of the world, the cloud point of the fuel — the temperature at which wax crystals appear during cooling — together with a standard test, the Cold Filter Plugging Point, are used to assess a diesel fuel's low temperature operability.

Some diesel fuels — such as Shell Advanced Diesel — also contain additives which enhance fuel quality. These include detergents, corrosion inhibitors, reodorants and foam suppressors which improve combustion, cold starting and fuel system cleanliness. The result is better fuel economy and reduced emissions, smoke and noise.

Improvements in engine design and fuel technology are helping to challenge the poor image from which diesel cars have traditionally suffered. Moreover, diesel cars have better fuel economy and, although more expensive to purchase, are generally cheaper to maintain and depreciate more slowly than their gasoline counterparts. Demand for diesel cars is growing in some parts of the world, especially in Europe, where passenger cars account for about 25% of automotive diesel demand.

As with gasoline, emissions from diesel cars can be divided into ground level emissions, which affect local air quality, and CO_2 which has an impact on global air quality. The main ground level emissions from diesel cars are HC, CO, NO_x, SO_x and 'particulates' — particles of carbon soot and other matter. Unlike gasoline vehicles, diesel vehicles do not produce significant evaporative emissions.

Since the diesel combustion process is extremely efficient — the fuel is almost completely converted into CO_2 and water — CO and HC emission levels are lower than for gasoline engines. However, NO_x emissions and particulates are a problem for diesel. The two are related: if NO_x emissions are reduced, for example, by altering injection timing, the result would be incomplete combustion and a consequent increase in particulate levels. For a given engine design, reducing NO_x emissions is thus generally at the expense of particulate levels and vice versa. However, reductions in both types of emissions have been achieved by changes in engine design, such as the introduction of intercooling and turbocharging.

Overall, therefore, gaseous emissions from modern diesel engines are generally lower than those from gasoline engines. In fact, gasoline vehicles need to be fitted with three-way catalysts to match the emissions performance of modern diesel vehicles without catalysts. Moreover, diesel fuelled vehicles are the lowest emitters of CO_2 on a per mile travelled basis compared to vehicles running on other road transport fuels.

Although already very low, CO and HC emissions from diesel cars can be reduced further by fitting oxidation catalysts. (Particulate traps — another form of after-treatment device still at the prototype stage — are bulky and are therefore only suitable for heavy vehicles such as trucks). Current designs have one major drawback, however: the catalyst used is non-selective, leading to increased levels of sulphate particulate in the exhaust. Nonetheless, it is possible that more sulphur tolerant, more selective catalyst technology can be developed shortly.

As is the case with gasoline cars, most of the reductions in emissions from diesel vehicles have been due to improvements in the engine technology. Such improvements are likely to continue to offer the best means of emissions reductions for some time to come. However, as engines become 'cleaner', the effects of fuel quality on emissions performance are also coming under scrutiny. In this context, the sulphur content of diesel fuel is the focus for increasing attention. This concern is reflected, for instance, in EC proposals to limit sulphur levels to 0.05 % mass by 1996, possibly using tax incentives as a means of encouraging production of low sulphur diesel fuels. Similar limits on sulphur content have already been set in US legislation.

Most of the sulphur in diesel fuel is oxidised to SO_2 and emitted as a gas. However, some of this SO_2 reacts with oxygen to give sulphur trioxide (SO_3) which in turn reacts with water to give sulphate particulate matter.

Particulates give rise to concern because of their impact on local air quality and the possibility that certain species may be carcinogenic. Particulate composition varies but comprises several main components, such as unburnt fuel and lubricant. Overall particulate emissions levels and the proportions of the main components depend mainly on engine design and operating conditions. However, as particulate emissions levels are being progressively reduced as a result of engine design improvements, the influence of fuel quality becomes greater in percentage terms: hence the interest in the contribution of sulphur to particulates.

It is generally recognised that reducing the sulphur content in diesel fuel to the limits set by EC and US legislation will significantly reduce total particulate emissions. However, further reductions would incur technical, financial and environmental penalties. A much lower sulphur content (or even the complete elimination of sulphur) would have technical side effects, such as problems with engine durability. The fuel would be more expensive to produce, as it would require more secondary processing in the refinery, which, in turn, would lead to an increase in overall CO_2 emissions. Such increases could significantly reduce the CO_2 advantage which the diesel engine currently enjoys over the gasoline engine.

The question of emissions thus requires a balanced approach which takes into account all aspects — economic, environmental and social — of the problem.

Alternative fuels

Interest in running cars on fuels other than gasoline or diesel is not new. As early as 1899 an electric vehicle named 'la Jamais-Contente' achieved a speed of 65 mph. In the 1930s, compressed natural gas (CNG) was introduced as a vehicle fuel in Italy. Following the two oil 'shocks' of 1973 and 1979, the focus on alternatives was a result of governments seeking to reduce dependence on Middle East oil and make use of locally available resources. There was also an emphasis on conserving finite resources such as fossil fuels.

Recently, renewed interest has been shown in alternative fuels because they are perceived as having a better environmental performance than gasoline or diesel, both in terms of ground level emissions and greenhouse gas emissions, especially CO_2.

Around eight million vehicles run on alternative fuels, the main users being the US, Western Europe and Australia (LPG/CNG), South America (ethanol) and South Africa, which uses 40% synthetic gasoline.

Natural gas consists mainly of methane (between 85 and 99% of total volume) and ethane but also some other gases such as CO_2, nitrogen and sometimes hydrogen sulphide. It may have value as an automotive fuel, especially in countries rich in natural gas reserves and markets can present economic and logistical disadvantages.

Natural gas can be used as an automotive fuel either compressed in cylinders as CNG or as liquefied natural gas (LNG). In practice, LNG is rarely considered, since it is more expensive and more difficult to handle than CNG. For instance, fuel tanks need to be heavily insulated, in order to keep the LNG at minus 162°C.

Natural gas is a comparatively well-tested alternative fuel: around half a million vehicles run on CNG, mainly in Italy, New Zealand and Canada. There is also some

Table 2: alternative fuels — some considerations

○ **No limitations** ● **Some limitations** □ **Limitations** ■ **Considerable limitations**

	Vehicle hardware	Distribution/ handling	Safety	Refuelling time	Vehicle range	Lubrication
Hydrogen	●	□	●	□	□	○
LNG	●	■	●	○	□	○
CNG	●	□	●	□	□	○
LPG	●	●	●	○	○	○
Methanol	□	□	■	○	□	□
Ethanol	●	●	○	○	●	○
Vegetable oils	○	●	○	○	○	■
Electricity	■	○	●	■	■	○

Other factors to be taken into consideration include **cost** and **CO_2 emissions**

interest in Latin America (taxis in Argentina, for example) and in the former Soviet Union. In Italy, which accounts for more than half the world's CNG vehicle fleet, the main advantages of CNG are economic. Since gasoline is heavily taxed (79% of the pump price is tax, compared to less than two-thirds in most European countries), it is more than twice as expensive as CNG on an energy equivalent basis. Vehicle conversion costs are low, since conversion equipment can be supplied locally.

In the early 1980s, the New Zealand government, anxious to reduce dependency on oil imports, encouraged the use of CNG by offering tax incentives and subsidising vehicle conversions. Government support has now been withdrawn somewhat and usage has declined. In Canada, the natural gas industry has been actively supporting CNG for more than six years, especially in British Columbia where a number of distribution sites have been established.

Due to its high octane number, CNG is an excellent fuel for spark ignition engines. Most CNG vehicles are, in fact, converted gasoline fuelled vehicles with the gasoline tank retained, making them dual fuelled. However, in a dual fuel vehicle, compression ratio and engine efficiency cannot be increased to take advantage of the higher octane number of CNG. Storage is also a problem: the natural gas must be stored in high pressure tanks which are heavy and reduce payload and luggage space in smaller vehicles. The weight penalty must also be taken into account: a CNG car with a 75 litre tank is about 150 kg heavier than its gasoline counterpart.

Emissions from a CNG vehicle depend largely on the quality of the vehicle conversion. In older vehicles not equipped with catalysts, CO and NO_x emissions are reduced with CNG, whereas in modern vehicles with catalysts, the difference in emissions compared to those from a gasoline vehicle is much smaller and NO_x emissions, may, in fact, be higher.

In terms of global air quality, CNG suffers from the fact that its main constituent, methane, is an even more active greenhouse gas than CO_2.

LPG, consisting mainly of butane and propane, is arguably not a true 'alternative fuel' since its availability is closely linked to crude oil production and refining. Supply constraints would thus limit the extent to which LPG could be substituted for conventional fuels. Nevertheless, it is most widespread of alternative fuels, with an estimated four million vehicles running on LPG, especially in the Netherlands, Japan, Italy, Australia, New Zealand, Canada and the USA. The plus and minus points of LPG are similar to those of CNG, except that the energy density of LPG is better since the fuel is stored as a liquid under relatively low pressure. Levels of NO_x and CO emissions are similar to those from CNG cars but the pattern of HC emissions is different.

Most LPG vehicles are dual fuelled, although some dedicated vehicles are manufactured, particularly in Japan.

Hydrogen can be considered as a 'true' alternative as it can be derived by electrolysis from a non-fossil fuel source, namely water. In its end use it is a clean fuel, with no carbon monoxide or CO_2 emissions and only negligible amounts of NO_x produced during combustion. However, hydrogen is an indirect use of electricity, which may be derived from fossil fuelled power stations. On a well-to-wheel basis, therefore, using hydrogen as an automotive fuel may still result in considerable CO_2 emissions.

A number of manufacturers have produced prototype hydrogen-powered vehicles, although there are no commercial applications to date. The main technical difficulty is storage: an expensive and heavy vehicle tank would be needed to contain hydrogen in compressed gas or liquid form. An alternative, and possibly safer, form of storage would be to use a metal hydride which absorbs the hydrogen and then releases it during operation by the application of heat (eg, from the car's exhaust). Safety is a major concern, both in use and distribution, since hydrogen is flammable over a very wide range of air/fuel ratios and burns rapidly with a high temperature, colourless flame.

The prospects for hydrogen as an automotive fuel are therefore poor in the short term. It may be an option in the longer term if the technical problems are solved and environmental pressures concerning urban air quality and global warming continue.

Methanol is a clear, colourless fluid which can be produced from natural gas, crude oil, coal or biomass. Although natural gas can itself be used as an automotive fuel, convert-

ing it to methanol removes the drawbacks associated with the remoteness of reserves and difficulties of transportation. Methanol is a liquid and can therefore be easily transported by tanker and stored on board the vehicle. It is relatively easy to handle, the technology used in its manufacture is well-established, its combustion properties are fairly good and in optimised dedication vehicles it is energy efficient.

However, methanol is extremely toxic and exposure to it during distribution and refuelling could be hazardous. As it is corrosive, it cannot be used in conventional fuel systems without modification of some components. It also requires special engine lubricating oil which must be changed more frequently than that used in conventionally fuelled vehicles. It has only half the energy content of gasoline, resulting in greater fuel consumption per unit volume and a shorter vehicle range.

Methanol has been described in some circles as a 'clean' fuel, as it is free of sulphur, polycyclic aromatics, benzene and other 'environmentally unfriendly' components of petroleum-based fuels. Although emissions from dedicated methanol cars have a lower CO, HC and NO_x content than those from gasoline cars, they contain more formaldehyde which is a known carcinogen.

Methanol has been strongly promoted in the US, leading to the development of flexible fuelled vehicles (FFVs). These are designed to run on any combination of gasoline and methanol (up to a maximum of 85% methanol), thus overcoming the problems of limited methanol distribution. FFVs avoid the problem of the poor cold starting ability of pure methanol but cannot exploit the latter's power and efficiency advantages. They do not offer significant emissions benefits compared to dedicated gasoline vehicles.

Fuels from biomass can be produced by processing agricultural crops — for instance sugar cane or corn for ethanol and rapeseed, sunflowers, coconuts or soya for vegetable oils. They are therefore renewable sources of automotive fuels. However, they are unlikely to become widely used, due to competition from agriculture for the large land areas which would be required.

Ethanol has a high octane quality and is used neat or in blends with gasoline in some countries, notably Brazil, where governments offer tax subsidies as an incentive to reduce dependency on crude oil imports. However, its use in Brazil is now declining, partly because a rise in sugar price has made it more economic to export sugar rather than convert it to ethanol. Ethanol is less toxic and less corrosive than methanol but otherwise its merits and demerits both in terms of technical performance and emissions levels are similar.

Vegetable oils have been promoted as possible diesel fuel substitutes due to their good ignition quality. (Their poor octane quality makes them unsuitable as gasoline substitutes.) However their high viscosity, resulting in poor fuel atomisation, fuel injector blockage and contamination of the lubricating oil, means that they are best blended with diesel fuels in mixes of up to 50%.

Carbon monoxide, hydrocarbon and particulate emissions are all higher than those of diesel and, in addition, vegetable oils are associated with unpleasant odours and aldehyde emissions.

Vegetable oil esters are made by reacting vegetable oils with alcohols and yield two potentially useful products — vegetable oil ester and glycerol. They offer greater potential than vegetable oils since they have lower viscosities and higher cetane numbers.

Electric vehicles are not a new idea: the electric powered 'milk float' has long been a familiar sight in the UK, for example. Concerns about the environment have renewed interest in these vehicles to the extent that many major motor manufacturers have built prototypes and some have produced small series of production vehicles. Further impetus to such developments has been given by legislation. In California, for instance, where electric cars are classified as zero emission vehicles (ZEVs), legislation has been passed requiring that, from 1998 2% of vehicle sales must be ZEVs rising to 10% by the year 2003.

On a 'well to wheels' basis, electric cars can only be regarded as ZEVs if the electricity they use has been emitted during electricity production, particularly in the case of a conventional coal-fired power station.

The main drawbacks with electric vehicles lie in their use of batteries which are heavy and can take up to eight hours to recharge. New types of batteries are being developed which are lighter and give a longer range than conventional lead/acid batteries. Other proposals include aluminium/air and zinc/air batteries, in which the metal is oxidised by air in an aqueous electrolyte solution in the presence of a platinum or cobalt catalyst. They can be regarded as types of fuel cells in which the metal fuel is consumed. They would not require charging in the traditional sense but would be mechanically 'refuelled' by the addition of fresh metal and electrolyte.

Electric vehicles will find a niche market as inner city or commuting vehicles. In this context, the hybrid vehicle may be of interest. Such a vehicle has a small internal combustion engine which is used either to drive the vehicle or to charge a battery from which power is drawn to provide an alternative electric drive. The electric drive could be used in areas sensitive to emissions such as city centres.

Despite some local successes, alternative fuels have not made a significant impact on world markets, mainly because they present the motorist with too many compromises. These vary from fuel to fuel, but include lack of infrastructure such as filling stations, the cost of vehicle conversion, engine performance, vehicle range, safety concerns and compatibility with lubricants.

In response to growing concern about the environmental impact of the motor car, emissions from gasoline and diesel vehicles have been progressively reduced as a result of improvements in vehicle technology and fuel quality. Further reductions in emissions can be expected as existing proven technologies such as three-way catalysts and carbon canisters become more widely adopted. Vehicle emissions will be controlled more quickly by the application of such technologies than by the development of alternative fuels.

Alternative fuels will find a limited market where there are special needs. For example, in cities with extreme air pollution problems the market for electric vehicles may increase, since in this case, the importance of reducing ground level emissions would outweigh the disadvantages of cost and limited vehicle range. The environmental case for CNG may be strong enough for its use as a transportation fuel to increase, especially in fleet vehicles where refuelling and infrastructure concerns are less of a problem.

However, the existing infrastructure coupled with the need to fuel existing vehicles will ensure that gasoline and diesel continue to be the preferred fuels for the motorist. The trend towards reformulated fuels is likely to spread beyond the USA as the composition of gasoline and diesel is altered to meet local environmental legislation.

Research by the oil industry and motor manufacturers into fuel and automotive technology development will continue, in order to meet increasingly stringent emissions limits set by legislation. To date, the spread of legislation relating to vehicle emissions has been extremely uneven. Greater uniformity of emissions standards is desirable to avoid the development of market specific products. These result in duplicated engineering effort, the cost of which is inevitably passed on to the consumer.

Like most activities, motoring has both benefits and drawbacks. A co-operative approach between governments, motor manufacturers and the oil industry is needed to ensure that the benefits of the motor car as a fast, convenient form of transport are not outweighed by its negative impact on the environment. □

The road to lower emissions

by Johanna Fender

1992 marks the 200th anniversary of gas supply in the UK. The nature of the gas has, of course, changed, from coal gas to natural gas from the North Sea; and so too has its uses. Originally supplied for lighting, gas went on to become the favoured fuel for cooking, heating and now electricity generation. As if to demonstrate its versatility, gas now looks set to become one of the transport fuels of the future. Indeed, gas-powered vehicles are already with us, with over one million fleet vehicles worldwide running on natural gas.

EMISSIONS legislation has tended over recent years to concentrate on the power generation sector, with subjects such as a carbon or energy tax high on the European agenda. And yet the worst offender in the areas of greenhouse gases and acid rain is by far and away the transport sector.

For years electric vehicles have been believed to hold the answer to the problems of transport emissions, and what happens when the oil runs out. And yet in terms of greenhouse gas emissions, EVs do not present the best alternative. The amount of CO_2, SO_x and NO_x produced in the generation of electricity, needed for recharging batteries for electric vehicles probably outweighs the environmental advantages of electrically-powered vehicles over gasoline-fuelled transportation.

There is, however, another viable alternative, already in widespread use in North and South America, Australia and New Zealand: natural gas vehicles (NGVs), using compressed natural gas (CNG).

The concept of using gas as a fuel for transportation is not a new one. During the last World War delivery vehicles were fitted with rooftop gas bags in order to save valuable liquid fuels for higher priority uses. Since that time several countries have developed techniques of retrofit conversion, and there are currently around one million gas-fuelled vehicles throughout the world.

Consumers Gas of Canada started to develop NGVs in 1983, and now converts over 100 vehicles a month. In Toronto alone there are 4000 NGVs, with 30 public and depot-based refuelling stations to serve this fast-growing market.

UK depot-based fleets can take advantage of NGV technology now. British Gas hopes the private vehicle market will follow.

British Gas, who acquired Consumers Gas of Canada in 1989, currently invests £1 million a year in NGV research, and has three research centres working on high pressure cylinder testing, low pressure storage techniques, fuelling facilities, engine performance and emissions standards. Trials are underway in four British Gas regions in the UK, and there are plans to convert several hundred vehicles by the end of this year.

The environmental advantages that apply to gas over other fossil fuels in the field of power generation also apply in the field of transportation. Compared to gasoline-fuelled vehicles, NGVs produce 30% less CO_2, with exhaust carbon monoxide reduced by up to 70%. Natural gas is also free of lead, soot, sulphur particulates and aromatic hydrocarbons. In addition, gas-fuelled engines are smoother and quieter than petrol or diesel engines, and the slower-burning gas results in reduced wear of engine components, so there is also a cost advantage.

CNG also has safety advantages over liquid fuels. Gas being lighter than air, leakages will quickly dissipate into the atmosphere rather than causing a local hazard, as with petrol spillages. In addition the risk of fire is reduced, as the ignition temperature for gas is around 700°C, some 250°C higher than that of petrol. In order the stand up to the pressure of the CNG, gas cylinders are much stronger than a conventional fuel tank, and therefore less likely to rupture in an accident.

An obvious barrier to the take-up of NGVs by the UK public is the lack of infrastructure. Converting your car to gas is one thing, but refuelling would prove more problematic. British Gas recognise this, and so have concentrated their attention on the UK fleet market. This still leaves an enormous potential

market. There are in excess of 23 million vehicles in the UK, with a fuel consumption of around 454 GWh. 293 GWh is accounted for by private vehicles, leaving 161 GWh consumed by commercial and fleet vehicles. As such vehicles return to base daily, these would have the opportunity of refuelling without the infrastructure of nationwide filling stations.

Research is currently underway on dedicated gas-fuelled engines, but in the meantime the greatest potential is likely to be for converted engines. Both spark ignition petrol and compression ignition diesel engines can be converted to operate with CNG. Petrol engine vehicles simply require a high pressure cylinder, valves, a regulator, a gas mixer, electronic controls and fuel gauge to enable the vehicle to operate either on gas or petrol. With these vehicles the type of fuel can be simply selected from a switch on the dashboard.

Diesel engines can be converted to run on a gas/diesel mixture (dual fuel) with the proportion of gas rising to 80%, depending on the type of conversion.

The payback on vehicle conversions is most likely to be attractive for the depot-based high mileage fleets. A typical petrol engine panel van conversion cost of around £1000 could be recovered after approximately 50 000 road miles, although this depends on local site factors. While the equivalent energy value in one gallon of petrol is 45.5 chargeable kWh, the cost of compression must be added to the price of the gas, as well as the applicable duty rate and VAT.

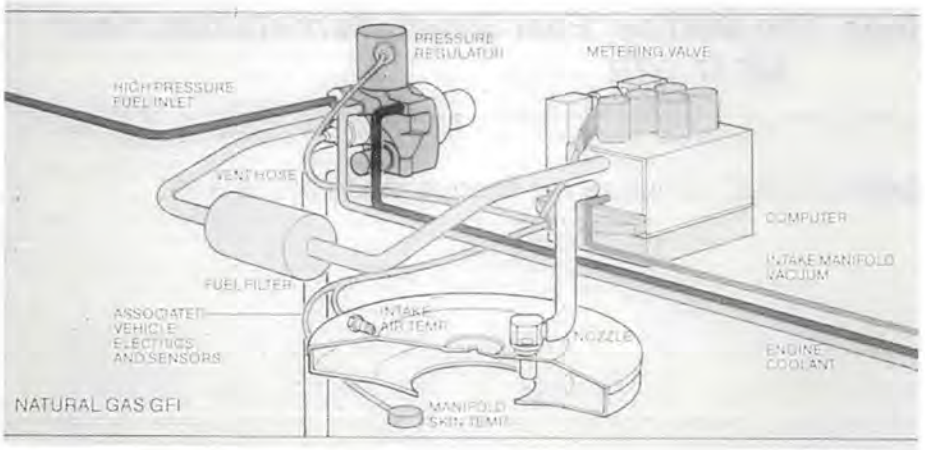
A typical CNG storage tank would have a capacity of around 50 litres, and when full would be pressurised to 200 bar. A typical car would require two 50 litre cylinders, whereas a lorry or bus would need more, or possibly larger, cylinders.

In countries where NGVs are already established, 'fast-fill' stations are in operation. These allow refuelling to be accomplished in a matter of minutes. Some of these are existing petrol stations with gas facilities added, others are gas only operations. The CNG is dispensed through a hose, and filling stops automatically when a pre-set pressure is reached. Metering facilities, incorporated in the forecourt dispenser, are similar in appearance to the familiar petrol pump. The method of refuelling results in another environmental advantage — the virtual elimination of evaporative emissions.

Refuelling: the lack of infrastructure makes use of NGVs most likely in the fleet market.

Gas is currently stored at ambient temperature at a pressure of 200 bar (CNG). Research is being conducted into cryogenic storage (liquid natural gas, LNG) at atmospheric pressure and a temperature of -161°C, a method currently used to transport gas by sea. Storage in an adsorbed form (ANG) is also a possibility for the future. Adsorbents 'condense' methane molecules giving greater storage capacity at a particular pressure. The pressure under trial at the moment is approaching 35 bar at ambient temperatures.

In a presentation made earlier this year by British Gas to the Parliamentary Alternative Energy Group, they put forward the outline for a Code of Practice, in the absence of any standards or regulations covering NGVs. Once completed the code will be issued as Institution of Gas Engineers Recommendations on Utilisation in addition to the Pressure Systems Regulations which give general guidance on high pressure and safety for storage cylinders. In addition BG have asked for Department of Transport authorisation of converted vehicles, to be renewed annually. They have also pointed out that demand for unleaded petrol greatly increased as a result of fuel tax reductions, and suggest that a similar stimulus be considered for CNG. They concluded in their report that the developing NGV industry needs government backing in the form of strong long-term endorsement of alternative fuels, to support the investment that is being channelled into it, to encourage UK manufacturers to compete with foreign imports of cylinders and conversion components. □



Natural gas GFI.

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WORLD ENERGY NEED

The following table originally appeared in *Energy World*, June 1992, and accompanied Dr George Cole's article 'Provision of the World's energy need'. Unfortunately several errors appeared in this table, so we have decided to reproduce the entire Table 4.

Table 4: Earth-based world power sources and possible practical expectations
Present world requirement is about 2 x 10^{13}W, perhaps rising to 10^{14}W

Source	Maximum output	Comments
Regenerative sources		
photovoltaics	10^{15}W	for total world land coverage: 7-10% conversion efficiency **required:** heavy duty storage system and higher conversion efficiency Land coverage difficulties Visual pollution
biomass	9 x 10^{12}W	for total world land coverage: Land coverage and harvesting provide social problems
wind power	1 x 10^{15}W	for total world land coverage: **required:** heavy duty storage system Land coverage gives technical and social problems — evident visual pollution
wave power	uncertain < 6 x 10^{12}W	useful for communities near the sea: heaviest and most expensive of engineering
hydroelectric	uncertain (<10^{12}W)	restricted in global application
tidal	<7 x 10^{12}W	restricted to tidal regions
geothermal	<3 x 10^{13}W	restricted to specific areas <present <3 x 10^{9}W (mid ocean ridges very long term)
High density sources		
nuclear	10^{15}W for 10 years	no more than 1K rise in environmental temperature problems of waste disposal and safety
fossil fuels	10^{9}W	small application for special, local uses: pollution extraction essential
(some use is unavoidable)	max allowable	

UK Coal '92

opportunities for trade

by Johanna Fender

In the midst of a storm the like of which the energy sector hasn't seen for some time, The Institute of Energy held the first of what they hope might become an annual event: the UK Coal '92 conference. Only two days after 'black Tuesday', speakers tried to make sense of what was left of the coal industry in this country, only to find the ground shifting beneath their feet as they spoke. Energy World's reporter was there to witness history as it unfolded.

From left to right: James Harrison, President-elect of the Institute of Energy; Tim Eggar MP, Energy Minister, and Michael Roberts, President of the Institute of Energy.

THE ORGANISING of any seminar has, by necessity, to be some time in advance of the event itself. In choosing a date for this seminar on the UK coal industry, the timing of the coal supply contracts to the generators was crucial.

As it turned out they were still unannounced on the day of the proceedings, but events had overtaken everything else.

Two days before *UK Coal '92 — opportunities for trade* the government announced that 31 British Coal pits would close, several by the end of that week. Only one week later, the pressure of public opinion and the prospect of a Tory Party revolt and Government defeat in the House of Commons, had forced the President of the Board of Trade to announce a moratorium on pit closures until at least the new year, whilst a Commons Select Committee looked into the whole question of the Government's energy policy.

However, on the day of the seminar, no moratorium was envisaged, and what speakers and delegates were left to discuss was a very small coal industry indeed.

Not surprisingly the mood was sombre. One delegate remarked to me that it felt like watching vultures pick over the wasted corpse of British Coal. This uneasy feeling was compounded by the choice of session chairmen. The morning's proceedings were presided over by Colin Gubbins, general manager of PowerGen's fuel purchasing department. The afternoon was chaired by Keith MacNair, National Power's director of fuel management. And following Jim Harrison's welcome address, a third 'villain of the piece', the DTI's Energy Minister, Tim Eggar, gave the opening address.

Mr Eggar spoke of the "painful and difficult" nature of the recent decisions taken by his department — a phrase to be echoed again and again by Michael Heseltine over the following days. He stated that coal demand was "bound to experience a substantial decline as a result of (the generating contracts) negotiations." He referred to the high levels of coal stocks which will have "no likely output or market". "British coal," he announced "cannot compete with imported coal" and there was "no way of avoiding that market situation." He went on to defend the Government's timing of the announcement: "we weren't doing the miners any good by delaying an inevitable decision."

Mr Eggar then turned to the subject of privatisation. No decision, he said, had yet been taken on its form, but his Government was looking at a number of key issues, such as health and safety, protecting pension interests and offering both management and employees a stake in whatever is left to privatise. Not surprisingly Mr Eggar's speech meet with lukewarm enthusiasm.

Andrew Horsler, director general of marketing at British Coal presented the 'British Coal scenario'. Although he tried to look forward to the future with optimism, it was an unconvincing performance: as he hinted in his opening remark "it has been an appaling week for British Coal".

Mr Horsler maintained that BC could offer the consumer a better deal if only they were given the chance, and that their intimate knowledge of the market gave them the competitive edge.

The highlight of the morning was the contribution from Bill Etherington MP. Formerly vice-president of the North Eastern branch of the NUM, he is now a Labour MP, and his comments seemed best to reflect the mood of the conference. In a sincere and impassioned speech he attributed the pit closures to a vendetta by the Conservative Party: revenge for 1974, when, as Lord Parkinson had so unwisely commented a couple of days earlier, the miners brought down the Conservative Government. Mr Etherington corrected him: the voters, not the miners, rejected Mr Heath's Government.

Bill Etherington MP.

Bill Etherington remarked on Crispian Hotson's (Ryan Group Ltd) closing remarks in a paper delivered prior to this one, in which he referred to the miners as "coal's greatest asset". What a change in attitude to the miners over the last eight years! In 1984 Mrs Thatcher called them "the enemy within".

A list of possible disasters followed. 80% of the country's coal reserves would be lost forever; imported coal would have an adverse effect on an already high balance of payments deficit. Ultimately, however, he saw gas as a greater threat to the UK coal industry, and pronounced the Government's energy policy to be a total failure. The warmth of the applause contrasted with the chilly reaction to the Energy Minister earlier in the day.

The seminar was understandably overshadowed by recent events, but speakers covered a range of interesting aspects of the industry, its markets and opportunities for trade when privatisation finally goes ahead, whatever its form.

Let us hope that the optimism inherent in the Institute's seminar title is confirmed, and that the Government has a profound change of heart about the relationship between its energy policy and market forces. □

Left to right: Andrew Horsler, director general of marketing, British Coal; and Albert Wheeler, deputy chairman of British Coal put on a brave face for the camera.

READERS' LETTERS

Meeting R&D needs

TWO excellent papers published by Dr Nicos Ladommatos CEng in the June edition of the Journal of The Institute of Energy have prompted me to write this letter.

Whilst output of this calibre is undertaken so successfully in the UK, surely it is in the UK's economic interest to increase research budgets at our Universities and Polytechnics. Being a futurist I strongly believe that the majority of the Government's investment in research should be long term, perhaps perceived as 'of little discernable relevance' to immediate and pressing needs. For surely no one, least of all entrepreneurs, would be prepared to invest in 'fanciful' projects. Short and medium term economic needs must be addressed, however, which in today's competitive culture means a proportion of GNP equivalent to our global rivals should be invested in the national R&D effort. The arguments to increase research budgets are overwhelming.

By necessity long-term research should be publicly funded, but I am also of the view that the best way to increase funding in other areas is to reduce and eventually eliminate the Government element.

Good research at centres of excellence attracts commercial funding from industry irrespective of whether they are in or outside the public sector. It is also true that all research is under funded, irrespective of allocation. Conversely, all provision is at the expense of another party's progress towards realisation of a research goal.

I have long suspected that academic objectivity with respect to career building takes precedence over the relevance, competition, financial, and even national interest, considerations. This is not wrong per se, but it is inaapropriate for the taxpayer to develop individual careers in this way. Particularly so when the tax payer is a private corporation which would otherwise invest the money in its own product development.

Having successfully dismantled the corporate state in respect of our supply side industry, it is now time to tackle the vested interests within ivory towers. The mechanism I propose is to cut research and development budgets to universities by 5% per year for five years, although long-term funding should remain stable, and be redistributed. The tax savings made should be targeted at corporation tax rate cuts to industry. In my experience both institutionalised and private shareholders are more sensible than their critics give them credit for, I do not subscribe to the view that any tax benefit to companies would be disbursed as dividends.

My estimate is that the UK economy would benefit by additional growth of circa 1% within five years. Research funding should grow at twice this rate as supply side pressures drive companies towards more competitive products and systems.

If such a policy is enacted and the benefits are realised, then the credit for the vision should go to Dr Ladommatos for demonstrating by focused research, woefully too rare in the UK, that the R&D needs of manufacturing industry are not addressed well by the academic's vested interest of never having to deliver the goods.

Eur Ing Colin R Coleman
Okehampton, Devon.

The second paragraph of Chris Finn's letter in the October issue of Energy World should have read as follows:

The quantity of energy required by an individual to maintain life is indeed about 150W (not per second!), but this equates to 13MJ/day and not 1.3MJ/day. Surely, coal gas has a CV of approximately 19MJ/m^3, unless Dr Cole is refering to producer gas.

Our apologies to Mr Finn for this typographical error.

Unique opportunity

PERHAPS, with a bit of luck and a following wind, we might end up with a coherent energy strategy.

No one could have foreseen the amazing reaction in Parliament and on the streets of London to the announcement that the Government and British Coal could and would close down more than half the remaining deep pits in Britain before March of next year.

Commentators have, of course, pointed out that spontaneous response may have been a result of pent up popular concern not only for the miners and their jobs but also of dismay at the deep malaise in the whole British economy.

Be that as it may, we now have an opportunity to devise a long-term strategy for energy in Britain that recognises that our fossil fuel resources are truly finite, that if we are to hold a place in an increasingly energy-hungry world we must husband those resources, and that we must never again allow blinkered short-termism to jeopardise the birthright of future generations.

Board of Trade President, Michael Heseltine has outlined a broad scheme for his examination of the events leading up to the decision to close the 31 doomed pits and the market circumstances that dictated it. He is willing, he says, to hear representations on every aspect of energy production, use and marketing and has invited submissions from any interested party. Similarly, the Select Committee on Trade and Industry, which includes many stalwarts from the now-defunct Energy Select Committee, also seems to have wide-ranging terms of reference which appear to include almost everything relevant and excludes very little.

Not since the days when Nigel Lawson, as Secretary of State for Energy, declared anathema on all energy planning and said that the market would take care of supply and demand, has there been an opportunity for bringing together the accumulated skills and experience of the energy managers and devise a strategy that will point the way to a balanced development of limited resources.

We have seen in the past two years that the perfect free market, endlessly correcting the imbalances of supply and demand through its natural mechanisms of checks and balances is a romantic myth. Like the Holy Grail it is endlessly sought but never found. Nothing could be less like a perfect market than the Byzantine structure of the electricity supply industry — a structure which has created a field day for the perennial opportunists who, whenever they see a market, look for ways of bucking it.

If a perfect free market had existed in the privatised electricity industry the coal industry would not have reached the perilous plight it is in today. Great areas of the market place could not have been ring-fenced for the protection of the nuclear generators, for French electricity via a cross Channel link. Nor could another large part of the market have been closed off by 15-year contracts for gas when similar contracts were denied to coal.

Britain's energy markets are chaotic. Divergent interests are pulling against each other, and the system of regulators set up after each industry was privatised does little more than tinker around the edges, unable because of limited terms of reference to take a view of what is in the long-term interests of the nation as a whole.

That is why the unique opportunity presented to us by the astonishing events of the second week in October must be grasped by the energy specialists themselves. It may be a once and for all opportunity to sort out some sensible long-term strategy that looks beyond narrow sectional interest towards an energy economy that avoids the wastefulness of cut-throat competition of the kind that could destroy the coal industry and sterilise massive energy reserves vital to Britain and Europe in the next century.

As I said, we might end up with a coherent energy strategy, but only if we grasp the opportunity before it slips from our hands.

Peter Heap *(Former Senior Press Officer with British Coal)*
London.

Renewables — economically viable?

HAVING been indoctrinated by such notions as pay-back times and economic viability in my employment before retiring, I am irritated by articles which expound on the possibilities of various renewable energy systems in which economic viability is either taken for granted or not considered. What is the effect I wonder of such articles? Do they strengthen the belief of the opponents of atomic energy that renewable energy systems will eventually supply all our electricity requirements? Do they allow the Government to drag its feet in producing a realistic long-term policy?

The Government is at present shutting down coal mines seemingly regardless of all else other than whether or not a mine has an expected long-term profitability, sufficient to attract private buyers. Whilst pursuing this policy it is condoning the conversion of power stations from coal firing to North Sea gas. It is also financing various renewable energy projects, none of which in my opinion could produce energy cheaper than that produced by the mines being shut down.

One of the more promising of the renewable energy systems is the wind turbine. But how promising is it in fact? I have tried below to give some idea of what would be involved to install a wind turbine system which could make a significant contribution to our electricity requirements.

The power in a stream of air is given directly in watts by the equation:

$$W = 1/2\ PAV^3$$

Where W is the power in watts
P is the air density in kg/m^3 ($1.1\ kg/m^3$)
A is the cross sectional area of the wind stream m^2
V is the wind velocity m/second

A wind turbine must exhaust air which is in motion, and which must still have kinetic energy. The maximum theoretical efficiency has been calculated by others to be about 59%. In practice a combined efficiency for a turbine and generator of 30% would be considered good. The generally accepted useful range of wind speeds is between 6 mph and 26 mph. At 6 mph the turbine would continue to run if started by a motor. At about 26 mph the turbine must be automatically reefed or feathered to prevent it blowing over or speeding itself to destruction.

To produce 2 000 000 kW, the capacity of only one fossil fuel power station, would require 8029 turbines at a wind speed of 26 mph.

There would be disadvantages and additional hidden costs associated with a large renewable energy system where maximum and minimum output does not coincide with maximum and minimum demand. When the system produces its maximum output at a time of minimum demand, this in effect increases the difference between maximum and minimum demands imposed on the plant controlling overall output, and hence reduces the overall efficiency, and increases the running cost per kWh of that plant.

From the ex-works price of a 6kW agricultural wind turbine, the installed cost of a 249 kW turbine, including administrative costs, delivery, civil works, erection, commissioning, switch gear and controls, allowing for economies of scale, would I guess be over £1 million.

It therefore seems unlikely that wind turbines, one of the more promising of the proposed renewable energy systems, could ever make more than a token contribution to our electricity supply.

It would be beneficial if those with access to available data could give a clear indication of which, if any, of the renewables could make a significant contribution, and be competitive with fossil fuels or nuclear energy. The Government might then be induced to draw up a realistic long-term energy policy, and ensure that appropriate action is taken before it is too late.

Gwilym Daniels *(Member)*
Sevenoaks, Kent.

Thorough guide

'Penetrant testing: a practical guide' by D J Lovejoy
Published by Chapman and Hall, London, 1991, 221 pp, £22.50.

'PENETRANT testing' is one of eight principal methods of non-destructive examination for surface faults in metallic materials, which commenced in about 1880. Many variations in procedure and chemicals used are explained, including recent more sophisticated methods which are suitable for very small to very large components. These may be used during manufacture and during their lifetime service.

The procedures are explained in a thorough manner, being accompanied by over 50 figures together with tables, also by questions and answers for each chapter, except the first. Ecological, economic, health and safety aspects are all addressed. The cost of the book is minute in comparison with the consequential losses of a material failure.

Nigel Gwyther

A challenging style

'Limiting greenhouse effects — controlling carbon dioxide emissions' Environmental Sciences Research Report ES10. Report of the Dahlem Workshop held in Berlin in December 1990. Edited by G I Pearman
Published by John Wiley, Chichester, 1992, 631 pp.

DAHLEM conferences are held on various topics to promote international exchanges on science and research. Since 1990 it has been incorporated in the Free University of Berlin. It is supported financially by the Berlin Senate as well as private foundations and industry.

The conferences involve participants from many countries and disciplines and, apart from the presentation of papers there are workshop sessions. Both the papers and the reports of discussion leaders have been edited for publication — which presumably explains the delay in publishing.

The participants were predominantly from Germany and the USA, bodies like the World Bank, World Wildlife Fund, Center for Global Change, Max Planck-Institut, Electric Power Research Institute and Environmental Protection Agency were represented.

The papers therefore have authority and cover all areas that contribute to the understanding of the problems and policies. The scene is set with papers on the climatic and atmospheric compositional background information, where the conclusion that the "greenhouse effect is real is indisputable" and that "changes in atmospheric concentration result in large changes in surface temperature and planetary climate". But there are large differences in the scale of the effects between the prediction models.

The factors to be considered in containing greenhouse gas emissions are complex. A Russian paper gives a wealth of background data on this subject. A Swedish paper claims that economic growth can be maintained in the developed states while improving the economy of developing countries and actively pursuing a policy of reducing greenhouse gas emissions. However, politically such a scenario requires a degree of international cooperation and political maturity which is currently not apparent.

The scope for large scale adoption of renewable sources is reviewed, and the present position is regarded as unsatisfactory, particularly in the scale of demonstration technologies. The list of challenges is stimulating and includes such oddities as the fact that in Germany, where there is a state subsidy for coal "wind power subsidises coal" and there is no overall policy on tree planting to ensure sustainable forest growth.

On fossil-fuel use there is an interesting short section on removal recovery and disposal of carbon dioxide. Absorption by amines or sea water (not always close to fossil fuel-fired power stations) is considered reasonably established technology, capable of absorbing 90% of the carbon dioxide at an output penalty of 35% or so. The plant cost would be considerable — two to three times that for a coal-fired station with flue gas desulphurisation. The process on a coal gasification plant is easier and less costly in output and cost. Disposal of CO_2 solvent in deep ocean locations seems to be a problem when most plant is a long way from the sea. The alternative of using the carbon dioxide to enhance oil recovery from low capacity wells also implies a change in power station location.

This book is therefore useful at many levels. It is a source of data and state of the art information. It also indicates what developments are in hand and what needs to be done. It deals not only with the technical points (in most cases probably too sketchy for most engineers) but also the political, commercial and organisational aspects. The chapter on 'Least cost climate stabilisation' reaches a number of important conclusions which seem to contradict directly the political stand taken by the USA at the Rio conference. Emission stabilising and reducing policies can save money overall and provide as good or superior services and comfort as at present. The picture presented by the authors from the Rocky Mountain Institute is one of optimism — mainly, that if the facts are put clearly and the true costs made public, most of what needs to be done can be accomplished without the need for new laws and regulations. This is a theme which if it can be confirmed, could be the right approach to an important international problem. If reducing emissions can be accomplished by using market forces, customer preference and company self-interest, leading to a rational use of energy, this is clearly the best way.

This optimistic view is the longest in the book and is written in a challenging style. If the authors' claims can be substantiated, could an aggressive public campaign for emissions reduction provide a means for pulling out of the present worldwide recession? It is only fair to say that the Rocky Mountain assessment did not seem to win support from the other Dahlem conference contributors.

It remains to note that there is a copious list of references with each chapter and that time has overtaken some of the material, as Eastern Europe and the USSR were still centrally planned economies.

N G Worley

Well illustrated

'Energy-efficient electric motors: selection and application' by J C Andreas, Marcel Dekker, New York, 2nd edition, 1992, 288 pp, $80.00.

THE book is part of a series of reference and textbooks on electrical engineering and electronics. Instead of being interested in the primary cost, since 1975 there has been a trend towards selection of electric motors on a life cycle cost with attention being given also to efficiency and power factor. This books refers to American National Electric Manufacturing Association standards and 60Hz standard frequency when it deals with various single and three-phase AC motors up to 180 kW.

It contains chapters on: induction motor characteristics, energy-efficient motors, power costs, power factor, applications, adjustable-speed drive systems, and the economics. The book is well illustrated and contains many useful graphs and tables.

Nigel Gwyther

Recently published

'Dictionary of Environmental Science and Technology'
Revised edition, by Andrew Porteous. Published by Wiley, 1992, 420 pp, £9.95.

'Fluid Power Systems, Modelling and Control'
4th International fluid power workshop, by C R Burrows & K A Edge. Published by Research Studies Press, UK, 1992, 400 pp, £85.00.

Key role on risk for engineers

A FORTHCOMING code of professional practice on risk issues intends to make engineers and technicians key figures in ensuring a greater awareness of risk and safety issues throughout business organisations and the general public.

The code, prepared by an Engineering Council working party, represents the engineering profession's response to a series of disasters, such as Hillsborough and the sinking of Herald of Free Enterprise.

The code sets out a ten-point plan to ensure engineers conduct themselves to the highest standards of professional competence and responsibility.

Working party chairman, Sir William Francis, outlined the provisions of the code in a speech to the International Risk Assessment conference in London in October. He said that engineers themselves are seldom the cause of disasters, but their ability to design, develop, construct and maintain products and projects means they sometimes have to risk the consequences of their engineering being misused or misapplied by others.

Outright technical failure is rarely the sole cause of any disaster. The working party's review showed that disasters are usually the result of the cumulative effect of a number of shortcomings. In particular the working party noted the lack of a structured and disciplined approach to risk management resulting in failures in supervision and management, in communication, in control of maintenance and in commitment to safety within organisations.

After presenting an embryo code last year, the working party received over 2600 comments from industry, institutions and individuals. They also visited a number of leading companies in the UK to study practical examples of good practice.

A point greatly stressed by the working party was the importance of good communications. Every effort must be made to develop a culture within which key information on risk issues can be reported at all levels within an organisation. Sir William Francis commended the Civil Aviation Authority's Mandatory Occurrence Reports Scheme, which enables individuals to report on 'near misses' without fear of disciplinary action.

The primary purpose of the code is to increase awareness among the 290 000 engineers and technicians registered with the Council about risk identification, assessment and management. This in turn demands a systematic approach towards risk assessment and management in education, training and continuing professional development of existing and potential engineers and technicians. A recent straw poll of engineers revealed that only about 10% had been introduced to risk issues in their education and training. The working party has therefore used the appendices to the code to make a number of suggestions as to how education on risk issues can be furthered at school, in higher education and as part of continuing professional development.

The Code of Professional Practice will come into effect on 1 March 1993, backed up by Engineering Council bye-laws, codes and rules of conduct. This means that in extreme circumstances any registered engineer or technician could be deregistered if they are found to be flagrantly disregarding the code.

Survey shows pay increase for UK engineers

BOTH the pay in real terms and the job satisfaction of the UK's qualified engineers and technicians have increased over the past three years, according to an Engineering Council survey published in October.

In addition, around 75% of engineers and technicians have received further technical or business training during the last year. A similar proportion recognise that the EC is now a factor in their professional lives. And an increasing number of engineers would recommend the profession as a career to young people, particularly women.

The 1992 Survey of Chartered Engineers, Incorporated Engineers and Engineering Technicians is based on a sample of nearly 26 000 of the 182 300 engineers and technicians under the age of 65, with a UK address on the Council's register.

The survey found that average earnings of chartered engineers have increased by 28.6% since 1989. This figure is 2.4% more than growth over the same period of the Average Earnings Index, and 7.2% more than the rise in the Retail Prices Index. This makes the average earnings for a chartered engineer £31 768, as against £24 705 in 1989. At the upper end of the scale 8% earn in excess of £50 000 per annum.

Incorporated engineers and engineering technicians have done slightly better, with their average earnings rising by 31.7% over the last three years, from £17 825 to £23 483.

In general the degree of career satisfaction reported by both chartered and incorporated engineers continues to recover from a dip in the mid to late 1980s. Both categories of engineer report increased or sustained job satisfaction.

The figures also indicate that residual perceptions of engineering as more suitable for men than women are disappearing fast, partly because more firms in the engineering sector offer women a career break option.

The unemployment rate among engineers on the day of the survey was 2% of chartered engineers and 2.4% of incorporated engineers.

The 1992 Survey of Chartered Engineers, Incorporated Engineers and Engineering Technicians, including 86 analytical tables is available from The Engineering Council, 10 Maltravers Street, London WC2R 3ER, price £130 (inc postage and packing).

JET visit for students

SOME of the UK's brightest engineering students came face to face last month with the largest research project in the European nuclear fusion development programme — the Joint European Torus, or JET.

This European engineering experience was organised by Lloyd's Register as one of the main prizes in the recent Young Engineer awards.

Three winners from France Hill School in Surrey spent two days at the JET site in Culham, Oxfordshire and nuclear plant manufacturers Framatome at Chalon sur Saone, France.

Ruth Putt (15), Alexander Ramsay (15) and Gary Sector (16) received a cheque for £1000 and the Lloyd's Register trophy.

Peter Gee of Lloyd's Register says, "This tour is intended to introduce students to an experience they could not possibly have during the normal course of club activities. By looking at joint European projects and major engineering establishments we are emphasising that engineering skills are essential to the wealth of all world nations. Given those skills, these students can make a vital contribution wherever they are and whichever industry they may join."

Lloyd's Register is the founding sponsor of Young Engineers, which was established in 1983 by the Standing Conference on Schools' Science and Technology (SCSST).Other sponsors are Biwater Ltd, BT and BAA.

The scheme aims to encourage young people to realise that engineering is a practical, exciting challenge which offers personal achievement and satisfaction as a pastime as well as a long-term career. Part of its mission is to forge permanent links between industry and education and to stimulate change in the National Curriculum for the benefit of students and their future employers.

The 'experience' began with a tour of JET, where students were told how it is attempting to establish the scientific feasibility of nuclear fusion as a source of limitless energy. After lunch the group flew to Paris, where they stayed overnight, and travelled by high speed TGV next day to Chalon sur Saone in central France to view Framatome's vast nuclear power plant production site. A tour of Paris rounded off the visit.

November 1992

Successful contract negotiations in the UK gas market
Conference, 25 November, London.
Details from Christine Rickards, IBC Legal Studies and Services Ltd, 57-61 Gilmoora House, London W1N 7TD. Tel: 071 637 4383; fax: 071 631 3214.

Energy for the 21st Century: a perspective on nuclear fusion
Esso Energy Award Lecture, 26 November, London.
Details from The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG. Tel: 071 839 5561 (ext 247).

Meeting or managing demands on the countryside
Conference, 27 November, Cardiff.
Details from Mrs Dee Gilmore, Co-ordinator, Short Course Unit, Department of City & Regional Planning, University of Wales College of Cardiff, PO Box 906 Cardiff CF1 3YN. Tel: 0222 874956.

2nd annual conference UK & European gas price, supply & demand
30 November — 1 December, London.
Details from IBC Financial Focus Ltd, IBC House, Canada Road, Byfleet, Surrey KT14 7JL. Tel: 071 637 4383; fax: 071 323 4298.

5th Australian coal science conference
30 November — 2 December, Melbourne, Australia.
Details from Dr D J Allardice, Coal Corporation of Victoria, 128 Exhibition Street, Melbourne 3000, Australia. Tel: (03) 654 6366; fax: (03) 650 2305.

December 1992

Standards of competence in practice: developments in the petroleum & other industries
Conference, 1 December, London.
Details from Caroline Little, Conference Officer, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Tel: 071 636 1004; fax: 071 255 1472.

Engineering Industry in the European Community
CPD meeting, 1 December, St Albans, UK.
Details from Peter Tye, Assistant Secretary, Institution of Plant Engineers, 77 Great Peter Street, London SW1P 2EZ. Tel: 071 233 2855.

Perspective for energy engineers — students & practising engineers in dialogue in Europe '93
Conference, 1-2 December, Frankfurt, Main, Germany.
Details from VDI-Gesellechaft Energietechnik, PO Box 10 11 39, W—4000 Dusseldorf 1, Germany. Tel: *49 211 6214-414; fax: *49 211 6214-575.

Combustion in engines: technology, applications & the environment
International conference, 1-3 December, London.
Details from Corinne Paine/Julie Brown, IMechE, Conference Dept (C448), 1 Birdcage Walk, London SW1H 9JJ. Tel: 071 973 1318/1316; fax: 071 222 9881.

Regulation & competition in electricity supply
Conference, 2-3 December, London.
Details from IIR Industrial Ltd, 28th Floor, 103 New Oxford Street, London WC1A 1DD. Tel: 071 412 0141; fax: 071 412 0145.

The changing world of the energy manager
IoE meeting, 3 December, University of Aston, Birmingham.
Details from Mr Evans (Hon Sec), New Wood Lodge, 2A Hyperion Road, Stourton, Stourbridge, West Midlands DY7 6SB. Tel: 0384 374329.

Wage war on wear
Regional workshop, 3 December, Bristol. Details from Marion Blower or Maria Clarke, tel: 071 973 1250.

Current problems of microbial spoilage of bulk distillate fuels
Workshop, 3 December, London.
Details from Miss Caroline Little, Conference Officer, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Tel: 071 636 1004; fax: 071 255 1472.

Nuclear power — legacy and lessons
Energy Policy Forum, 3-4 December, London.
Details from Caroline Sumner, Conference Manager, The Energy Policy Forum, Meetings Management, Straight Mile House, Tilford Road, Rushmoor, Farnham, Surrey GU10 2EP. Tel: 0251 255414; fax: 0251 252101.

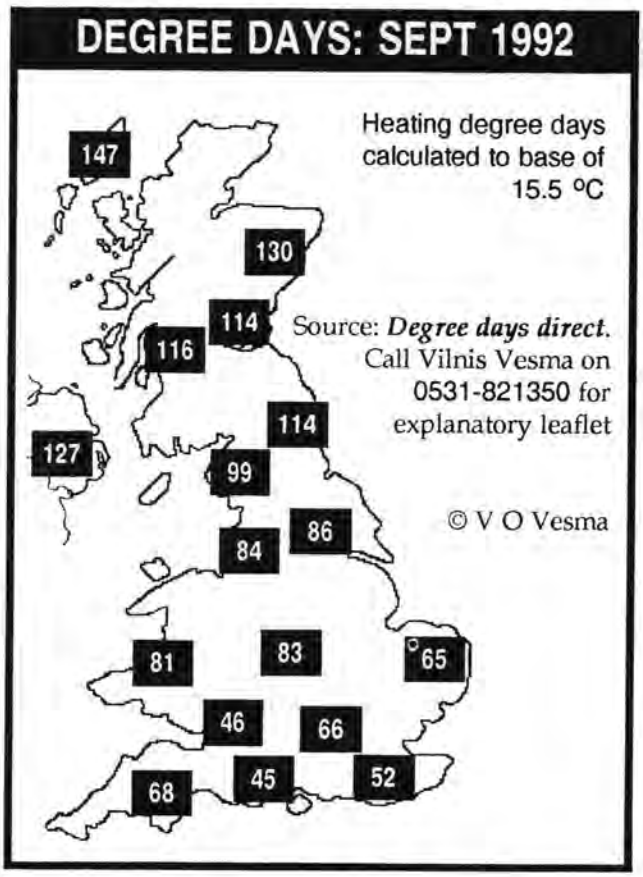
Safety and reliability assessment
Conference, 3-4 December, London.
Details from Liz Hide, IBC Technical Services Ltd. Tel: 071 637 4383; fax: 071 631 3214.

Flammable and toxic gas detection
Tutorial, 7 December, Manchester. Details from Sira Communications Ltd, South Hill, Chislehurst, Kent BR7 5EH. Tel: 081 467 2636 (ext. 373); fax: 081 467 7258.

Thermo-economic optimisation of power and process plant
Seminar, 7 December, London.
Details from IMechE, 1 Birdcage Walk, London SW1H 9JJ. Tel: 071 222 7899; fax: 071 222 4557.

World energy demand: is growth inevitable?
Conference, 7-8 December, London.
Details from The Conference Dept., Chatham House, 10 St James's Square, London SW1Y 4LE. Tel: 071 957 5700; fax: 071 957 5710.

Effects of dispersed inerts on gaseous explosions
Discussion meeting, 8 December, University of Oxford.
Details from Dr Harry Phillips, 27 Errwood Avenue, Buxton, Derbyshire SK17 9BD.



INSTITUTE OF ENERGY CONFERENCES

The following programme is currently being organised by The Institute of Energy. **For further details please contact the Conference Department, Tel: 071-580 0008 or Fax: 071-580 4420**

1993/94 PROPOSED PROGRAMME

Fuels For Power Generation	London	20 April
Control of Industrial Air Pollution	London	25 May
Energy & the Greenhouse Effect	London	24 June
International Symposium on **Combustion & Emissions Control**	Cardiff	September
Making Energy Privatisation Work — The future of regulation	London	November
2nd International Conference on **Ceramics in Energy Applications**	London	Spring 1994

EXHIBITION SPACE IS AVAILABLE AT ALL OF THE ABOVE EVENTS

Conferences co-sponsored by The Institute of Energy

1993

17 March — **Waste Management Duty of Care**
Contact: David Suthers, Combustion Engineering Association
Tel: 0685 8799119/874201

Mid March — **The Use of Oxygen in Combustion**
Contact: David Suthers, Combustion Engineering Association
Tel: 0685 879119/874201

22/23 March — **3rd International Confeence on Desulphurisation**
Contact: IChemE on 0788 578214