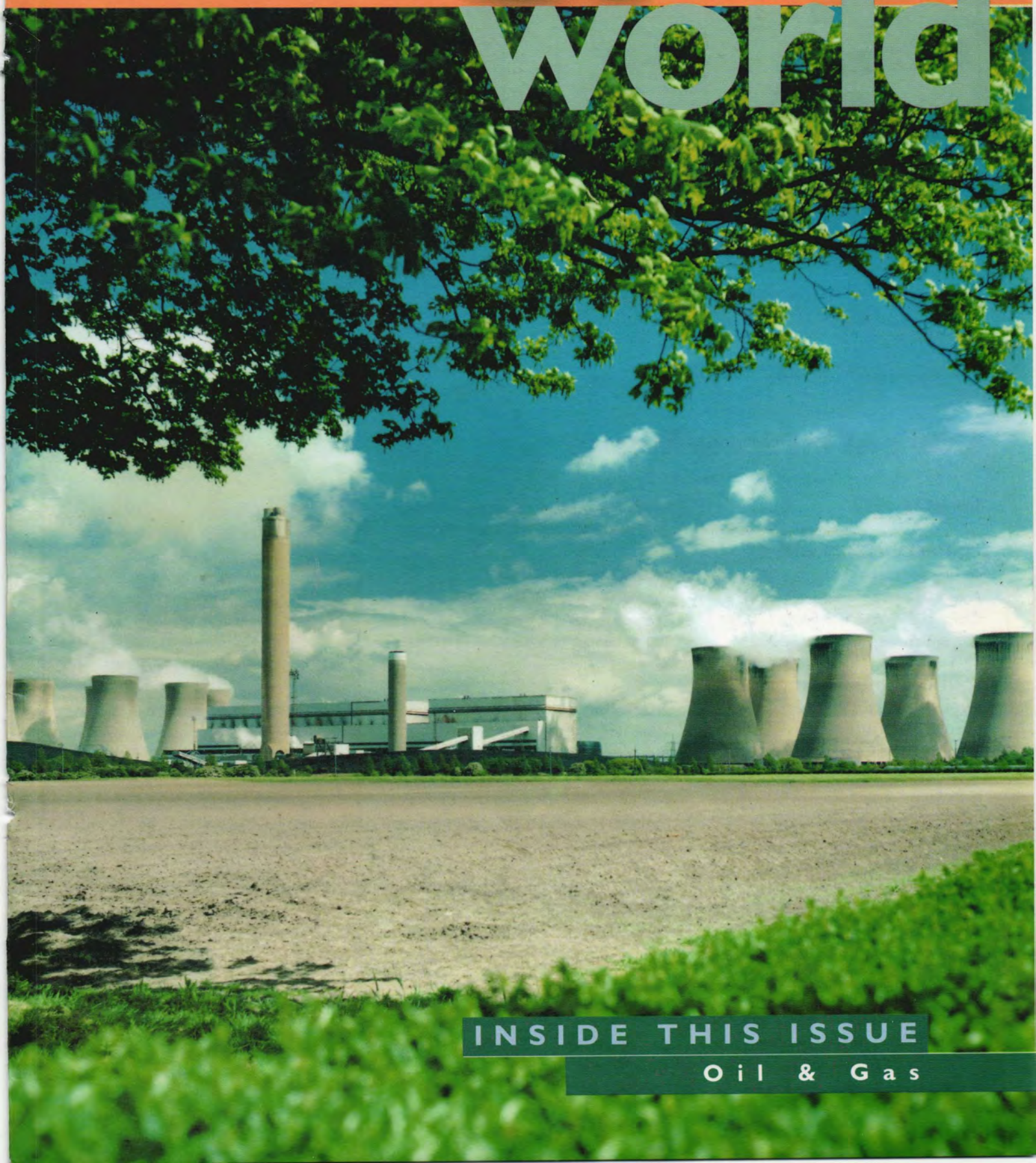
THE MAGAZINE OF THE INSTITUTE OF ENERGY

# energy world

the institute of energy

No.247 March 1997



## INSIDE THIS ISSUE

Oil & Gas

## DEGREE DAYS: JANUARY 1997

Source: **Degree days direct**


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

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

Readers can get more information on the use of degree days from Vilnis Vesma, 8-10 Church St, Newent, Glos GL18 1PP (01531 821350)

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

http://vesma.com/ email: ddd@vesma.com

# Annual Lunch

## Please note

The ticket price for the Annual Luncheon, on the 29 April 1997 is actually **£18.00 + VAT = £21.15** rather than £21.50 as printed on the insert enclosed.

Therefore please make sure you make your cheques out for the correct amount. The Institute would like to apologise for any inconvenience this may have caused, but ask you to note that the tickets are even cheaper than you originally thought so why not ask a guest. There is really no excuse not to join us.

***We look forward to seeing you.***

# Diary of Institute Events

## MARCH 1997

***NORTHERN IRELAND BRANCH***
Tuesday, 18 March
Annual Dinner at the Culloden Hotel. Contact Dr P Waterfield, tel: (01232) 364 090, email: p.waterfield@ulst.ac.uk

***SOUTH WALES AND WEST OF ENGLAND BRANCH***
Friday, 21 March, 10.30 am
24th Idris Jones Memorial Lecture, "The Energy Market, the story so far and the road ahead", by Dr Brian Count, Operations Technology Director, National Power at Cardiff Castle. Apply in writing to Mr D Suthers, 2 Danybryn Close, Radyr, Cardiff, CF4 8DJ

***INSTITUTE OF MEASUREMENT & CONTROL***
Tuesday, 25 - Thursday, 27 March
"1st International Symposium. Multi-Body Dynamics" which will highlight the many techniques employed in dealing with the complex dynamics problems encountered in various industries. To be held at the University of Bradford, in association with The Institute of Energy, member rates are available. Contact Ms Clare O'Brien, tel: (0171) 387 4949

***NORTH WEST BRANCH***
Wednesday, 26 March at 6.00 pm
"Nuclear Issues", AEA, Thompson House, Risley. Contact Mr E Curd, tel: (0151) 625 6744

***NORTHERN IRELAND BRANCH***
Wednesday, 26 March, 12.30pm
Presentation from Bord na Mona, a joint event with IEI. at Kirk McClure Morton, Boucher Road, Belfast. Contact Dr P Waterfield, tel: (01232) 364 090, email: p.waterfield@ulst.ac.uk

***LONDON AND HOME COUNTIES BRANCH***
Thursday, 27 March, 6.00pm
Branch AGM, 5.30pm followed by a talk "Combined Heat and Power for the New Millennium" David Green, Director, Combined Heat and Power Association - Royal Institution. Contact Mr PM Johnson, tel: (01793) 893330, email: phillip.johnson@natpower.com

## The 1997 Ellis Memorial Lecture

**"Requirements for Success in the Competitive Energy Sector"**

*to be presented by*

**Mr E A Wallis**
Chairman, PowerGen plc
on Wednesday 23rd April 1997
at
The Birmingham Botanical Gardens
Westbourne Road, Edgbaston, Birmingham, B15 3TD

Coffee Reception at 10.45am
Lecture at 11.15 am
Luncheon at 1.00pm

Tickets - £12.50 to include luncheon and wine

Applications for tickets should be made to:
Mr J E Ingham
Chairman, Midland Branch
The Institute of Energy
c/o Cory Coal Ltd
Blackhorse Rd, Longford, Coventry, CV6 6ND
Tel: 01203 361531
Fax: 01203 317390

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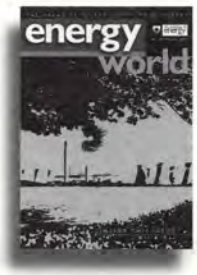
# Contents

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## COVER

Nestling in the greenery - National Power's 4,000 MW Drax coal-fired power station is fitted with both low NOx burners and the largest flue gas desulphurisation unit in the world, making it a good example of clean coal technologies in action. An article from ETSU on page 16 of this issue of *Energy World* takes a comprehensive look at the UK's clean coal programme and asks: Is there a future for coal R&D?

# Renewables - what support post-NFFO?

*David Porter, chief executive, Association of Electricity Producers*

**The Government wants** to see 1,500 MW of electricity coming from new renewable energy schemes by the end of the century. That aim would have been considered somewhat eccentric as recently as ten years ago when the Association of Independent Electricity Producers was formed. Nearly all electricity production and supply was in the hands of the state monopoly which was far from enthusiastic about private producers, whether industrial power generators or alternative energy freaks.

Today, in the Association of Electricity Producers, as it is now called, the vital coal, oil and gas-fired power interests, sit alongside other privately-owned companies that make electricity from sources as varied as municipal waste, landfill gas, wind, water, scrap tyres and chicken litter. The companies using fossil fuels produce the cheapest electricity, of course, but the fact that renewable energy is in the market at all and that some of it is beginning to approach competitiveness is a tribute to the companies that have persisted with it for so long. Some are now able to consider selling their expertise in a growing world market for renewable energy. The mechanism that has enabled the renewables industry to develop is the Government's Non-Fossil Fuel Obligation (NFFO) for England and Wales and similar arrangements in Scotland and Northern Ireland.

The fourth round of NFFO was announced in February, revealing contracts at an average price of 3.46p per kilowatt hour. The very lowest prices were even more surprising. The cheapest was 2.66p per kilowatt hour. This is close to the Electricity Pool's half-hourly market price.

Despite all this, the renewable energy industry cannot sit back and bask in the glory of its success. Some prices may have fallen but most renewable energy is still more expensive than other forms of generation. The most successful technologies can nearly stand on their own feet, but others have contracts at twice the Pool price and the least well-developed ones, which might well prove to be promising in the longer term, may be too expensive to feature in NFFO at all. This suggests that if the Government wants to continue to support renewable energy, the mechanisms which provide that support may have to become more flexible than the present NFFO arrangements.

## Finding answers

The industry is finding some of the answers itself. The renewable energy businesses which provide the very cheapest electricity are not far away from the market price. With a share of the commercial benefits that derive from local generation and supply, compared with electricity bought over the transmission system, they would be closer still. Gradually, they are winning some of those benefits.

Other renewable energy businesses can offer power to suppliers such as The Renewable Energy Company of Stroud, which sells to customers that specify that their electricity should come from renewables. At the moment, only customers with a demand of 100 kilowatts or more have the right to choose their electricity supplier, but in 1998, when the supply market is fully liberalised, domestic and small business customers will be able to exercise that choice, and choose renewable energy, if they wish.

The two options above could help existing renewable energy schemes and in particular those that have NFFO 1 and 2 contracts expiring at the end of 1998. At the moment, however, they offer little hope to new projects, most of which need the comfort of long-term contracts in order to secure finance. In a changing electricity market, where prices continue to fall, such contracts are not readily available.

## Developing NFFO for the future

This means that the Non-Fossil Fuel Obligation is still very important to the development of the renewable energy industry. In the medium term, the Obligation may need to be re-shaped, not least because the bidding process is a bureaucrat's dream and a businessman's nightmare. My Association is discussing the possibility of a simple 'open' band where any renewable energy technology that can achieve a near market price could bid for a contract.

In the longer run, the very nature of the Obligation may have to change. It might be simplified by the Government requiring suppliers to secure a percentage of their electricity from renewable energy sources. The Labour Party's energy spokesman has spoken kindly of renewables and is said to prefer a clean energy obligation, which would enable advanced coal-burning coal technology to benefit as well as the non-fossil alternatives. At present, the renewable energy industry can look forward to only one more Order under the Non-Fossil Fuel Obligation - in 1998. One way or another, it needs to know what kind of support will be available in the longer term. Having fought its way to the edge of competitiveness, that is the least that it deserves.

# BP's $1 billion gas supply deal with Ruhrgas

**BP has signed** a 15 year agreement to supply 15 billion cubic metres (bcm) of gas valued in excess of $1 billion to Ruhrgas of Germany commencing in October next year. The gas, to be supplied from BP's North Sea portfolio of fields, will be delivered to the Continent via the Interconnector pipeline currently under construction from Bacton in Norfolk to Zeebrugge in Belgium. Onward transmission to the German border will be undertaken by Distrigaz in Belgium.

Rodney Chase, chief executive of BP Exploration, said, "This is a landmark gas supply deal for BP as it represents our first sale into continental Europe from the UK and our first use of the capacity we own in the Interconnector pipeline. It underscores the substantial and growing importance of BP's exploration and production portfolio in gas.

BP also announced that since the restructuring of its gas marketing activities in the UK in August last year, its share of the commercial and industrial gas market has more than doubled to reach 15% and its combined sales of gas to industry, commerce, the power sector and the spot market now place it second to British Gas in gas marketed in the UK.

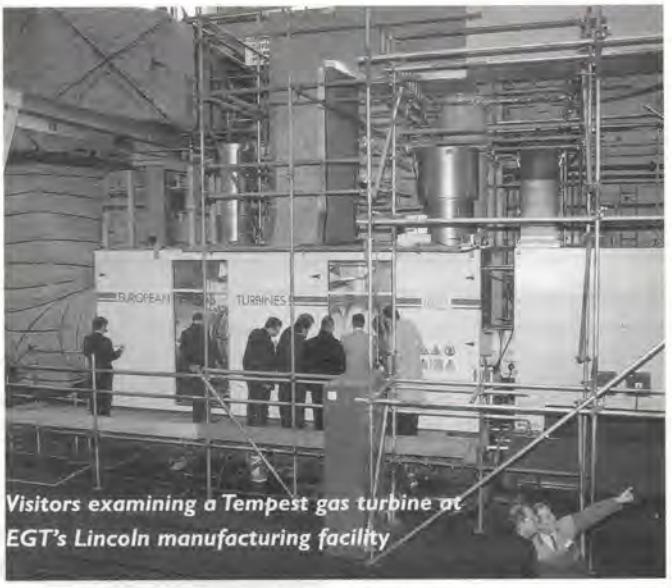
*See page 8 for a feature on the UK-Continent Gas Interconnector.*

# EGT wins orders for three Tempest gas turbines

**GEC ALSTHOM's** European Gas Turbines (EGT) subsidiary has won orders worth over £13 million to supply its latest industrial gas turbine, the 7.5 MW Tempest, for cogeneration plants on Belgium, Turkey and Japan.

EGT will supply two Tempest gas turbine generating sets and generators, for a paper and cardboard manufacturing plant located at Oudegem, Belgium. The gas turbines will be equipped with a dry low emissions combustion system to minimise both NOx and CO emissions.

The company is also to supply three Tempest turbines and generating sets to provide electrical power to a textile factory in Turkey. Steam will be used in the factory process and surplus electrical power will be sold to the Turkish National Electricity Company. Also in Turkey, EGT will supply two Tempest turbines to one of the world's largest manufacturers of ceramic tiles located in Kalebodur. The gas turbines will run in parallel with the Turkish National Grid with exhaust steam to be used in the factory process.



*Visitors examining a Tempest gas turbine at EGT's Lincoln manufacturing facility*

In Japan a Tempest will generate electrical power for what will be the country's third super waste incineration plant. Agai, surplus electrical power generated will be sold to the grid company. The above contracts bring total sales of the Tempest gas turbine to eight.

# ABB consortium wins order for power plant in Argentina

**A consortium** including ABB, the international electrical engineering company has won an order to build a 775 MW combined-cycle power plant in Argentina. The $235 million order, of which the ABB share is about half, was placed by Central Dock Sud SA, an independent power producer. The power plant, to be located in Buenos Aires, will be one of the largest and most efficient combined-cycle plants in Argentina.

The order was won with ABB's latest generation of high performance GT26 advanced gas turbines in an intensely competitive market. Construction of the plant is scheduled to begin in April with electricity from the first turbosets to be available within 24 months. The total plant will be completed in 26 months.

ABB will supply two type GT26 sequential combustion gas turbines, one steam turbine, the electricity generators and the overall power plant control system. When fully operational the plant will achieve an overall efficiency of nearly 58%, much higher than conventional power plants. This will provide a crucial advantage in Argentina's deregulated power market to ensure competitively priced electricity and maximum power out put over the lifetime of the plant.

# AEA Technology takes UK expertise to Australia and China

**AEA Technology plc** has been awarded a contract to study the use of bioremediation - which speeds up the natural recovery of beaches - to treat oil spills in tropical waters in Australia. The contract demonstrates the international recognition of AEA Technology as an expert in treating oil spillages as well as illustrating the company's increasing penetration into the world-wide environmental consultancy and technology market.

The work, which will be carried out on the coastline adjacent to Australia's Great Barrier Reef, could help to protect the area, one of the world's natural wonders from oil pollution. The project will be carried out in conjunction with the Australian Institute for Marine Science.

There is significant interest in the possibility of using bioremediation to treat polluted waters and coastline after oil spills. Unlike other cleaning procedures which rely on the use of chemical or physical methods to remove oil, bioremediation enhances a natural process and is therefore environmentally sound and cost-effective.

Although studies on the suitability of bioremediation for cleaning up oil spills have been undertaken in the past, most of the work has been carried out under temperate climate conditions such as those in North America and Europe. The aim of the study is to determine whether bioremediation techniques developed by AEA Technology have a role to play in helping to aid the recovery of tropical shorelines after an oil spill.

Bacteria which are capable of breaking down oil into less harmful products occur naturally on most beaches. Bioremediation is a technique where the rate of this breakdown is increased by the addition of naturally occurring nutrients which allow the bacteria to function more effectively. The breakdown of the oil allows beaches to recover more quickly and could significantly reduce environmental damage caused by an oil spill.

China is set to benefit from Britain's extensive expertise in radiological protection following the signing of a memorandum of understanding between AEA Technology and the National Environmental Protection Agency of China.

The agreement puts AEA Technology in a good position to exploit future nuclear opportunities in China. China's first nuclear power plant at Quinshan came on line in 1992 and the country is developing its nuclear programme to cater for increasing energy demands. Twelve new nuclear plants are scheduled to be built over the next ten years, with a further twenty currently in the planning stage.

# CODEL equipment for Chinese power station

**CODEL International** has received an order from boiler plant manufacturer Mitsui Babcock Energy for the supply of emissions monitoring equipment to be installed in the stacks of the new 700 MW coal fired power station currently under construction at Dandong, Liaoning province, China. The order closely follows those for monitoring equipment on power stations at Fushun, also in mainland China, and at Black Point in Hong Kong.

The equipment installed at Dandong will form part of an integrated on-line monitoring system capable of continuously measuring the concentrations of $SO_2$, $NO_x$ and CO. In addition to pollutant gas analysers, instruments for measuring oxygen, opacity, pressure, flow and temperature in the stacks will also be installed.

Readings taken from each of the instruments will be relayed, via a serial data link, to a central control room where it will be analysed and displayed in real-time on computer hardware also supplied by CODEL and running the company's well proven integrated emissions monitoring software package.

The order also includes ambient dust and temperature monitors and wind velocity and direction measuring equipment.

*One of CODEL's multi-gas stack emission monitors*

# NFFO-4 extended to 843 MW

**Enough electricity** to power more than a million homes - generated from landfill gas, wastes, wind, hydro, farm wastes and energy crops - could enter the market following the Fourth Non Fossil Fuel Order laid in Parliament last month by Junior Energy Minister Richard Page.

Lower than expected prices bid for supplying electricity from renewable fuel sources have boosted the size of the Order, to make it the largest yet. It obliges the regional electricity companies to place contracts which could result in some 843 MW of new renewable generating capacity being developed.

The RECs are now expected to sign contracts for 195 projects at an average price of 3.46p/kWh, a price which betters the previous round's average by almost one penny and shows that convergence with market prices is now within reach, according to the DTI.

The Order supports the development of urban CHP projects by including ten sizeable waste-fired CHP plants - see Table - although waste-fired fluidised bed plants and landfill gas projects both have lower bid prices. It also includes 48 new wind farms (with a declared net capacity of greater than 0.77 MW) as well as 17 smaller wind developments. A few small projects to exploit anaerobic digestion of wastes and gasification or pyrolysis of biomass are also included, despite fears that the higher bid prices of these less mature technologies could rule them out altogether.

Mr Page said: "Responses by bidders to the tender invitation was very impressive. The industry has achieved an average price for these projects of 3.46 p/kWh, almost one penny better than the 4.35 p/kWh achieved in NFFO-3."

Over 428 MW of capacity is already operational under the first three Orders.

Mr page added: "Our aim is to work towards 1500 MW of new renewables-based generation capacity by 2000. This objective requires steady convergence under successive orders between the price paid under the NFFO and the market price, which is being achieved through effective competition in the allocation of NFFO contracts.

"The Government took this into account in determining the size of the bands. In particular it took into account the cost and quality of proposals received, and the assessment of the implications for the policy objective of helping the different renewables technologies to enter the commercial electricity generating market.

"By having separate bands we have ensured that the technologies involved have the opportunity of contributing to the capacity required under the order, to the extent that is appropriate to each particular technology.

"Policy will be reviewed prior to the fifth Order, NFFO-5, in 1998 and will take into account progress under NFFO-3 and this largest Order, NFFO-4. Over the next few years I expect increasing numbers of renewable energy projects to be developed and be able to generate in the liberalised electricity market without needing support under the NFFO arrangements."

### SUMMARY OF NFF0-4

| Technology | Contracted capacity MW DNC | Number of projects | Capacity-weighted average price p/kWh |
|---|---|---|---|
| Landfill gas | 174 | 70 | 3.0 |
| Waste-fired CHP | 115 | 10 | 3.2 |
| Waste-fired fluidised bed combustion | 126 | 6 | 2.7 |
| Small-scale hydro | 13 | 31 | 4.2 |
| Large wind energy | 330 | 48 | 3.5 |
| Small wind energy | 10 | 17 | 4.6 |
| Anaerobic digestion of agricultural wastes | 7 | 6 | 5.2 |
| Biomass gasification or pyrolysis | 67 | 7 | 5.5 |
| Total | 843 | 195 | 3.46 |

### WIND UP 35%

The installed capacity of UK wind energy increased by 35% during 1996, according to the British Wind Energy Association. Britain currently has 34 wind farms in operation, five of which swung into action during the year, including Europe's largest wind farm at Carno, mid-Wales. A further ten are either being built or awaiting construction, which will add a further 74 MW or 28% of installed capacity. Wind energy now provides sufficient installed capacity to power a city the size of Bristol, says the Association.

### "TOO MUCH WIND"

The Council for the Protection of Rural England have strongly criticised the amount of support offered to wind power projects by NFFO-4. Citing pressure from its own regional groups, the CPRE says that the NFFO-4 announcement "flies in the face of strong public concern about their impact on our most beautiful landscapes" and suggests that the Government should be "supporting a range of less damaging renewable energy technologies".

***See Viewpoint on page 2 for further comment on NFFO-4.***

# Safety reviews give AGRs another ten years

**The Health** and Safety Executive's Nuclear Installations Inspectorate has completed its assessment of the Periodic Safety Reviews (PSRs) of the Advanced Gas-cooled Reactor (AGR) nuclear power plants at Hinkley Point B in Somerset and Hunterston B in Ayrshire. As a result of its assessment, the NII is satisfied that it is safe to continue operation of these reactors beyond the age of 20 years, subject to continued satisfactory results from routine monitoring and inspection.

Nuclear Licensees are required periodically to carry our major safety reviews of their plants as a condition of their site licences and to satisfy NII that the safety of each station remains adequate for continued operation. These are the first major safety reviews of any of the AGRs and the PSRs of the Hinkley Point B and Hunterston B plants were carried out respectively by Nuclear Electric Limited and Scottish Electric Limited. It is now generally accepted international practice that PSRs are carried out every ten years on nuclear power plants. NII's current decision to allow operation up to 30 years is based on its assessment of the reviews together with the successful operating and maintenance history achieved to date at those sites.

There are two well recognised potential life limiting features of the AGR, namely the graphite core ageing and materials properties of the reactor internal components. These features have been scrutinised particularly closely and the conclusion has been reached that there are no safety factors which will necessarily limit the life of the stations to less than thirty years. However, it is acknowledged that it is difficult to make long term predictions in areas such as these and a programme of regular formal reviews will continue to take place throughout future operation.

***Scientists from electricity generator, Magnox Electric, have made a world breakthrough in laser technology by developing a new remote inspection technique that is set to revolutionise material and liquid analysis within any hazardous environment. Based on research carried out at Swansea University, the system was initially developed by Magnox Electric for remote metal sampling in nuclear reactors, but it already has the potential for commercial use beyond the electricity generating industry - both at home and abroad. With the scope to sample non-metals and liquids, the technology could be used for inspections in chemical and radioactive waste tanks as well as to sample liquid effluent, including sewerage and industrial discharges. Known as LIBS - laser induced breakdown spectroscopy - the technique was developed for the nuclear industry by Magnox Electric to identify and measure trace metals in steel reactor components.***

# Government ups its energy efficiency target

**Government departments** will face tougher targets to improve their energy efficiency performance to the year 2000. Building on an average of nearly 15% energy savings over the past five years, Departments will have to work towards an overall 20% improvement over the 1990/91 base year.

The new target was announced as the energy efficiency returns for the Government estate for 1995/96 were announced to Parliament.

According to Environment Minister, Robert Jones: "The Government's energy efficiency record has improved by just over 14.5%; very close to the 15% target we set five years ago. This is an important achievement and reflects much effort and commitment by the staff concerned."

But Mr Jones warned of reading too much into the achievements of individual departments: "Comparisons between Departments need to be treated with care since their estates and activities vary considerably. There have been greater pressures on electricity use, resulting in particular from the greater use of IT equipment: some very large increases in electricity usage are due to moving a dominant HQ building from naturally ventilated premises to air-conditioned ones."

"Green Ministers have now agreed a further energy saving target of 20% by the year 2000, on the 1990/91 base year, and my Rt. Hon friend the Prime Minister has given his personal support. I remain determined the Government should set an example and contribute to the reductions we need in meeting our climate change commitments."

# Energy policy needed to cut $CO_2$ - Sustainable Development Panel

**The Government** should develop a strategic energy policy to include energy efficiency, and press for tougher targets for $CO_2$ reduction programmes beyond the year 2000, according to the Government Panel on Sustainable Development.

The Panel, established in 1994 to provide independent advice to the Government on Sustainable Development, says that international progress on containing greenhouse gases has been slow and that about half of the major industrial countries will fail to reduce emissions to 1990 levels by the year 2000.

In its third report, The Panel: "welcomes Government efforts to push forward international consensus and action on climate change, and supports, as a minimum, the proposal by the Environment Secretary that all industrial countries should aim to reduce greenhouse gas emissions to a figure between 5% and 10% below 1990 levels by the year 2010. Much greater reductions will be required later. The Panel also believes that the Government should continue to press other countries to meet their obligations for the year 2000 and recommends that the Government should strive to secure agreement, within the European Union and with the United States, on exacting new world targets beyond the year 2000 in time for the Third Conference of the Parties to the Climate Change Convention in Japan in December."

The Panel complains that development of renewables in the UK has been piecemeal and has lagged behind initiatives elsewhere: "The relative short termism of competitive markets means that market forces will not lead to the development of renewable resources on the necessary scale."

The Panel disagrees fundamentally with the Government's hands-off approach to energy policy: "fossil fuel prices do not take into account of damage to the environment, climate change and environmental costs generally; nor will the removal of subsidies or the introduction of more competition into energy markets ensure that environmental objectives are met."

The Panel: "considers that to reduce or even to contain emissions of greenhouse gases beyond 2000, the Government will need to develop a strategic policy which promotes energy efficiency and conservation in all sectors of society; incorporates costs relating to climatic factors into energy prices; and provides continuing support for non-fossil fuel sources of energy.

# UK renewable manufacturer wins US recognition

**The US** Department of Energy has awarded a Certificate of Recognition to Thermomax Limited for its renewable energy products.

Thermomax is an innovator in the development and production of solar technology. Its evacuated solar collector operates effectively in all types of climates and can provide some 60% of annual hot water requirements even in the UK, according to the company.

The Award follows a number of commendations from British local authorities including Canterbury City Council and London Borough of Havering.

Canterbury has already used Thermomax's products for a number of projects, including sheltered accommodation, a caravan site shower block, homeless persons hostels and some council owned domestic properties. And, following the first year of the operation of a system at one of its elderly persons' homes, the London Borough of Havering's Energy Management Officer has recommended that the Council should consider Thermomax panels for any appropriate new-build or refurbishment projects.

***Roof-mounted solar collectors can supply up to 60% of hot water heating needs***

# DoE contracts to cut its own $CO_2$ emissions

**AHS Emstar** has signed a unique contract energy management (CEM) agreement with the Department of the Environment for the management of the energy requirements at Eland House and Ashdown House, the DoE's new headquarter premises in Victoria, London. But the eight year CEM agreement stipulates minimising carbon dioxide emissions, rather than the usual energy consumption criteria requested in such partnerships.

AHS Emstar will manage the engineering services installed, which include a 480 kW CHP unit, in such a way as to minimise carbon dioxide emissions, the method of specifying energy use which emerged from the climate change concerns raised at the Rio Summit. Performance will therefore by judged on how efficiently the energy requirements of the buildings are managed.

The target set by the DoE in the design brief is for carbon dioxide emissions not to exceed 70 kg per $m^2$ of floor area per year. Extensive sub-metering across both buildings will measure energy consumption and figures from these meters will be compared to the targets on a monthly and annual basis.

# The UK-Continent

*by Roger Cornish, managing director, Interconnector (UK) Ltd*

***We all now know that the proposed UK-Continent Gas Interconnector is underway - a photograph of construction work at the Belgian end of project was featured on the cover of last month's issue of Energy World. The new pipeline will link the UK and continental gas networks for the first time, and first gas is due to flow next autumn. Here, the project's managing director Roger Cornish gives an overview.***

**For years now,** the impact of the UK-Continent Gas Interconnector has been frozen - tantalisingly - in its anticipation. Would it actually happen, let alone would it be used? Things are different now on both counts. Since last November, when construction work began, people have been able to see that it definitely is happening. And with 20% of shipping capacity already sold for use at start-up, it is clear that people will use it.

There is an unquenchable thirst for information on just how the gas industry will react to the pressures it is currently facing. It looks likely that that the market in continental Europe will develop on differing lines from that of the UK, and certainly the drive in some nations - backed by the efforts of the European Union - will produce far reaching changes to the marketing and the flow of gas throughout the continent. With energy prices some 30% higher than in the USA there is a pressing need to increase competition if the overall competitiveness of the European Union is to be sustained.

Of course, the Interconnector is one example of these changes. It has been termed "a piece of debottling of the European gas grid". Economically and physically, that is a faultless definition. In practical terms though, the Interconnector is a piece of hardware on which a lot of people depend, and which needs to be - and will be -delivered, functional, within budget and on time.

As an engineering project, it breaks no new ground in terms of pure technology. But as a simple means of transportation - like a bridge or a highway - its impact is arguably more significant that any infrastructure project seen for many years.

We are still some way from the start-up date of 1 October 1998, and many challenges lie ahead. But now is a good time to review the achievements to date, and to chart the steps between now and when we can see the flow of gas link the UK to continental Europe physically as well as economically.

## How the Interconnector came about

The idea of an Interconnector is not a new one. James Allcock, our Chairman, can recall the concept being discussed within British Gas as far back as 1979. Studies continued sporadically throughout the eighties, spurred on in part by that same political drive that gave rise to the Channel Tunnel. However, it was not until the acceptance of the concept that gas oversupply in the UK was leading to a potential stagnation of exploration and development activities in the North Sea, that the idea of an interconnector link to Europe started to gain real momentum among those organisations whose financial performance was being limited by both the size and structure of the UK market.

In the meantime, continental Europe had moved towards a greater reliance and acceptance of imports from both Norway and Russia, but with a realisation that a diverse supply, including both the UK and Algeria, would offer tangible advantage both in terms of security of supply and competitive leverage. The stage was set.

Interestingly, the spur to action was supplied by Government, in the form of the then Energy Minister, Tim Eggar. It was clear from the start that there was to be no public finance, and a study group of seven companies was set up to develop the project further. It was an open, well-publicised, procedure, and the study led to a brochure which was finally sent to 100 companies. Detailed discussions were held with 19, of whom nine went on to become the shareholders of Interconnector (UK) Limited.

Initially the equity was to be held in proportion to the shipping capacity, thus ensuring that the risk takers were also the equity holders. This will change in the future, as both shareholdings and capacity can be assigned separately, providing that the company can be satisfied that the incoming shipper or shareholder is in a financial position to accept its responsibilities.

The importance of the initial link of shareholding to capacity was due in part to the fact that the nine were taking an unusual level of risk for our business, on what could be described as a speculative venture without the customary sales contracts in place to support the investment in advance.

Although the Norwegians left the project, our nine companies of producers, marketers, shippers and users bring a diversity of cultural, financial and business backgrounds. The project benefits daily from the wide range of expertise and skills of Russia, France, Germany, the UK, Belgium and the USA.

Interconnector (UK) Ltd came into being in 1994. Since then its responsibilities have much more than the physical construction of the pipeline. We have had to secure the relevant permits for example, as well as arrange the financing and operating agreements. Equally important has been the establishment of the contracting alliances, which bind us together with the construction companies working onshore and offshore in a risk and reward

# Gas Interconnector: a visible reality

arrangement which helps an alignment of purpose and a sense of mutual ownership.

When it came to financing, each shareholder needed to examine the case from its own perspective, based on its size, financial situation and percentage share. We considered using shareholder equity and debt based on cash flows, but opted instead for a leasing arrangement, whereby IUK pays rentals to a leasing company which owns the asset, thus maximising the economic benefit for what is after all a major capital intensive project. In order to lower the cost of the lease the funding has been separated from the lease. This means that the pipe is leased to Interconnector (UK) Ltd by Abbey National. However, leasing companies do not like credit risk, and so the lease will be fully collateralised, and this in turn reduces its cost.

Funding of this security deposit is separate, and comes from a small amount of equity, shareholder loans and a European Investment Bank loan supported by shareholder guarantees. The tariff income will pay for the lease over a period of 20 years, and the security deposit is reduced as the lease payments are made.

## What this means for shippers

There is a clear and important distinction between the roles of Interconnector (UK) Ltd and that of our shippers. IUK is a transporter of gas and not a trader. When our shippers opted for their varying levels of capacity in the pipe, they committed themselves to paying an annual tariff from start-up regardless of the quantity of gas shipped. They can either use their capacity to ship the gas which they have sold or they can sublet their capacity without constraint. The price for subletting is a matter between the two parties involved and, since there could be more than one shipper with spare capacity at any one time, a competitive price for capacity should emerge. In this instance, a shipper retains all his contractual responsibilities to Interconnector and therefore carries the risk of the sub-lessee.

Alternatively, a shipper might want to assign his capacity on a permanent basis. If so, he would need the approval of Interconnector, which would then make its decision primarily on the financial strength of the incoming party.

Finally, the shipper has a third option. He can ask Interconnector to market remnant capacity he has been unable to sell, along with other shippers' remnant capacity. This "pooling" arrangement is the only time that Interconnector could become a seller of capacity - though to date we have received no such request from any shipper and have made no provision for this eventuality.

So far, we have seen three contracts agreed to sell gas through the Interconnector. The first consortium member off the mark was Conoco which, in February 1996, announced that it would be exporting 1 bcm of gas to Wingas GmbH of Germany annually over two years. In July, British Gas doubled this, by contracting to supply the same company with 2 bcm annually. This was followed a few weeks ago by the news of BP's agreement with Ruhrgas to supply 15 bcm of gas over fifteen years.

These deals are as good for Interconnector (UK) as they are for the shippers themselves. They underpin what I see as a growing confidence among UK and continental companies, who clearly understand the vast potential in utilising a mechanism which ensures security and stability of gas supply in the European market.

My objective, that of IUK and the shareholders I serve, is to provide a tool to assist the establishment of equilibrium in a larger market. It is for others to speculate on likely transacted volumes, prices and flow directions. However, for the line to have this competitive impact, it is critical that the operational agreements now being negotiated provide for our shippers a framework within which they can trade and compete in the market more easily.

Simply by existing, the Interconnector will enlarge that market by at least a factor of three, as viewed from the UK side of the Channel. At the end of 1998, when we are fully operational, the UK will effectively have become a regional gas market within Europe, and therefore better placed to take part in the wider opportunities the Interconnector will have made possible.

| *Interconnector participants* | As shippers bcm/year | As shareholders percentage stake |
|---|---|---|
| Amerada Hess | 1 | 5 |
| BP | 2 | 10 |
| British Gas | 8 | 40 |
| Conoco | 2 | 10 |
| Distrigaz | 1 | 5 |
| Elf | 2 | 10 |
| Gazprom | 2 | 10 |
| National Power | 1 | 5 |
| Ruhrgas | 1 | 5 |

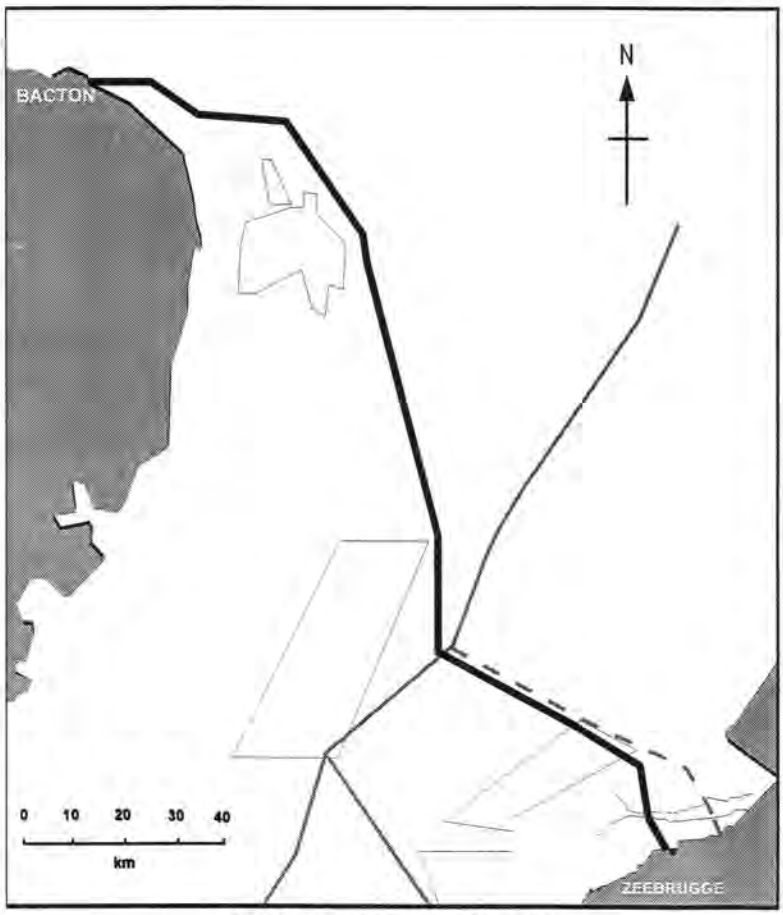
## THE INTERCONNECTOR - TECHNICAL DETAILS

The Interconnector - as a project - is a £450 million enterprise which embraces the design, construction and commissioning of a compression facility at Bacton in Norfolk, a reception terminal at Zeebrugge in Belgium and the subsea pipeline which runs between them. It is scheduled for completion and hydrotesting in spring/summer 1998, with the first gas due to flow on 1 October. When operational, it will have the facility to transport gas to the continent at a rate of 20 bcm annually and an initial capability for reverse flow back to the UK at a rate of 8.5 bcm.

The selection of Bacton was driven by the existing and planned capacity to bring gas ashore there and the inward and outward trunk lines feeding into the UK National Transmission system. The advantage of Zeebrugge is that it already hosts an LNG terminal for Zeepipe, and provides an easy link into the continental grid.

The Interconnector pipeline comprises 130,000 tonnes of linepipe steel, 40 inches in diameter, running under the North Sea for approximately 230 km. The offshore pipeline leaves the Bacton coast from a landfall approximately 1 km from the compression facility site. From there the route runs into the North Sea to the south of the existing pipelines and passes to the east of the gravel-winning area off Great Yarmouth and a restricted zone further south. It then turns south-east into Belgian waters, avoiding a dredging area and crosses the Scheur shipping channel to the landfall west of Zeebrugge. From here the onshore pipeline runs under a freshwater lake within a nature reserve and through the polder to the reception terminal in a light industrial development zone.

The steel for the pipeline, provided by British Steel and Nippon Steel, is coated internally with an epoxy lining, largely to enhance the flow. The external surface of the offshore pipeline is protected from corrosion by means of a 6 mm thick coating of asphalt enamel. A concrete weight coating between 65 and 105 mm thick will also provide negative buoyancy to stabilise the pipeline on the seabed.




***The Interconnector- The route***

As a safeguard against coating breakdown, the pipe is also provided with cathodic protection in the form of anodes, which give a design life of 50 years. The anodes take the form of aluminium bracelets which are clamped around the pipe at 40-50m intervals.

Both the Bacton and Zeebrugge facilities have been designed as an integrated unit, which means working closely with TransCo in the UK and Distrigaz in Belgium. Gas received at Bacton from the UK National Transmission System or direct from independent suppliers will be compressed to a maximum pressure of 140 bar by four gas turbines.

The Bacton compression facilities will be located on a separate 5 hectare site within the existing TransCo terminal and will include:

- a compressor house, containing four 29 MW gas turbines powering four centrifugal compressors
- four aftercoolers incorporating electrically driven fans and heat exchanger pipes to cool the gas following compression
- scrubbers to prevent solids or liquids entering the compressors
- a gas supply connection point from the existing British Gas NTS feeder within the terminal
- A 25 m vent stack to depressurise sections of the terminal pipework and equipment for maintenance or in emergency
- utility requirements, including 11 kV electrical supplies with standby generator and battery backup, communications including pipeline integrity monitoring system, fuel gas system, fire water and sewerage
- a pig receiver/launcher for cleaning and on-line inspection of the pipeline during operation
- a facility for operational control from the main British Gas control room

At Zeebrugge, the terminal will accommodate:

- seven parallel heating trains to maintain the gas temperature above 1°C
- three flow and pressure regulators
- isolation valves - in case of Interconnector or Distrigaz grid depressurisation
- metering, which will be undertaken by Distrigaz itself.

# Oil Shock: a rejoinder

*by Peter R. Odell, Professor Emeritus of International Energy Studies, Erasmus University, Rotterdam*

**Professor Odell is keen to refute the central message contained in an article by Mr C J Campbell in the June 1996 issue of Energy World - that oil production rates must peak around the turn of the century.**

**Colin Campbell's** apocalyptic view of the future of oil (*Energy World*, June 1996) is derived from documentation which is not in the public domain. The study, of which he was the joint author, The World's Oil Supply, 1930-2050 (Petroconsultants, Geneva 1995), is available only against a subscription of $32,000: and even then, only on condition that it is for the "exclusive use" of the purchaser. The price and the condition of sale mean that it can neither be bought by interested members of the public, nor borrowed by them from a library. Thus, the contents and conclusions of the study cannot be subjected to normal peer review.

## The resource base

The oil resource base as defined by Campbell contrasts sharply with the publicly known facts and with the results of other presentations. Indeed, his assessment of a total ultimately recoverable availability of conventional oil of 1750 x $10^9$ barrels is even some 70 x $10^9$ barrels less than the sum of all oil produced to 1995, viz 760 x $10^9$ barrels plus the end-1995 declaration of remaining proven reserves of 1060x$10^9$ barrels: with the latter defined by BP[1] as "the quantities which geological and engineering information indicates with reasonable certainty can be recovered in the future from known reserves under existing economic and operating conditions."

Note that this definition specifically excludes not only the additional oil which will eventually become producible from currently known reserves as a result of improved technology and from more favourable economic conditions (viz higher prices and reduced costs of exploitation), but also oil which will be found in fields yet to be discovered from continuing high levels of exploration. Put at its crudest, Campbell's assessment implies an immediate end to investment in geological exploration and to any further development of production technology; and, of course, an expectation that the price of oil will never rise above 1995 levels!

The United States Geological Survey (USGS) has a long record of ultimately recoverable reserves' evaluation. Its work in this respect has a reputation for conservative estimation, particularly in respect of the oil resources of the world's developing countries from most of which US oil companies were, until recently, excluded from oil exploration and exploitation. Yet the USGS' most recent work[2] indicates an original endowment of recoverable conventional oil of around 2,330x$10^9$ barrels - some 25% more than Campbell's assessment.

Similarly, a recent simulation of global oil resources[3] which incorporates different resource estimation techniques (viz both the Hubbert life cycle and the USGS geologic analogy methods) - and so involves the input of geological data, technology developments and economic (including price) components - indicates a recovery of 2000x$10^9$ barrels of oil by 2025 and of 2700x$10^9$ barrels by 2100. This is not only 50% more than Campbell's assessment, but also comes within spitting distance of our early 1980's evaluation[4] that "there are at least 3000x$10^9$ barrels of ultimately recoverable conventional oil, including oil from improved recovery rates based on known technologies and economic at existing levels of costs and prices." This is now also the mid-point of Shell's estimates[5] of ultimately recoverable reserves.

Campbell offers no explanation for his seriously low assessment of ultimate reserves in his *Energy World* article - other than denying the impact of improving technology and even of the higher oil prices he predicates on recovery rates. Elsewhere[6] however, he does make specific a number of important omissions from his assessment, viz enhanced recovery, oil from hostile environments and from subsize fields and petroleum liquids from natural gas production. Yet all of these omissions from his assessment of ultimate conventional oil reserves constitute part of the historic, the contemporary and the future processes whereby the industry supplies oil to markets: as a result not only of technical and economic developments, but also of changing political circumstances.

## Reserves additions

Twenty-five years ago oil was priced at less than $2 per barrel; the international oil companies were excluded from the exploitation of oil from more than half the globe, viz the USSR, China, India and Brazil - four of the world's five largest countries - plus dozens of smaller countries in Africa, Latin America and Asia; and the oil industry was then one with only rudimentary abilities to explore for and develop offshore oil. It was also technically unable to achieve better than modest (about 30%) rates of recovery from most of the fields which it found. At that time, therefore, it is hardly surprising that M. King Hubbert had predicted the near future peak of US oil production and a rapid decline thereafter; and that others extrapolated his justifiable concern for a very inefficient upstream oil industry, working in an adverse legal framework, to the international level.

Since then, however, the parameters within which the oil industry operates have changed fundamentally. Legal, political and economic conditions more favourable to oil exploitation outside the lowest production cost countries have enabled the technological evolution of the industry to be applied to the exploitation of oil in many new locations. Over the same period, however, the traditional oil producers and exporters (linked in OPEC since 1960) have generally nationalised the foreign private companies' operations and, in the context of a reduced demand for OPEC members' oil since 1979 and of the use of

the national state oil companies' profits elsewhere in the economies of the countries concerned, have largely given up the search for new oil fields.

Under such a combination of changed circumstances for the oil industry internationally, it is hardly surprising that the process of the evolution of reserves has changed from being one in which new discoveries (mainly in the Middle East) constituted the main element, to one in which additions to reserves from previously discovered fields have become much more important, both relatively and absolutely. In essence, this has occurred because the new economic and political conditions made a more extensive and intensive process of recovery interesting, while new technology made it possible.

As a result, the industry has been eminently successful in its achievement of reserves' appreciation: this is shown in the post-1970 addition of some $300 \times 10^9$ barrels of reserves to the proven remaining reserves of $620 \times 10^9$ barrels as declared at the end of 19707. And by the data which shows that the $655 \times 10^9$ barrels of proven oil declared in 1980 have now become $995 \times 10^9$ barrels. Campbell's omission of the phenomenon of reserves appreciation over long periods of time is a serious error in his presentation. It is, indeed, worth noting that a comparison of the data he uses (in Figure 2 of his article) with the earlier data from 1970, shows that there has even been $40 \times 10^9$ barrels of appreciation since 1970 in the reserves in the set of fields which had been discovered by 1950; and, an appreciation of $160 \times 10^9$ barrels in the reserves of the set of fields discovered by 1960.

## Reserves appreciation

As already shown in the proceeding section it is clear that this is a phenomenon of central importance to any evaluation of the evolution of oil reserves. Equally clearly, the data also shows that the process continues over decades. This is the case because it is a combined function of technical and economic factors. On the one hand, the process of producing oil from a set of fields steadily enhances the knowledge of the potential to be exploited while on the other hand, revenues arising from the ongoing production process generate the investment funds which enable the re-development and/or the rehabilitation of the reservoirs to be undertaken. Thus, in general, the older the discoveries, the greater the appreciation. As shown above, this continues even to enhance the volume of oil recoverable from fields discovered as long ago as 1950.

Campbell chooses to ignore the

***Table 1 Proven reserves, reserves/production ration, oil production and net growth/decline in reserves over the 23 year period from 1973***

| Proven reserves at the beginning of year (R/P ratio in brackets - in years) | Production of oil in year (barrels $\times 10^9$) | Gross additions to reserves in year (barrels $\times 10^9$) | Net growth (+) or decline (-) in reserves in year (barrels $\times 10^9$) |
|---|---|---|---|
| 1973 577 (29.9) | 21.2 | 35 | +14 |
| 1974 591 (27.9) | 21.2 | 32 | +11 |
| 1975 602 (28.4) | 20.2 | 31 | +11 |
| 1976 613 (30.3) | 21.9 | 4 | -18 |
| 1977 595 (27.2) | 22.6 | 16 | -7 |
| 1978 588 (26.0) | 22.9 | 45 | +22 |
| 1979 610 (26.6) | 23.7 | 22 | -2 |
| 1980 608 (25.7) | 22.8 | 34 | +11 |
| 1981 619 (27.1) | 21.3 | 67 | +46 |
| 1982 665 (31.2) | 21.1 | 30 | +10 |
| 1983 675 (33.6) | 21.0 | 21 | +1 |
| 1984 676 (33.8) | 21.1 | 44 | +23 |
| 1985 699 (33.1) | 20.5 | 30 | +9 |
| 1986 708 (34.5) | 21.4 | 67 | +45 |
| 1987 753 (35.2) | 21.9 | 129 | +107 |
| 1988 860 (39.3) | 22.8 | 83 | +60 |
| 1989 920 (40.3) | 23.5 | 87 | +63 |
| 1990 983 (41.8) | 23.8 | 26 | +2 |
| 1991 985 (41.4) | 23.7 | 65 | +41 |
| 1992 1026 (43.3) | 23.9 | 46 | +22 |
| 1993 1048 (43.9) | 23.7 | 27 | +3 |
| 1994 1051 (43.8) | 24.3 | 26 | +2 |
| 1995 1053 (43.3) | 24.7 | 34 | +9 |
| 1996 1062 (43.0) | | | |
| Totals 1973-96 | 513.0 | 1001 | +488 |

Sources: Reserves' developments based on date from the annual survey of world oil reserves in the Oil and Gas Journal, 1973-95; from World Oil, 1974-96 and from De Goyler and MacNaughton's Annual Survey of the Oil Industry, 1973-83. Annual production data from the BP Statistical Review of World Oil/Energy 1974-1996

significance of past and continuing reserves' growth through reservoir evaluation, field extensions and enhanced rates of recovery. In his consideration of the past, his concern only with the question of the frequency and size of the discovery of new fields enables him to avoid entirely the fact that the industry has, since 1973, added two barrels of oil to the stock of reserves for every one barrel which has been used (see Table 1 below).

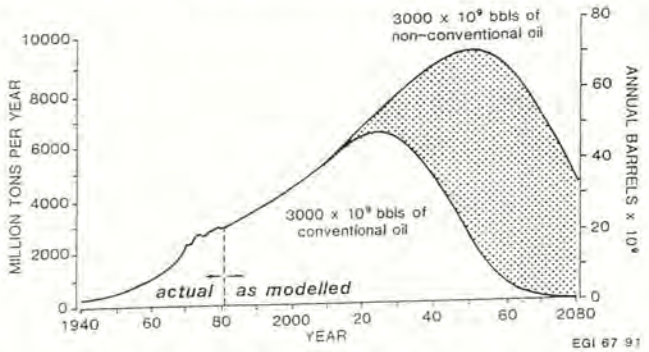
But oil companies and oil consumers are hardly likely to be much concerned whether the next barrel or litre of oil products they sell or buy, respectively, has been derived from crude oil from a new field; or from a field extension; or from enhanced recovery. And with reference to the future, his failure to take account of the continuing appreciation of oil reserves thus appears to represent a deliberate aim to understate the prospects so that he can use 1750 billion barrels as, in his own words, a "good number" against which to forecast near future supply difficulties supply difficulties and the inevitability of new price shocks.

On the contrary, the ultimate impact of the continuing appreciation of the reserves of each year's set of fields discovered over the past 30 or even 40 years will, firstly, eliminate the downward 'inflection' marked at about 1965 in Campbell's discovery curve with reserve revisions backdated (Figure 2) and, secondly, eventually increase the height of the most recent years columns by at least another $400 \times 10^9$ barrels[8].

## Non-conventional oil

Campbell's under evaluation of the reserves prospects for conventional oil from new discoveries and appreciation is, however, modest compared with his perfunctory treatment of non-conventional oil. Indeed, he mentions it in the text only to dismiss it, viz "as a contribution to the tail end of (oil's) depletion ... as its production rises only slowly to a long plateau". As illustrated in his Figure 6 one sees non-conventional oil production correctly shown as having just started: but it is then portrayed as rising only about threefold over the next 30 years (to about 8 million b/d = about $3 \times 10^9$ barrels per year) and, thereafter, as remaining on a plateau for the remaining 25 years to 2050. This plateau for non-conventional oil production is, moreover, predicted to occur in spite of Campbell's expectation that the production of conventional oil will be concurrently halved from about 30 to under 15 million barrels per day.

***Figure 1 A prospective depletion curve for the world's conventional and non-conventional oil to 2080***




What possible explanation can there be for this seemingly perverse behaviour of the oil industry and oil markets at that period? Non-conventional oil can be processed and refined into the range of products required by the market so that it constitutes a near perfect substitute for conventionally derived oil. In any market in which demand and price conditions are appropriate, products from non-conventional oil will supplement the supply of products derived from conventional oil (as they presently do in Canada to a significant degree). In such markets prices will, if necessary, be bid-up sufficiently to generate new non-conventional oil supplies and hence re-equilibrate supply/demand relationships close to the levels established by conventional oil. This will occur in the context of a potential availability of non-conventional oil resources which is non-constraining (given the size of the resource base)9. Under these conditions, Campbell's supply curve for non-conventional oil in his Figure 6 is an economic nonsense.

The more likely shape of the curve of non-conventional oil supply, against a demand for oil rising at 2% per annum, is as shown in Figure 1. In this hypothesis the production and use of non-conventional oil comes in first to complement and then to replace the use of the remaining barrels of conventional oil. Its use thus serves to extend the period of growth of the oil industry (at the 2% per annum rate) into the second half of the 21st century.

## Conclusion

In contrast with Campbell's perception of near future oil supply problems related to the inadequacy of potential supplies and a year 2000 or thereabouts price leap, the reality of conventional plus non-conventional supplies' prospects indicates that the industry could progress in an expansionist mode for at least another 60 years: to produce a mid-21st century almost three times its present size.

Not that this prospect seems, however, the most likely future for oil. Given, first, that the world's long-term prospects for alternative sources of energy (initially natural gas and, subsequently, renewables) are good; and second, that environmentally generated restraints on the use of fossil fuels will be imposed before 2020, then the prospects for oil will be demand, rather than supply, constrained well before the issue of the adequacy of oil resources becomes relevant. As in recent decades, when demand limitations have kept large resources of producible coal unmined, so with oil before the mid-21st century. Much of it will eventually be left in situ, unrecovered, unwanted and unmourned. Moreover, fears for the security of oil supplies from politically unstable areas and/or price shocks induced by supply constraints on oil from such areas will simply bring forward the date of oil's substitution by the alternatives and mean that even more of it is left in the ground.

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4 Odell and Rosing, The Future of Oil: a Simulation Study of the Inter-relationships of Resources, Reserves and Use, 1980-2080, Kogan page, London, 2nd Edition, 1983, p192.

5 Shell Briefing Service, Energy in Profile, No 2, 1995, p1.

6 C. J. Campbell, "Prophet or Cassanndra?" Petroleum Economist, Vol.62, No.10, October 1995, pp22. Footnote to the table.

7 Derived from C. J. Campbell, Energy World, No.240, June 1996, p9; Figure 2: and Peter Odell, Energy: Needs and Resources, MacMillan, London 1974, p20; Figure 11. In this, reserves as assessed in 1970 and backdated to the year of discovery were plotted.

8 Shell Briefing Service, op cit, p1. As an example of the potential from improved recovery see S. Nj,, "Improved Oil Recovery: the Norwegian Case" in The Proceedings of the World Petroleum Congress, 1994 op cit, pp447-8. The average currently scheduled 36% rate of recovery from Norwegian North Sea fields will be increased to 45% by the early years of the 21st century adding 4 billion barrels to the 9.4 billion declared remaining proved reserves at the end of 1994.

9 Odell and Rosing, op cit, 2nd Edition, pp28-29 and pp192-198.

# Abiotic origins of oil - revisited

***Current debate about any impending shortage of petroleum is seriously flawed by a fundamental misunderstanding about its origin: petroleum does not have an organic origin - rather it is a "primordial material erupted from great depth". So argued J F Kenney of the Russian Academy of Sciences in Energy World No 240 last June. But mainstream opinion in the west, represented below by a view from Shell International Exploration and Production BV, does not support this view.***

**The following scientific** arguments can be put forward in favour of the biotic or organic origin of oil and gas:

Oil and gas deposits are invariably found associated with sedimentary basins, which contain sediments rich in organic matter (dominated by the remains of micro-biota such as algae and bacteria). Coals, which are rich in plant remains, also are found in sedimentary deposits. If oil and gas were derived from inorganic sources, one would expect many deposits in eg weathered granites (which have porosity).

Crude oils contain complex molecules (biomarkers), which are very similar in structure to molecules extracted from living biomass. These molecules do occur also in organic rich sediments. An example is the molecule cholestane found in crude oils, which is very similar to the molecule cholesterol found in most living organisms. These type of similarities are very unlikely to have been generated from abiotic synthesis.

Oils are "optically active", a feature typical of many compound mixtures derived from living organisms (eg sugars). Inorganically derived solutions do not feature optical activity.

The carbon isotopic composition of crude oils is very similar to that of modern day organisms, such as plankton and plants. Abiotic sourced matter usually has a very different carbon isotopic signature.

Artificial conversion of organic-rich sediments produces a liquid that is very similar indeed to crude oils thought to have been derived from these sediments.

Having seen these arguments, one can see why there is only little support for the abiotic origin. We acknowledge there are few occurrences of organic matter that are exceedingly difficult to explain based on the normal concepts of oil and gas generation, migration, and accumulation. For example, per-alkaline igneous rocks sometimes have fluid inclusions filled with a tar-like substance while it seems impossible to construct a migration path from a sourcing sedimentary horizon to that igneous body (Greenland is a case in point).

Fluid inclusions from mantle or deep-crustal rocks very often have methane rich fluid inclusions. Volcanic eruptions may have significant concentrations of methane. Obviously these occurrences cannot come from the sedimentary pile. Out-gassing of the earth's mantle, therefore, is a widely accepted concept.

From this observation to a commercial deposit of methane gas is a big step, however. From mantle gas to crude oil is a far bigger step still.

In the late eighties the Swedish government drilled an exploration well to 9 km depth on a gneiss complex to penetrate a seismic anomaly (high amplitude, flat) that Consultant Gold convinced them to be associated with a gas accumulation. The well found gas in the parts-per-billion range only, completely explainable by methane escaping from crushed fluid inclusions.

The formation of crude oil from the polymerisation of crustal derived methane has never been tested by the drill bit.

In conclusion all oil companies (including Shell) work with the assumption that oil and gas have a biogenic origin, while only a few non-industry researchers are investigating the possible abiotic origin of oil and gas. But of course we in Shell monitor research and other studies and publications on this topic, even though we view the evidence for the abiotic origins of oil and gas as not compelling.

# Combining CHP and heat pumps for domestic application

*by P C Few, M A Smith and J W Tidwell, School of Engineering and Manufacture, De Montfort University, Leicester*

***CHP is a proven and effective method of reducing $CO_2$ emissions. However, for the full environmental benefits to be realised, wide-scale domestic application must be achieved. This article explains the concept of a domestic scale CHP-heat pump hybrid (CHP/HP) system which is being developed at De Montfort University. The system provides a high degree of flexibility to meet domestic energy demands.***

**To bring the significant** environmental benefits of CHP to the potentially huge domestic market, grid compatible, gas fuelled micro-CHP plants are being developed. The domestic implementation of CHP presents a number of additional problems in comparison with larger conventional gas fuelled systems. Power balance and engine sizing are still of prime importance but noise and vibration problems must also be addressed.

The useful heat to power output ratio of most gas fuelled CHP plants is in the region of 2:1, which would be similar to a micro-CHP plant. Domestic heat and power demands vary drastically and would rarely match the output of a micro-CHP plant. A 1 kWe conventional CHP plant would produce 2 kW of thermal energy, hence for most domestic situations additional heating plant would be required.

Engine sizing is critical, as the conversion efficiency of small engines drops considerably at part loads: for instance, a 1.5 kWe gas engine is around 20% efficient at full load but at half load this efficiency drops below 12%. In order to realise the full environmental and economic benefits of domestic CHP plant, the base electrical load must be met efficiently. As domestic base loads are usually below 0.5 kWe, a very small engine would be required leading to low efficiencies and engine life problems. A solution to both of these problems is to incorporate a heat pump in the CHP plant (a CHP/HP plant).

## The CHP/HP concept

A CHP/HP plant will consist of an engine/generator set with heat recovery and a vapour compression electrically driven heat pump. Such a plant will run in a number of

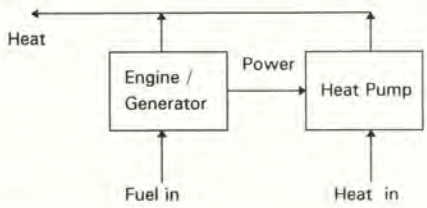



***Figure 1- HP mode***

modes or inter modal states. These are explained by the following energy balances

CHP mode - when electrical demand is very high, all the electrical output of an engine/generator set will be delivered to the host dwelling and heat will be provided by heat recovery from the engine exhaust and cooling jacket -

HP mode - with high thermal demand and no electrical demand, all the electrical output of the engine/generator set will be used to drive the heat pump - see Figure 1. Low grade thermal energy from the environment is upgraded by the heat pump and is delivered to the dwelling, with

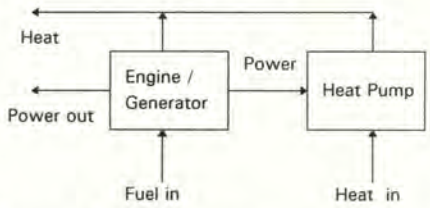



***Figure 2- CHP/HP mode***

additional heat recovered from the engine exhaust system. Owing to the coefficient of performance (COP) of the heat pump (typically around 3:1), more energy can be delivered to the dwelling than is consumed by the engine, giving an effective (or economic) efficiency of over 120%.

CHP/HP mode - the plant will first meet the dwelling's electrical demand and the surplus electrical generating capacity will be used to drive the heat pump, boosting the thermal output - see Figure 2. Base electrical loads as low as 100 W can be met with a 1.5 kWe engine/generator set, without sacrificing engine efficiency.

Cooling mode - by reversing the operation of the heat pump, a CHP/HP hybrid plant could provide cooling for a dwelling. This extends the envelope of operation of the plant, in the summer period.

Preliminary modelling of the concept has been completed and a prototype plant is under test at De Montfort University. The prototype comprises of a commercially available 1.5 kWe engine/generator set and heat pump. The research is concentrating on the thermodynamic interaction between engine/generator set and heat pump, and plant optimisation. Once the prototype plant has completed laboratory testing, it will be installed in a test dwelling.

## Commercial application

For CHP/HP to become commercially feasible, a suitable engine/generator set must be developed. This would be a purpose built 'V' twin gas engine designed for quiet running or a Stirling engine. An exciting future prospect would be the use of small fuel cells, which are electro-chemical machines which are not subject to the Carnot efficiency. With no moving parts, fuel cells are noise and vibration free, making them suitable for domestic CHP implementation. Other practical considerations include grid compatibility, which requires power electronics to synchronise the electrical output of the plant with the grid to avoid generator instability. Finally a complex control system would be required to monitor plant and dwelling conditions.

# Is there a future

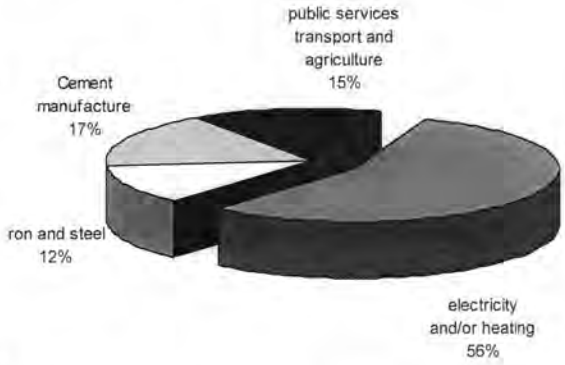
***Gas is a cleaner and more efficient form of energy than coal and is fast becoming the favoured fuel for electricity generation within the UK. Why then, is the Department of Trade and Industry still making a financial contribution of around 20% to a coal research programme which currently stands at £112 million? This article, from ETSU, gives an overview of the Government's policy on coal research and identifies some of the drivers of the Coal R&D programme.***

**Since the privatisation** of the electricity supply industry, power generators in the UK have focused on gas as a primary source of energy rather than coal. There are advantages to using natural gas, namely it is a more efficient and 'cleaner' energy source and generally the cost of electricity production is cheaper than conventional fossil fuelled power generation. Why then is the Government making a large financial contribution to coal research?

Coal has been recognised as a major source of energy for centuries and it currently accounts for 28% of world energy usage. World coal production rose by 55% between 1973 and 1992 and is expected to increase by a further 40% between 1993 and 2010. Of the coal produced, 56% is currently used for electricity generation and heating, 12% in the production of iron and steel, 17% in cement manufacture and other industries and the remaining 15% in public services, transport and agriculture (Figure 1). Coal is a major source of fuel for power generation, with 40% of the world's electricity being generated from coal.

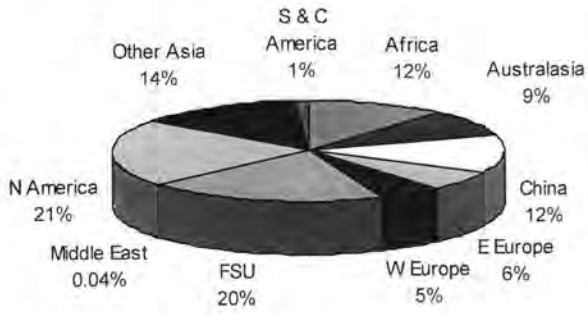
Of the fossil fuels, coal is by far the most plentiful. In 1994, it was estimated that there was over one thousand billion ($1 \times 10^{12}$) tonnes of coal reserves which are economically accessible using current mining techniques (Figure 2). At 1994 levels of production, these reserves are sufficient to last around 230 years. This excludes the reserves yet to be found, and reserves that may become more accessible with improved mining techniques. Improved engineering techniques are expected to increase the use of currently uneconomic lower grade coals as well as extracting more useful energy from every tonne of coal burned.

***Figure 1 Uses of coal produced in 1994***




Energy supply, regardless of the source, will have economic and environmental consequences. Fossil fuel combustion has for many years been viewed as a 'dirty' source of energy, because of the significant quantities of sulphur dioxide ($SO_2$), oxides of nitrogen (NOx) and particulate matter that accompany it. More recently, emphasis has been placed on trace element emissions and water pollution which further compounds the negative public image of coal combustion.

***Figure 2 Coal reserves***




A major increase in energy demand is expected in the future, with the greatest increases expected in the developing nations. For example, in China, 10-12 GW of coal-fired power are being added to the grid annually. Coal fired generation there is expected to reach a total of 450 GW by the year 2010, an increase of 270%. Currently in East Asia, coal-fired generating capacity accounts for only 28% of the electricity generated; this figure is expected to double by 2010. In Indonesia, the production of electricity from coal is expected to increase by 1,300%, with an associated 50% increase in power supplied to the rest of East Asia. The main drivers for this increase in energy demand are the significant increases expected in population growth and a rapidly expanding economy leading to an increased per capita electricity consumption.

This expected massive expansion in coal use world-wide, combined with the need to meet efficiency and environmental demands economically, is creating a substantial market for clean coal technologies (CCTs).

Within the UK, CCT development is increasingly being driven and co-ordinated by the Coal R&D programme, managed under contract by ETSU, an operating group of AEA Technology plc, and funded by the Department of Trade and Industry. Energy Paper 63 outlines the Government's policy towards CCT research, development and demonstration. The

# for coal R&D?

Programme as it stands now, is focused on the development of CCTs for both power generation, in particular, and the industrial markets. For power generation there is substantial scope to develop CCT components and expertise for the growing overseas market (Figures 3 and 4). The Government also emphasised the importance of ensuring that coal is used as cleanly as possible in the existing plant within the UK.

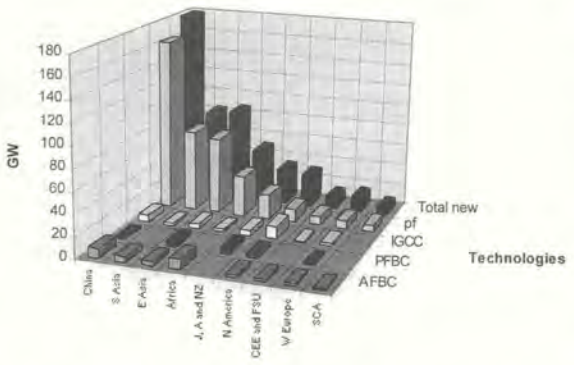
## The DTI Coal R&D Programme

The DTI Coal R&D programme was established in 1991 to provide a central focus for coal &D in the development of CCTs. The objective of the Programme is to provide a framework for developing clean coal technology research and development in the UK, so there is a firm foundation for the exploitation of the technologies in the overseas markets. It also aims at collaboration between the Government, industry, universities and overseas organisations and to evaluate and develop novel and innovative technologies which offer promise to the widening market. The present Programme focuses on clean technologies for both power generation and industrial markets, and covers all areas of the coal-energy chain. As of the end of 1996, the DTI Coal R&D programme is supporting approximately 110 projects with a total value of £112 million, of which the DTI contribution is 19% (£21 million).

## Technology Transfer and Commercialisation

During 1995/96, a technology transfer and export strategy was launched for the Programme. This intended to maximise the UK share of the increasing world clean coal technology market. It features a number of high profile export promotion initiatives such as outward/inward trade missions to/from China and India, as well as clean coal technology export brochure for use by British embassies. It is integrated with the UK's Technology Foresight programme and includes a number of common workshops.

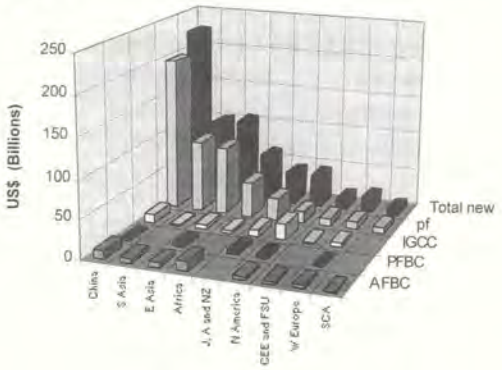
***Figure 3 Estimated installation of new capacity to 2010***




The strategy seeks to reduce the perceived barriers to, and identify available option for, the uptake of CCTs - especially for small-to-medium sized enterprises. Coal represents both a major environmental challenge and a market opportunity for the UK clean coal industries.

This element of the Programme is also designed to ensure that research results are taken up by industry as soon as possible. This is generally achieved by involving industries in all aspects of project initiation and management, by maximising on collaborative projects and producing publications for every project. The dissemination of publication and information is dealt with through the Coal R&D Database, which currently comprises of 500 'clients'.

***Figure 4 Market potential for new power generation CCTs to 2010***




## Fundamental Coal Science

This includes the joint funding programmes with the British Coal Utilisation Research Association (BCURA) and the Engineering and Physical Science Research Council (EPSRC). Both of these joint funding programmes aim to maximise collaboration between universities and industries to encourage the level and speed of take-up of new technologies within industry. There are currently 12 projects within the BCURA portfolio covering topics like coal characterisation related to pyrolysis and gasification, gaseous and trace element emission production and handling characteristics. There are also 20 projects within the EPSRC portfolio.

## Coal Exploration and Extraction

UK coal mining and mining equipment has traditionally been at the forefront of the mining community throughout the world. UK research in this field was curtailed in recent years, but with the increased energy requirements, a potential for further development was recognised. The aim of the research is to ensure that the UK maintains its lead in mining technology, to examine the potential for in-situ conversion appropriate to remote and offshore seams and to improve monitoring and control of the underground mining environment.

One project looks at the control of

mine climate, which is becoming increasingly important as heat inputs from underground machinery and from the strata, a function of working depth and geothermal gradient, increase with time. The project draws on the experience gained in the metal mining industry where working depths, and therefore climatic problems are often considerably greater than those encountered in coal mining. Improving climatic conditions in mines should enhance both safety and productivity, and the findings could also be relevant to other industries.

## Coal preparation

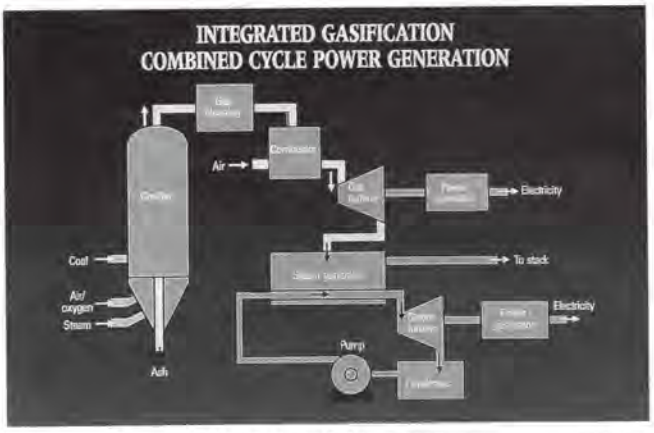
Basic coal preparation involves sizing of coal to remove coarse and other non-combustible materials from feedstocks. Coal homogenisation, washing, screening and cleaning are some of the newer technologies employed to improve the quality and consistency of the coal feedstock provided to customers. They are aimed at economically reducing components of coal that are likely to produce environmental problems. With increased environmental pressures, more emphasis has been placed on the removal of sulphur from the coal prior to combustion. The cost to produce a 'cleaner' low ash, low sulphur coal may be offset by reduced costs in waste minimisation at the user's end.

Dry coal cleaning was widely used in both the UK and the USA in the 1950s and 1960s, but was discontinued due to dust-related environmental problems, and because the process was less selective than conventional wet cleaning. However, water is an undesirable component of any coal product because it reduces heating value and can cause handlability problems. A scoping study to re-examine the potential for dry coal cleaning was commissioned in order to recommend areas of future research. Dry cleaning could have a potential market in hot, arid countries where water supply is problematic, and in very cold climates where freezing of cleaned coal is a serious problem.

## Coal handling and supply

Coal goes through a number of handling stages which include transport, stockpiling, blending and bunkering. Although coal handling is generally efficiently carried out within the power industry, handling costs can be a significant proportion of total costs in other industries. Any problems associated with the handling of coal are generally associated with the chemical and physical characteristics of the coal.

*Figure 5 Schematic of IGCC Power Generation*




Changing the design of the transport, storage and stockpiling equipment can reduce the effects of these characteristics. Material linings installed in bunkers or hoppers can reduce potential 'rat-holing' or coal build-up problems. More recently, models are being used to understand and predict the behaviour of solids within bunkers and hoppers.

Projects include assessing and quantifying the effects of physical and chemical properties of coal on their behaviour within hoppers and silos. There is also research aimed at developing pulverised fuel flow meters, to measure flow rate of coal and determine particle size.

## Conventional combustion processes

Since half of the world's coal production provides 40% of the world electricity demand, and the fact that developing countries are likely to increase this demand substantially before 2010, this area of research is of greatest interest to the international market.

The principal problem with fossil fuel combustion, is the significant quantities of gaseous and particulate emissions produced. These can be minimised with various combustion and post-combustion technologies, which are quite well advanced and proven.

Carbon dioxide ($CO_2$) production is directly linked to the efficiency of the plant. Conventional power stations are being made increasingly more efficient with moves to higher temperature and higher steam conditions. Subcritical boilers, which operate at less than 221.1 bar pressure and 540°C, can achieve efficiencies of 36-38% (LHV). Supercritical boilers, of which there are a few operational units in Japan and Denmark, operate at pressures greater than 221.1 bar and have achieved efficiencies in excess of 45%. With the development of high strength steel and new turbine designs, ultra-supercritical boilers are possible. These boilers will operate with steam pressures of greater than 248 bar at temperatures above 566°C, and should attain efficiencies above 50%. A number of ultra-supercritical projects are currently in progress in Denmark, Germany and Japan.

Sulphur production is reasonably well understood and $SO_2$ emissions can be reduced to a certain extent by switching to lower sulphur fuels. NOx formation is more complicated, and a large proportion of research has been put into the understanding NOx formation and reduction by means of modelling techniques. There are also various low-cost NOx reduction methods available. NOx emissions can be reduced by up to 50% by using reburning techniques, air and fuel staging and low NOx burners which modify the combustion conditions of the boiler.

Post-combustion techniques for the removal of $SO_2$ and NOx are more costly, but are more efficient means of removal. Flue gas desulphurisation (FGD) plants can attain a $SO_2$ removal efficiency of up to 95%, while selective catalytic reduction (SCR) installed for the removal of NOx emissions can achieve reductions of 80-90%. Improvements to both technologies have made the

processes more simple, thereby reducing costs and making them more economically viable options. There are also combined $SO_2$/NOx control technologies achieving commercialisation.

Particulate emissions are kept under control by means of electrostatic precipitators (ESPs) or fabric filters. Both technologies have an efficiency of greater than 99.5%. Improvements in the design of ESPs and increased availability of new material for fabric filters are further improving the efficiencies. Investigations are also underway to develop dual systems using both ESPs and fabric filters simultaneously.

Projects include air staging and reburning, coal characterisation associated with burnout prediction, NOx control and measurement and co-firing and trace elements modelling. The Programme also undertakes fundamental coal combustion research directly related to the pulverised fuel combustion process, as well as much more applied activities.

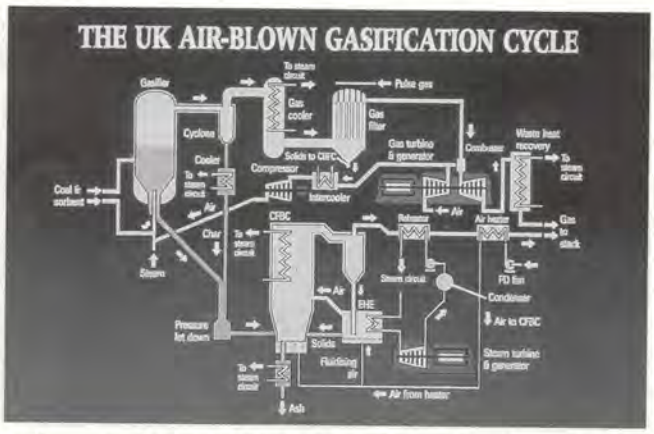
## Advanced power generation

Gas has a shorter resource life (around 60 years) than coal and therefore the coal-based plant is likely to become the preferred option in the future. New coal plant will be based on advanced power generation processes, which offers technologies that are more efficient and have a lower environmental impact. The DTI's Advisory Committee on Coal Research suggested that the technologies be monitored and reviewed for possible exploitation in the overseas market.

Advanced power generation can be based on gasification or combustion processes or a combination of both. Fluidised Bed Combustion (FBC) systems offer more efficient processes that can burn low-grade and mixed fuels, with relatively low $SO_2$ and NOx emissions. They range from small scale power generation (<10MW) to larger scale power plant and can combine heat and power schemes. Such schemes are found in Sweden, France and Germany and the efficiency of these plants is in the region of 38%. Pressurised FBC (PFBC) generates gas that can be expanded through a gas turbine to generate more electricity of 42-45%.

Gasification of coal is not a new technology and has been used for domestic gas production and in chemical industries in the past. Converting coal to gas is an attractive way to combine steam and gas turbines, with a reduced environmental impact. There are various gasification techniques which can be used in combined cycle plants. The integrated Gasification Combined Cycle (IGCC) uses a fuel gas, which is a mixture of carbon monoxide and hydrogen, to feed a gas turbine . The exit gases are then cooled in a heat recovery steam generator, where superheated steam drives the steam turbine. Current IGCC systems offer efficiencies of 43-45% with low emission levels (Figure 5).

*Figure 6 Schematic for UK Air Blown Gasification Cycle*




There are currently 40 projects and seven related BCURA/EPSRC projects running with a DTI contribution of approximately £11.7 million. Projects include hot gas desulphurisation, advanced desulphurisation, advanced gas turbine design and IGCC. One of the largest suite of projects within this programme area is the development of components for the Air Blown Gasification Cycle (ABGC), previously known as the British Topping Cycle (Figure6). In February 1993, the DTI indicated the ABGC a hybrid cycle incorporating combustion and gasification technologies, was potentially superior to other advanced power generation systems, but that more R&D was required to bring the plant to commercialisation. In September 1993, an industry-led Clean Coal Power Generation Group was established to ensure that the programme achieves its objectives.

## Other processes

This area of the Programme covers the research required in industries other than power generation that use coal as an energy source. These industries include steel and cement manufacture, chemical processing and space/process heating. One of the largest projects within this programme area was the coal liquefaction pilot project at Point of Ayr. Ten years of research has shown this to be a viable process. 70% of the world steel manufacture is based on smelting iron ore with coke. CCTs have improved producing synthetic natural gas from the gasification of coal. Domestic coal use is still prolific in developing countries and the development of smokeless fuels also has a great potential market.

Projects include on-line particulate emission monitoring, predictive indices for performance optimisation of various coal conversion processes and utilisation of industrial waste products.

## Conclusion

Increasing population and economic growth in developing countries will substantially increase energy demand in the future. Since coal is a stable and secure energy supply, and is indigenous to a number of developing countries, coal is likely to be the dominant fuel source. The expected massive expansion in coal use world-wide, combined with the need to meet efficiency and environmental demands economically, is creating a substantial market for CCTs. The Government's policy is to stimulate the development of CCTs and further develop UK expertise to enhance competitiveness and increase the potential to use UK coal. The Coal R& D programme has done much to help the UK to develop a firm foundation for exploiting this rapidly increasing world market.

# US utilities will

***While liberalisation of the privatised UK electricity industry continues apace, the US follows. Here, Patricia Irwin explores one aspect of deregulation of the industry - the future reliability of the transmission system.***

**After decades** of regulated power monopolies, the US electric industry is becoming competitive. Spurred by a government deregulation order, utilities are recreating themselves, turning their backs on long held, non-competitive practices and positioning themselves to be to lean, mean, competitive machines. The difficult and painful conversion is creating a new set of financial and technical problems. In particular, legislators and engineers alike wonder how reliability will fair in the newly competitive arena.

## Deregulation issues

Deregulation became reality on April 24, 1996, when the US Congress issued the Federal Energy Regulatory Commission's (FERC) Order 888. The Order requires utilities to unbundle or separate their generation and transmission services. All power providers will have as much access to a utility's transmission lines as the utility itself. To ensure this is done fairly, the FERC Order carefully addresses the need for Independent System Operators (ISO's), or independent regional dispatchers.

The Order also addresses the pre-eminent financial issue: stranded costs. Rightly expecting to continue as monopolies, utilities built plants and entered into contracts, expecting to recover their capital investments over long periods of time. As the industry moves toward competition, plants may be devalued and long-term, low-profit contracts uncompetitive. The unrecovered costs of capital investment will be "stranded" or unrecoverable without legislative help.

## Deregulation - a short history

Until the 1960's, limited technology and economies of scale made the biggest power plants the least expensive way to generate power. These huge plants could take 10 or more years to design and build. With growing projected demands, utilities continued to design and build very large plants; some companies entered the nuclear market.

In the 1960's, things began to change. Rapid inflation and climbing interest rates hurt power companies, the most capital intensive of all industries. Ongoing construction projects suddenly cost much more than planned. Nuclear plants were hardest hit as new safety and environmental concerns multiplied costs and dramatically extended construction time.

Rising electricity rates led to power conservation programs and economic downturns caused businesses to cut back on energy use and new construction. Demand for power shrank.

By 1970, new power generation technologies, like combined cycle units and circulating fluidised bed boilers, made small power plants more cost effective than larger plants. According to Federal Energy Regulatory Commission (FERC) calculations, smaller, efficient plants can produce energy for 3 to 5 cents per kWh. Power from larger, older, coal plants costs 4 to 7 cents per kWh and nuclear power costs 9 to 15 cents per kWh. Large, industrial power users which had the means began building their own generating plants. Following the international oil embargo, the US Congress passed the Power Plant and Industrial Fuel Use Act to encourage power producers to build plants not dependent on foreign oil. The 1978 Act required utilities to buy power from certain qualified facilities (QF's), mainly cogenerators and small power producers, at a rate not exceeding their avoided costs (what it would cost if the utility added the generation capacity themselves). By the early 1990s there were 1,200 QF's in the US producing 47,774 MW of power.

In time, other independent power producers (IPPs) entered the market and were successful even though utilities were not required to buy their power under the Act. FERC authorised IPPs to sell power at market rates over utility owned transmission lines on a case-by-case basis. Utilities still controlled the transmission lines.

By the 1990s three things were obvious. First, electric rates were creeping up - the Energy Information Administration's Monthly Energy Review reported the average residential customer paid 25% more for electricity in 1985 than in 1970, and industrial prices rose by 86%. Second, non-utility, commercial ventures could produce cheap power with their small plants. Third, these commercial ventures were willing to sell their power to whoever wanted it, but they did not have access to utility-owned transmission lines.

FERC issued Order 888 on April 24, 1996, leading the power industry to wholesale competition. The Order "unbundled" or separated generation and transmission services and will allow open access to transmission lines.

## Saving money

Deregulation is intended to bring the benefits of competitive pricing to electricity customers and even out power prices, which vary from 3 to 5 cents per kWh in the Northwest states to 9 to 11 cents in California. It is difficult to argue against saving money. The Introduction /Summary of Order 888 states: *"The (Energy Regulatory) Commission estimates the potential quantitative benefits from the Final Rule will be approximately $3.8 to 5.4 billion per year of cost savings"*

It is also difficult to argue against deregulation and competition in general.

# compete - reliability suffer?

*by Patricia Irwin, P.E., freelance writer*

These are sacred words in the United States. Here people believe that setting the wolves-of-free-market loose produces better companies and services. But, deregulation requires a fundamental change in the way utilities do business and many people worry that in the shuffle, more will be lost than gained.

One theory has it that, if power becomes a truly free market, people who can afford it will pay for a reliable service. Others could cut their expenses by buying a cheaper, less reliable service and only market forces would determine the price and quality of electricity. Reliability is cheap to provide under normal operating conditions, but very expensive in emergencies.

## Utilities cut - States regulate

The question of reliability becomes more important as electric companies do what they have to be competitive: reduce costs. Utilities are cutting back on many programs affecting reliability, like tree trimming and transmission and distribution maintenance. Periodic maintenance programs, where equipment is maintained on a fixed schedule regardless of use, are being replaced with performance based systems. To save money, new equipment purchases are also being delayed. This leaves older devices, which receive less maintenance, to carry the load.

So far, a dozen States have written regulations to insure reliable power in a deregulated environment. California's Bill AB 1890, passed in September of 1996 is one example. Beyond setting up ISO's and stranded cost recovery, it creates an oversight Board with a duty to ensure that inspection and maintenance, repair and replacement regimes sufficient to provide "high quality, safe and reliable service" are put in place. The Board also has the power to order sanctions, including penalties in the form of rate reductions or monetary fines if standards have not been met.

*US electricity transmission systems - under threat?*

## Utilities downsize

In the past, utilities were faithful to their employees and employees were faithful to the company. This was important in an industry where it took seven years to fully train a lineman (high voltage certified). Facing deregulation, most companies are undertaking drastic reorganisation to create flat, horizontally organised corporate structures.

In real terms, reorganisation means thousands of skilled employees losing their jobs - entire layers of middle management are disappearing. Cutting the work force is very disturbing in an industry where 30 year service records were commonplace.

Both the International Brotherhood of Electrical Workers (IBEW), representing 220,000 workers, and the Utility Workers Union of America (UWUA), representing 50,000 workers, are concerned about how quickly deregulation is occurring, how it will affect workers and small consumers and whether safety and reliability can be maintained. Says one official: "Consider that utilities need trained, competent workers - mistakes that might be tolerated in other industries can have disastrous consequences in the electric power industry."

## Charging forward

Deregulation is coming and power companies will adapt. Eventually, the industry will find a new status quo. Reliability and costs will, again, be in balance. But, the road from here to there has not been built yet.

In the short term, economics will pressure companies to operate at maximum efficiency. Transmission lines will sometimes carry the maximum load. Less maintenance, longer wheeling distances and hot, high demand days may spell disaster.

# Renewables - a major contribution, but when?

**Nobody I know suggests** that the renewables will make a "major contribution" to energy supplies within the lifetimes of our present power stations. There is too much other plant for that. The most that is anticipated on this sort of time scale, even by enthusiasts like myself, is 10%.

This contribution is not negligible, however, and the trend is clear. We shall see a lot more of the renewables much sooner than Mr Loram thinks. He misses several important points in his article (*Energy World* December 1996, pp14/15).

He points out that the (weighted) average pool price is around £29/MWh and he gives the impression that pool prices are falling. They are not. He says that, "The current price for power has dropped by the fall in the price of the pound over the last 13 years". On the contrary, the price has been rising rapidly every single year at an average rate of 9%.

He discusses the minutiae of Electricity Pool prices to four significant figures, as if they represented the real prices at which most electricity is traded. They do not!

Although technically all electricity has to be traded through the pool, most trading (around 90%) is hedged by longer-term contracts at substantially higher prices. Just as with oil, most trading is actually based upon confidential and unquoted long-term contracts which are quite stable, not on quoted spot prices which fluctuate wildly.

To find the real price of electricity, it is only necessary to check the published annual accounts of the generators, such as National Power, and to divided their sales income by the units sold. These figures are much higher than the ones that Mr Loram quotes, nearer to £34/MWh.

Pool prices will almost certainly continue to rise as deregulation proceeds. That will bring them much closer to the generator's actual prices and to the latest NFFO bid prices which are below £40/MWh for wind. NFFO prices are falling fast, so the renewables are converging in the electricity market and they are rapidly becoming economic. This means that support will involve less interference with the market and it will certainly increase the rate of market penetration.

So Mr Loram has his trends wrong. He can question the arguments for supporting renewable energy and he can dismiss them as "political rhetoric" if he likes. The fact is that, at the Rio Conference, this Government committed the UK to such support and they are delivering on their promises. For better, for worse, the EU as a whole is similarly committed.

The methods of support may vary and it remains to be seen whether there will be any further rounds after NFFO 5 but the international community has been promised that help of some sort will continue. A Labour Government would be even less reluctant to interfere with free market forces when the environment is at stake. We are told the "... Shadow Minister for Energy ... gave his view that the Government had not done enough to promote renewable energy". A change of Government would evidently do more, not less, for the renewables.

Mr Loram does not seem to like this rapid trend - although I wonder why not. Most people in the country do, when asked. But whatever his objections to Rio Conference decisions, the move towards the renewables seems set to continue apace.

***Prof D T Swift-Hook (F)***

**I have the following** comments to make on Prof Swift-Hook's letter.

There is really not all that much disagreement between us; we are virtually agreed that the true price paid for electricity is in the region of £34/MW as near as anyone can tell. Indeed it was not I that said that prices were falling now, that was Martin Alder; but it is a fact that the price that could be obtained for generation during weekday daylight hours under the 1983 Energy Act tariffs averaged out at £35/MW. I was working on EfW and LFG projects at the time and that was the price we used in our calculations. But the £ was worth a good deal more in 1984 than it is now so I hold that it is true that the current price, in real terms, is now lower by the compound rate of inflation than it was in 1984. Furthermore in National Power's half yearly report in 1992 they said that the average price that they had received for that period was £33/MW, that gives a rise of about 3% over the past 3 - or is it 4? - years. So I fail to detect this steeply rising trend of which the Professor speaks, nor have I heard of it from any other source.

As for the falling trend in renewables prices, if one discounts NFFO-1, NFFOs 2 and 3 only provide two points on the graph and, as a scientist, I am sure Professor Swift-Hook would not consider that to be a trend upon which one could place much value *(However NFFO-4 now adds a third point - see page 5 - Ed)*. As many a planner, house buyer or investor in the stock market will affirm, trends have a habit of levelling out and even reversing. I have earlier, in these pages, pondered as to how it was that many renewable energy schemes were able to significantly reduce the prices they needed for viability between NFFOs 2 and 3 without any discernible change in technology or economies of scale. Anyway, it is very questionable whether a further reduction on such a scale is feasible - my experience suggests not.

The Professor seems to have concluded that I am antagonistic to renewable energy but, although it may no longer be my bread and butter, it remains a great interest and a means of spreading a thin layer of jam on the bread and butter of my pension! However, we renewables men must acknowledge that others put forward a respectable argument that the millions spent on our patch could be more effectively spent on supporting energy savings and energy efficiency so that we need generate less power in the first place.

***R G Loram***

## March 1997

***Power Generation & Maintenance 97***
Exhibition, 18-19 March, Glasgow. Details from Nicky Molloy, FMJ International Publications Ltd, tel: 01737 768611, fax: 01737 761685

***Environmental design***
BRE seminar, 20 March , Garston, £95. Details from BRE, tel: 01923 664775, fax: 01923 664688

***Performance indicators in utility companies***
Conference, 20-21 March, London, £799 + VAT. Details from IIR, tel: 0171 915 5055, fax: 0171 915 5056

***Reviewing and assessing the commercial impact of the Network Code***
SMi conference, 20-21 March, London, £799 + VAT
Details from SMi Ltd, tel: 0171 252 2222, fax: 0171 252 2272, e-mail: 100531.3067 @compuserve.com

***Where are the utilities going?***
Strategic Planning Society conference, 24-26 March, Stratford-upon-Avon, £1050
Details from the Society, tel: 0171 636 7737, fax: 0171 323 1692

***Reporting and investigation of gas-related incidents***
Institution of Gas Engineers seminar, 26 March, London, £195 + VAT. Details from the IGE, tel: 0171 636 6603, fax: 0171 636 6602

***Central & Eastern European Power Industry Forum***
Conference, 26-27 March, Warsaw, Poland
Details from Pennwell Conferences, tel: +31 30 265 09 63, fax: +31 30 265 09 15, e-mail: elly@pennwell.com

## April 1997

***Industrial furnaces and boilers***
Conference, 1-4 April, Porto, Portugal. Details from INFUB, tel: +351 2 9734624, fax: +351 2 9730746

***Gas turbine technology***
Course, 2-4 April, The Netherlands. Details from The Centre for Professional Advancement, tel: +31 20 638 2806, fax: +31 20 620 2136

***Industrial air pollution monitoring***
Short course at the University of Leeds Department of Fuel and Energy, 7-9 April, Leeds
Details from Jamie Strachan, tel: 0113 233 2494, fax: 0113 233 2511, e-mail: shortfuel@leeds.ac.uk

***The competitive market for energy - 1998 and beyond***
IMechE seminar, 8 April, London
Details from IMechE, tel: 0171 973 1290, fax: 0171 973 0182

***The expanding gas arena***
Sixth annual Mediterranean gas markets conference, 8-9 April, Rome, £850. Details from Overview Gas Conferences, tel: 0171 613 0087, fax: 0171 613 0094

***et/er 97***
Exhibition covering energy resources and environmental technology, 8-10 April, NEC Birmingham. Details from ticket hotline, tel: 0181 910 7840, fax: 0181 910 7989

***The impact of improved catalytic processes on refinery economics***
Conference, 10 April, London, £325 + VAT. Details from the IoP, tel: 0171 467 7100, fax: 0171 255 1472, e-mail: lis@petroleum.co.uk

***Diesel particulates and NOx emissions***
Short course at the University of Leeds Department of Fuel and Energy, 14-18 April, Leeds
Details from Jamie Strachan, tel: 0113 233 2494, fax: 0113 233 2511, e-mail: shortfuel@leeds.ac.uk

***Understanding heat treatment***
Course, 15-17 April, Birmingham, £735
Details from the Wolfson Heat Treatment Centre, Aston University, tel: 0121 359 3611, fax: 0121 359 8910

***Low-head hydropower***
Conference, 17-18 April, London. Details from Paul Cowley at IT Power Ltd, tel: 01189 730073, fax: 01189 730820, e-mail: itpower@gn.apc.org

***CHP: technology and the environment***
Short course at the University of Leeds Department of Fuel and Energy, 22-23 April, Leeds
Details from Jamie Strachan, tel: 0113 233 2494, fax: 0113 233 2511, e-mail: shortfuel@leeds.ac.uk

***Alliances in oil and gas***
International Quality and Productivity Centre conference, 22-24 April, Aberdeen, £895 + VAT
Details from Fiona Walker at IQPC, tel: 0171 421 3500, fax: 0171 831 9249, e-mail: iqpc@cityscape.co.uk

***How to do an energy survey***
Mid Career College course, 28 April, Birmingham, £187
Details from Mid career College, tel: 01223 880016, fax: 01223 881604, e-mail: midccoll@uk.pi.net

***Monitoring and targeting energy and water consumption***
Mid Career College course, 29 April, London, £187
Details from Mid career College, tel: 01223 880016, fax: 01223 881604, e-mail: midccoll@uk.pi.net

***How to do an energy survey***
Mid Career College course, 30 April, London, £187
Details from Mid career College, tel: 01223 880016, fax: 01223 881604, e-mail: midccoll@uk.pi.net

## May 1997

***Monitoring and targeting energy and water consumption***
Mid Career College course, 1 May, London, £187
Details from Mid career College, tel: 01223 880016, fax 01223 881604, email: midccoll@uk.pi.net

***Using advanced glazing to improve daylighting and thermal performance in buildings***
Seminar, 8 May, Oxford
Details from JLJ Rosenfeld, University of Wales, tel: 01222 874797, fax: 01222 874317

# Annual General Meeting

**Notice is** hereby given that the seventieth Annual General Meeting of The Institute of Energy will be held at The Institute of Energy at 10.30 am on Thursday, 8 May 1997, to transact the following business:

1 To sign the minutes of the 69th Annual General Meeting held on the 2 May 1996.

2 To receive the Annual Report and Accounts of The Institute for the year ended 31 December 1996 together with the report of the auditors.

3 To receive the Annual Report and Accounts of the Benevolent Fund of the Institute of Energy for the year ended 31 December 1996, together with the report of the auditors.

4 To elect Lawford & Co, chartered accountants, to serve as auditors for the ensuing year and to agree that their remuneration be fixed by the Executive Committee.

5 To determine the level of annual subscriptions payable by individual grades of membership for 1998.

6 To announce the names of new members of Council.

Dated this 7th day of March 1997. By Order of the Council
***JEH Leach***
***Executive Secretary***

# A meeting venue in the heart of London

**If your organisation** promises to care about the preservation of natural resources why not enhance this ethos by holding your meetings, seminars and workshops at The Institute of Energy. Our Georgian building provides a warm and pleasant atmosphere adding a traditional touch to your small functions. Set in the heart of London's West End, we are within minutes of rail termini and London Underground connections, making us an attractive and accessible venue.

The nearest Underground stations are: Great Portland Street and Regents Park; both stations just a five minute walk away. Oxford Circus and Warren Street are only a ten minute walk. The nearest rail terminus is Euston, a 15 minute walk away from the Institute. ***For information on rates and availability, please contact Derek Smith at the Institute. Tel: 0171 580 7124. Fax: 0171 580 4420 or email: djsmith@ioe.org.uk***

# Obituary: H Raymond Hoy, OBE, BSc, Fellow of the Royal Academy, Senior FInstE

**H Raymond Hoy,** who died on 27th December 1996 at the age of 79, was a great development engineer who influenced and pioneered many advanced coal combustion and gasification concepts.

Raymond graduated in Gas Engineering and Fuel Technology at Leeds University in 1939. Following six years war service as an Engineer Officer in the RAF, he was invited in 1946 to join the Leatherhead Laboratories of the British Coal Utilisation Research Association (BCURA). Here he worked for some 40 years on research and development on the pilot-plant scale. Starting as a Section Head, Raymond progressed to becoming, in 1968, a director of BCURA.

In the 1960s, Raymond turned to what was to become the main activity for the rest of his life: pressurised fluidised-bed combustion (PFBC) for combined cycle power generation. He had the vision to realise the potential of the system and in 1969 built the world's first PFBC pilot plant.

In January 1971 BCURA came under the control of the National Coal Board, which promptly decided to close the Leatherhead Laboratories. Thus began Raymond's most critical time; believing that PFBC would eventually enjoy commercial success, he laboured long, hard and successfully for support to continue his work at Leatherhead. Raymond's endeavours to keep PFBC alive in those early days ensured its survival. He was later deeply involved in the IEA's Grimethorpe PFBC project. Raymond's biggest project, however, was the development in the late 1970s of the (US) Cogas Development Company's gasification system for producing SNG synthesis gas without the use of oxygen.

The Leatherhead facilities finally closed soon after Raymond "retired" in 1983, when, with some of his senior staff, he formed Hoy Associates Ltd as a consultancy group. He continued his activities in PFBC almost until he died, and enjoyed the satisfaction of seeing PFBC achieve commercialisation.

He was known throughout the coal world (and particularly in the USA) as a compulsive worker who single-mindedly pursued a course of action - sometimes to the frustration of his staff, but always with their admiration and ultimate cooperation.

Raymond received the Thring Award from the Institute of Fuel in 1966, the OBE in 1976 and was presented with a gold medal at the Seventh International Conference on Fluidized Bed Combustion in Philadelphia in 1982. He was elected Fellow of the Royal Academy of Engineering in 1983. He became an associate member of The Institute of Energy in 1946 and became a Senior Fellow in 1965.

Raymond Hoy was a man of extraordinary vision, possessed of the power to lead others to astonishing achievements. The world is poorer for his departure.

***AG Roberts***
***JE Stantan***

# Travel grants available to researchers

**Members of the** Institute involved in engineering research may take advantage of grants available from the Royal Academy of Engineering to help with the costs of travelling overseas to attend or present papers at conferences, participate in short collaborative research projects or make field trips.

The scheme is open to postgraduate students, postdoctoral researchers, lecturers involved in research, and chartered engineers in UK higher education institutions and industry. Grants up to 50% of costs are available for visits of up to two months duration.

Applicants should contact the Academy in plenty of time before travelling to enable full use to be made of APEX and similar fares.

***Contact the International Travel Grants section, the Royal Academy of Engineering, 29 Great Peter Street, London SW1P 3LW. Tel: 0171 222 2688, Fax: 0171 233 0054***

# European VAT recovery

**The Institute** has arranged for Quipsound VAT Recovery Services Ltd to handle the recovery of European VAT for members travelling or exhibiting in Europe on behalf of their companies. Quipsound will reclaim much of the VAT paid in connection with European business travel, exhibition expenses, hotel accommodation and various other costs. Tel 01959 563228 for more details.

# Concessionary subscription rate for retired members

**Fully-retired** members are reminded that there is a concessionary membership subscription rate for membership of the Institute. The Institute defines a retired member as one who is not less than 60 years of age, who is no longer in receipt of earnings and whose annual subscription to the Institute is no longer treated by the Inland Revenue as allowable expenses to be offset against earnings.

The concessionary subscription rate is currently £23.95 for 1997, plus the retired rate for CEng/IEng, (currently £6.40 and £5.10 respectively).

Members are also reminded that discounts of up to 35% are available to members hiring a car from either Avis or Hertz car hire, as long as they obtain the necessary discount number or club card from the Membership Department of the Institute.

***Contact the Institute's Membership Department on 0171 580 0077 or email ppowell@ioe.org.uk for further details.***

# Services for hire

**In previous issues** of *Energy World*, we have kept you up to date with developments and our achievement in producing the National Standards for Managing Energy. As many of you may also know, the Institute is the only Delivery Centre in the UK to award NVQ units in Managing Energy.

If you are confused by this latest initiative, bogged down with the bureaucracy of Vocational Qualifications, or just believe they are of no consequence to you, then please contact Louise Evans or Louise Collins in the Projects & Marketing Department and give us the benefit of the doubt by allowing us to come and talk to you about the benefits. The Institute has been awarded a contract from the Department of the Environment to manage the dissemination, and create awareness of this initiative, so that the UK can become more environmentally aware and develop it's competitive advantage.

# Building bridges across Europe

**The Institute's Projects** & Marketing Department has recently received project approval from the Leonardo programme, to complete the first phase of a project entitled; Transnational Training in Energy Efficiency and Environmental Awareness for young workers through a social partnership.

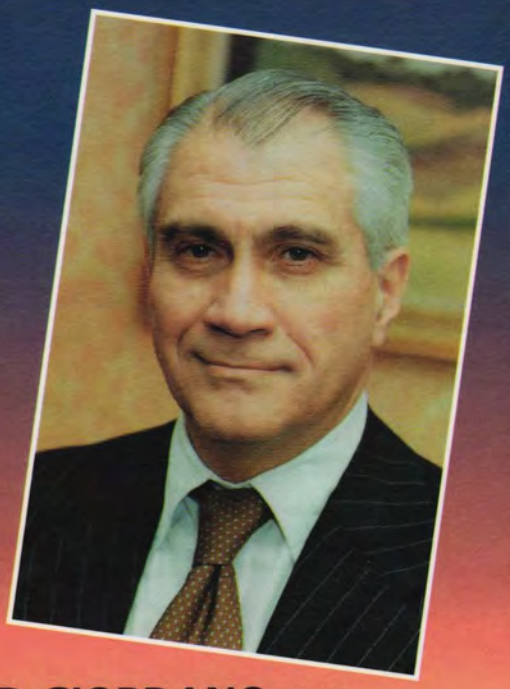
The project consists of sourcing and evaluating existing material in the UK and European countries and then collating all this material to form a European Guide to Energy Efficiency and Environmental Awareness for Young Workers.

The second phase of the project will allow a number of young workers in the UK to visit the other European countries involved and vice versa, to share their knowledge and expertise in working practices and energy efficiency.

The final phase of the project will be to hold an international conference on how to exchange expertise across European boundaries to the benefit of all; discussing energy policies, and contributing to the organisation's overall goals, enabling young workers to contribute to management activities. Our partners are Shorts Brothers, Northern Ireland Electricity plc, The Amalgamated Engineering & Electrical Union, Engineering Training Council, The Federation of Italian Metal Workers, Verbund, The Austrian Ecology Institute and the Austrian Federation of Trade Unions. Through this programme the Institute hopes to strengthen its relations and impact upon energy issues on a pan-European scale.

# The most important two days for gas people – June 19th & 20th 1997

## THE Great Debate "Competition"



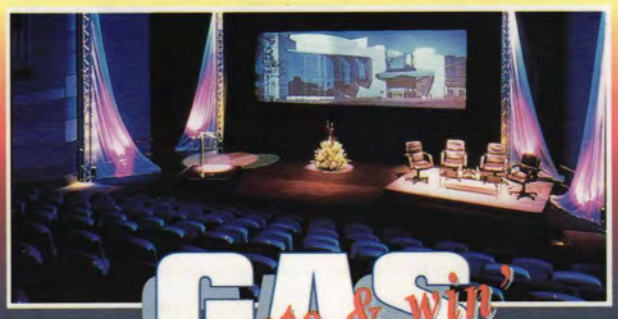
**SIR ALAN COCKSHAW**
Chairman AMEC

V

**RICHARD GIORDANO KBE**
Chairman British Gas plc

The expansion of the world gas industry and the implications of competition mean that it is vital for gas professionals to be up to date. This year, the biggest and most prestigious gas conference in the UK will provide that input. With a top venue of the Birmingham Conference Centre and 30 of the world's most authoratitive speakers to address and answer questions, these two days must not be missed. Major topics include: deregulation and 'lessons in introducing the competitive market'; technological advances; European and global opportunities; the world gas site on internet; reporting of gas related incidents and The Great Debate. The IGE Conference will be lead by President, Cedric Brown and includes a breakfast address by TV personality, Carol Vorderman.

CEDRIC BROWN



'compete & win'

GAS CONFERENCE

CAROL VORDERMAN

Booking & information from: Nelson Events, Nelson House, 46A High Street, Gravesend, Kent DA11 0AY, England
Tel: +44 (0)1474 536535 Fax: +44 (0)1474 536552