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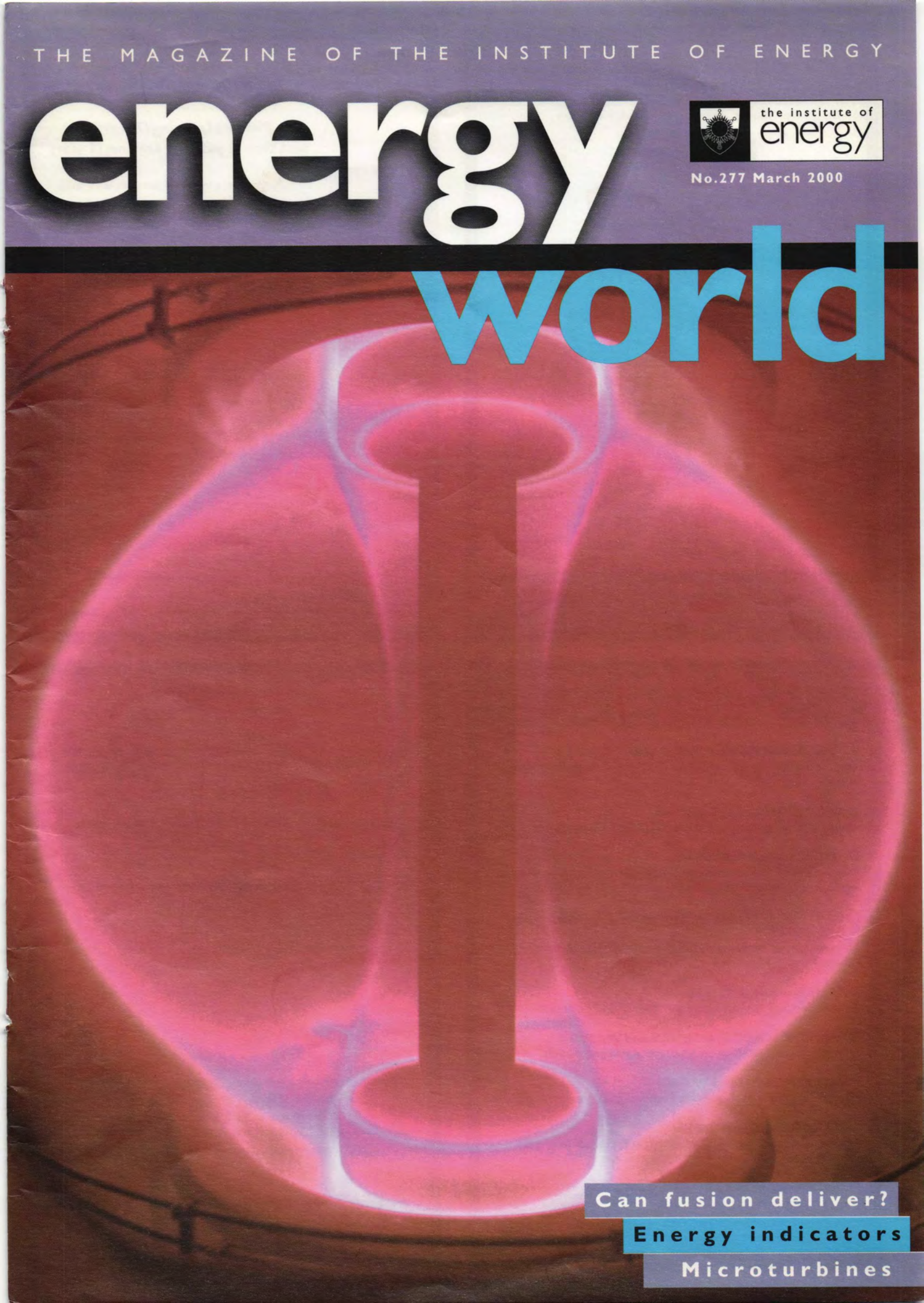

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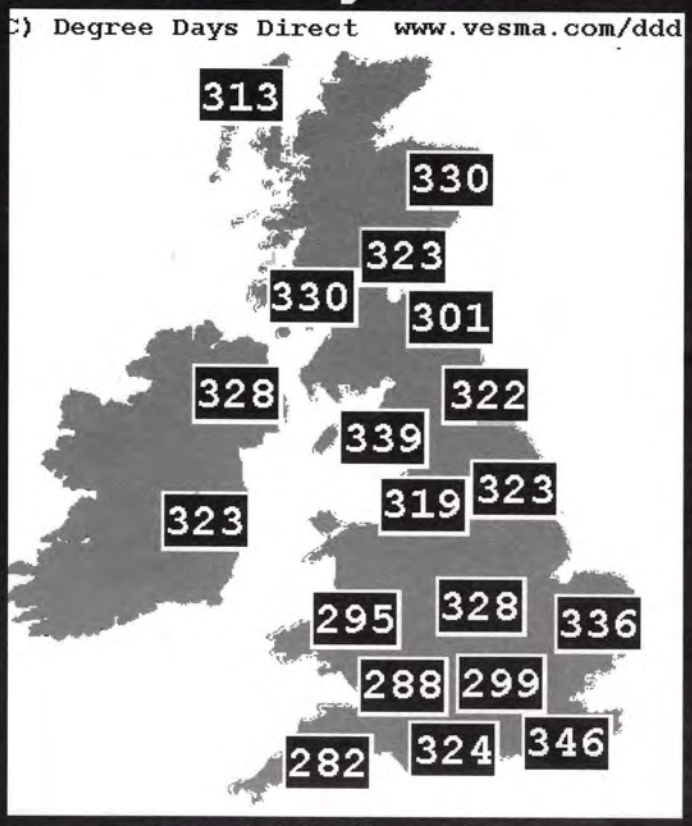

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COVER

Fusion power – energy for the future? The picture shows a near-spherical plasma with a diameter of about 1 m inside the START fusion experiment at Culham. Operated by the UK Atomic Energy Authority, the Oxfordshire laboratory is the world's leading centre for fusion research and host to the Joint European Torus (JET) project.
Fusion researchers are convinced that the technology offers a way out of an approaching energy gap – when coal is squeezed for environmental reasons, world oil and gas production is in decline and renewables are still ramping up towards making a significant contribution. But the technology presents formidable scientific and engineering challenges as well as the promise of enormous quantities of energy for future generations.
See page 16 for the full story.

Equipping professionals to tackle climate change

Phillip Ward, Director of Energy, Environment and Waste at the DETR

We're all going to Hell in a wheelbarrow. That was the prediction of the nation's favourite weather forecaster, Ian McCaskill, about the outcome on climate change at a recent CIBSE annual dinner. Those of you who never believe weather forecasters can choose to ignore this prediction. The rest of us need to reflect on it.

McCaskill was gloomy on two counts. That we are already too late to avoid man-made climate change, the evidence is that it is already underway; and that we have no prospect of making progress while the most energy intensive economy in the world - the USA - still won't face up to the need for action.

On the first he is right to be gloomy. The evidence of rising global temperatures is now difficult to deny. A stream of research reports supports the physical temperature record. More evidence too is appearing about some of the likely impacts. Our press has documented the threat to areas of East Anglia from flooding as sea level rise. Another recent report raised concern about the thawing of the alpine permafrost and the impacts that might have on the stability of structures like ski lifts and on the incidence of avalanches.

There are larger concerns, but the financial cost to a major industry, even in this single example, will be real, and explains why the insurance industry was one of the first to take climate change seriously.

But if it is too late to stop this process from starting, it is not too late to ameliorate it. Most of the modelling underlying the predictions from the Intergovernmental Panel on Climate Change assumes that international action will be taken to limit atmospheric carbon dioxide concentrations to twice pre-industrial levels. The Kyoto agreement, which was groundbreaking in setting the first binding obligations, will not achieve a stable concentration - or anything like it. We have to start to think about our energy needs in a completely different way.

The Government's Climate Change Programme

A starting point will be the Government's Climate Change Programme, due any day now. As well as showing how the Kyoto obligation is to be delivered, it will show how we can move towards the much more challenging manifesto goal of a 20% reduction in carbon dioxide emissions.

All sectors of the economy are expected to play a part in achieving the goals and a range of different policy instruments will be set out. The efficient use and management of energy is - not surprisingly- expected to be high on the priority list. The climate change levy for business users will redirect their attention to this aspect of their cost base after a period when the focus of energy management had shifted to procurement.

The evidence that major energy efficiencies are available to business is irrefutable. The energy intensive sectors have identified savings worth 2.5 million tonnes of carbon - or £600 million - a year. Other business users have at least as much to save. And these are all cost-effective savings. The technically possible options are higher.

Making these savings in practice will need the input of a larger and better qualified force of energy professionals, something which I know the Institute of Energy is well aware of and is responding to.

Cutting domestic emissions, tackling fuel poverty

The domestic sector will not be excluded, indeed it has a central role to play. New requirements on energy supply companies to deliver substantial energy savings will both reduce their customers' energy bills and ensure that the domestic sector will bear its share of the action.

At the same time the new programmes for the fuel poor will begin to deal with the significant numbers of vulnerable people who cannot afford enough energy to maintain their health. For the first time we will have a programme which deals with fuel poverty by comprehensively reducing energy need rather than relying on income increases or fuel price cuts alone. It will be a balanced piece of Government action involving several departments, health professionals, local government and private sector providers in 'joined up' government.

For business the incentives of the Climate Change Levy are already beginning to be appreciated. The Levy sends an important signal about the importance which government attaches to climate change. The recycling of £150 million of the revenue into energy efficiency measures and tax incentives creates opportunities for all businesses to reduce their costs and their emissions.

The public sector cannot benefit from tax allowances, but the reduction in employers National Insurance Contributions funded from the levy should create opportunities for energy managers to argue for the creation of special rolling funds. These would fund energy saving investments and be replenished from cost savings with the surplus going to service improvements.

Creativity and a willingness to look for new solutions have a big part to play in our response to climate change. Without them Ian McCaskill's prediction is probably about right. I would rather prove him wrong.

Wind turbines in the Netherlands add to the European total (Photo courtesy of NedWind)

Wind energy posts its best year ever

Global wind energy had its best year ever in 1999, according to the American Wind Energy Association (AWEA). Preliminary estimates of the new wind energy capacity installed last year total 3,600 MW, bringing the world's wind energy capacity to roughly 13,400 MW. Although Germany added the most wind capacity - 1,200 MW - the United States showed the second-highest growth, with a surging market adding 732 MW, says the AWEA.

The European Wind Energy Association (EWEA) says that its target for 8,000 MW of wind energy in Europe by the year 2000 was achieved early. Latest figures show that over 8,800 MW of wind energy capacity had been installed in the countries of the European Union before the end of 1999. This is an increase of more than 2,000 MW in a single year, a growth of over 30%, says the EWEA.

Germany continues to be the most buoyant European market, with the next busiest market in Spain. There have also been significant capacity increases in Denmark, the Netherlands and Italy.

In contrast, continuing planning difficulties meant that just 20 MW of new capacity was added in the UK.

US green power programmes reach 112 MW

The total new renewable energy capacity installed in the US due to new 'green power' marketing programs has reached 112 MW, according to the US Department of Energy's National Renewable Energy Laboratory. Another 107 MW are either under construction or have been formally announced.

Wind power is the dominant technology, accounting for around three-quarters of the built total, while biomass accounts for half of the planned or announced capacity. The figures exclude renewable capacity built before green power marketing took off in the US.

Tucson Electric Power Co is the latest to launch of a new program for its customers to buy electricity from renewable energy sources. The company's GreenWatts program will sell the electricity, sufficient to power 4500 homes, from a landfill-methane power plant at a premium price.

National Power moves to the US

The UK's National Power is to invest $600 million in two new gas-fired power stations that will increase its commitments in the US to around $1.9 billion. The new combined cycle gas turbine (CCGT) plants to be built are:

- a 550 MW addition to the 1,100 MW plant already under construction at Midlothian, Texas, around 26 miles from Dallas. The 1,650 MW facility will be the largest CCGT in the US.
- a 570 MW plant at Bellingham, Massachusetts, around 30 miles from Boston, and some 10 miles from the company's similar 550 MW plant at Blackstone.

The projects will give the company a total of around 4,000 MW of fully operational CCGT plant in the USA by the end of 2001. The state-of-the-art 'merchant' plants will sell electricity competitively in the market place.

The projects will be managed by the Company's US subsidiary, American National Power, Inc; built by ABB Alstom Power Generation, Inc; and will be 100% funded by National Power. Work is to start immediately on the two plants, and they are scheduled to be operational in the last quarter of the year.

The Company is also in varying stages of development of around 5,000 MW of additional CCGT project opportunities in New England, Texas and Eastern New York State.

CHP would have reduced storm damage effects

Cogeneration campaigners are suggesting that France's dependence on a highly centralised electricity generation and transmission system added to the problems caused by serious storms last Christmas. Some 3.5 million customers lost their electricity supplies when severe gales brought down power lines in the south west of the country during a three day storm staring on 26 December.

Some 360 staff from British utilities were among those drafted in to start repair work. Repair work, with a total estimated cost of £1.7 billion, may take a year to complete.

But fewer customers would have been cut off if more local CHP generation plant had been in place, say campaigners. France has perhaps the most centralised electricity system in the EU.

Powering the South Pole - the Amundsen-Scott Research facility at the South Pole is to extend its use of Caterpillar engines in its upgraded power system designed to cover increases in staffing. The station is currently powered by a Cat 3412 generator set rated to provide 500 kW of prime power.

Six new gen sets have been flown to McMurdo Station, located 729 miles north of the South Pole facility, for temporary storage. These will be flown on to Amundsen-Scott during the 1999-2000 summer period, and installed in a new power plant facility the following year.

Once the gen sets are installed, one Cat 3512B will be paralleled with one Cat 3406 to provide prime and peaking power to the facility, while the remaining two 3512Bs will provide back-up and maintenance power. Two Cat 3406s will be housed in a separate facility and used for emergency power only.

Engine generated waste heat is also used for station heating via a cogeneration system that conducts heated coolant through the various station structures.

Egypt to add 1400 MW of power

Foster Wheeler Corporation subsidiaries have been awarded contracts valued together at more than $100 million by Electricite de France to supply and erect four steam generators and auxiliary components at two power plants in Egypt.

The new plants, which are expected to go into full operation in 2003, will be located at sites in Port Said and Suez Gulf. Each plant will be rated to produce 700 MW of electricity.

The Foster Wheeler natural circulation, conventional steam generators for the new power plants, rated at a nominal 350 MW each, will burn natural gas and oil.

Electricite de France will own and operate the power plants for 20 years. After that, the facilities will be transferred to the Egyptian Electricity Authority (EEA).

Boosting solar efficiency

The US Department of Energy's Oak Ridge National Laboratory (ORNL) is developing a new solar energy system that could potentially boost solar efficiency and economics by a factor of three. The 'full-spectrum solar energy system' uses a roof-mounted, two-axis tracking system to concentrate the sun's light while dividing it into its visible and infrared components. Visible light is distributed through optical fibres into the building, providing a natural light source, while the infrared light is converted into electricity.

The system achieves high efficiencies because the visible light is simply gathered and redistributed, rather than being converted into electricity, says the ORNL.

Kenya commissions hydro and diesel stations

Inside the Kipevu diesel power station

Kenya's largest single hydroelectric power unit - at the Gitaru underground power station - has entered commercial operation. The 80 MW vertical Francis turbine/generator was installed with help from Mott MacDonald on a fast-track programme just 23 months after the contract was awarded to German consortium Siemens-Voith in December 1997. The addition of the third unit to the Gitaru station - originally built in 1978 and comprising two 72.5 MW units - will provide the Kenya Electricity Generating Company with year round peaking power.

Mott MacDonald's role involved overseeing all civil works plus the installation of the generating unit and ancillary equipment, including one 95 MVA 15/220 kV transformer, and 9 km of single circuit 220 kV transmission line.

Meanwhile, Kenya's latest thermal power station has been successfully commissioned and the six 12.5 MW generating sets have now successfully completed their performance and reliability tests on programme. The 75 MW diesel power station – also implemented with help from Mott MacDonald – is located next to an existing steam station at Kipevu on the outskirts of Mombasa. It will provide much needed additional capacity to the Mombasa area and cover periods of low rainfall in a country with a high percentage of hydroelectric generation.

White Paper aims for 'lean and mean' renewables to generate 10% of electricity by 2010

The Government is to replace the Non Fossil Fuel Obligation (NFFO) – the funding mechanism that currently supports renewable energy – with a new obligation on electricity suppliers to ensure that 5% of UK electricity is generated from renewable sources by 2003, and 10% by 2010. Or it plans to do so, once it has yet again consulted interested parties on whether these targets are too tough.

These are the main conclusions in a new Government White Paper: *New and Renewable Energy – Prospects for the 21st Century, Conclusions in Response to the Public Consultation.*

The definition of 'eligible' renewable technologies will also be subject to consultation, although hydro-electric schemes greater than 10 MW in size are likely to be excluded, says the White Paper.

The proposed 'Renewable Energy Obligation' will mandate licensed electricity suppliers to supply the required proportion of power from renewables and allow them to pass on any extra costs of doing this to their customers, subject to a yet-to-be-agreed price cap. Alternatively, they will be able to buy 'green certificates' to demonstrate that another supplier has made up the supply shortfall, or pay a higher 'buy-out' price to energy regulator Ofgem. Powers will be taken in the Utilities Bill to merge existing NFFO contracts (NFFO-3,4 and 5 and SRO-1,2 and 3) into the new market in order to create a growing market, adds the Government.

The Obligation will also be backed up with the development of a strategy of regional targets to increase local acceptance of proposed renewables schemes in the planning approvals system. A revamped programme of R&D, demonstration and information support is also planned and, as Energy Minister Helen Liddell added at the launch of the White Paper, heat and power from renewables will also be exempted from the climate change levy.

But the announcement was roundly condemned by environmental campaigners and elements of the renewables industry. The Confederation of Renewable Energy Associations was the least rude: "The target of 10% of UK electricity from renewables by 2010 is greatly welcomed, but there are a number of critical details which have not been thrashed out yet: what will be the penalties if the electricity companies have not contracted for their 10%? Unless these penalties are severe then the policy will be toothless. Second, renewables projects are often small and difficult to finance; this new policy will make it more difficult to raise finance than the previous policy. Thirdly, the largest single obstacle to the development of renewables has been the planning regime; until Government addresses this issue there is little chance of reaching the 10% target".

Friends of the Earth reacted angrily to "yet another consultation paper on renewable energy – the third since the 1997 general election". FoE complained that the Government was both dithering, and wavering in its support for the 10% by 2010 target.

The British Wind Energy Association complained at the lack of specific support for renewable technologies which are not yet proved in the marketplace; particularly offshore wind. BWEA chief executive Nick Goodall said: "The absence of a short-term replacement for NFFO financial support presents a real threat to establishing an offshore wind energy industry in the UK. Many prospective developers do not share the Government's view that the market alone will invest sufficiently early on to secure the enormous manufacturing and export opportunities that this new industry offers the UK".

The White Paper says that some extra support will be offered to 'longer-term' technologies such as offshore wind and energy crops through the Climate change levy Fund.

Self-styled "founder of the renewables market" the Renewable Energy Company, was more enthusiastic; encouraged by the introduction of regional targets: "each area wil have to assess their own resources and planners won't be able to avoid their responsibilities".

Helen Liddell emphasised the Government's shift away from financial support for renewables and towards a *supply* obligation: "Many renewable electricity generation schemes, using established technologies, are now close to producing power competitive with that generated by mainstream coal and gas plant. It's time to make the next generation of technologies lean and mean as well as clean and green."

Copies of New and Renewable Energy – Prospects for the 21st Century, Conclusions in Response to the Public Consultation are available from DTI Publications Orderline, tel: 0870 1502500, e-mail: dtipubs@echristian.co.uk, or on the DTI website at www.dti.gov.uk/renew/policy

New hydro plants for Scotland

National Power is to build the first of a portfolio of hydro electric power station in Scotland as part of plans to increase its output from renewable energy sources.

The company is to construct the 850 kW Scottish plant at Glen Tarbert, some 20 miles south west of Fort William, at a cost of around £1 million. Construction will be managed under a turnkey contract by Caledonian Energy, a local developer of hydro electric projects.

The station is expected to be operational – powered by the waters of the Alt Corie na Creiche and Gleain Feaith n'Amean burns near Strontian – in the autumn. The plant has a contract under the government's Scottish Renewables Order.

Britain 'urgently needs an energy policy'

Britain urgently needs a long-term, co-ordinated energy strategy, according to Sir Crispin Tickell, Convenor of the Government's Panel on Sustainable Development, speaking at the launch of the Panel's sixth and final annual report. The Panel is to be replaced with a new Sustainable Development Commission in the summer.

The report also looks at genetically modified organisms, world trade, investment and sustainable development, noise nuisance, the ethics of biotechnology and fisheries.

The Panel has had an effect on Government thinking and action, says Crispin Tickell: "When the Panel was first established in January 1994, the somewhat slippery concept of sustainable development was peripheral to mainstream thinking and policy on the environment. That is no longer so, as successive Government responses to our Reports demonstrate.

"There remains much to do. Progress has been variable. The Panel believes that points of particular importance for the future Commission on Sustainable Development are: the need to develop better means for determining the real cost of environmental policy; to cope with the widespread impacts of climate change; to deal more effectively with the disposal of waste, including radioactive substances; to ensure the quality and supply of fresh water; and to do more to encourage energy generation from renewable sources."

He was particularly clear about the need for an energy policy: "There is a critical need, already recognised by many in the fossil fuel industry, for a long term co-ordinated energy strategy. The Government has already given a lead, particularly over climate change, but a reappraisal and re-ordering of priorities is essential to protect the environment and the natural resource base on which we all depend."

Copies of the report are available, free, from DETR Free Literature, tel: 0870 1226 236 and on the Panel's website at www.open.gov.uk/panel-sd/homesd.htm.

Energy intensive sectors agree efficiency targets

The ten main energy intensive sectors of industry have agreed challenging energy efficiency targets with the Government, which will lead to companies in the sectors benefiting from an 80% discount in the rate of the climate change levy.

The sectors' commitments will deliver reductions in carbon emissions of around 2.5 million tonnes of carbon per annum by 2010, says the DETR. The climate change levy package as a whole, including the savings from these agreements, is expected to achieve savings of at least 4 million tonnes.

The sectors are: cement, food and drink, glass, non-ferrous metals, aluminium, paper, chemicals, foundries, steel and ceramics, which together account for over half of the energy used by manufacturing industry within the UK.

The ten year agreements will have two-yearly points at which progress will be measured.

Sectors will be able to achieve their targets by improving energy efficiency, and by engaging in emissions trading both with other companies within the agreements and within wider emissions trading schemes.

New emission levels for power stations

The Environment Agency has set new limits for the control of air pollution from coal- and oil-fired power stations in England and Wales. The decision, which follows comprehensive consultation with industry, sets new limits for sulphur dioxide and nitrogen oxides, and particulate matter.

Environment Agency Director of Environmental Protection, Dr Paul Leinster, said "We have aimed to create a solution that encourages operators to install and use flue gas desulphurisation (FGD) technology – to neutralise acid emissions and therefore protect the environment."

In the decision the Agency reviewed both the A-Limits (those relating to the emissions of SO_2 from an individual power station that help protect the local environment) and B-Limits (SO_2 emission limits on *all* power stations owned by a particular generator that help protect the overall environment) to ensure all aspects of the environment were protected.

As a result of this decision, the Agency will:

- require that by September 2005 the total amount of SO_2 to be released from coal- and oil-fired stations in England and Wales is less than 398,000 tonnes – a reduction of approximately 60% over 1996/97 rates;
- require individual operators to run their FGD-equipped power stations ahead of non-FGD stations;
- allow generators who are increasing their share of the electricity generation market a degree of contained flexibility, within limits set by the Agency;
- allow controlled flexibility in B-Limits in the last two years of construction to companies installing FGD plants;
- limit the amount of SO_2 released per unit of electricity generated;
- require all operators of existing FGD plant to submit a case for their upgrading to improve the removal of SO_2 by October 2000.

Utilities Bill will cut electricity bills by 10%

Stephen Byers: "a fair deal from our utilities"

Currently making its way through Parliament, the Government's Utilities Bill will put consumers' interests at the heart of utilities and deliver further price reductions to consumers, says Trade and Industry Secretary Stephen Byers. The Bill will also put right the deficiencies of the present structure, which fails to ensure effective competition.

The Bill forms the central part of the Government's plans to modernise the energy and other utility industries. Proposals include:

- a new principle objective for regulators to protect the interests of consumers;
- a range of reforms to the electricity market, including the establishment of the New Electricity Trading Arrangements (NETA). The DTI expect this to lead to reductions of 10% - in some cases possibly more - in electricity prices to all consumers;
- powers to enable fuel poverty to be tackled;
- tough fines to be imposed on companies guilty of bad practice or poor performance, such as mis-selling, interruptions to supplies and the speed of reconnecting customers. There will be no upper limit on the fines the regulator can impose;
- 'one stop' independent consumer councils to be established for gas and electricity, telecommunications and water utilities to investigate complaints and assist customers;
- price-regulated utilities to publish links between directors' pay and quality of service;
- regulators to give reasons for their key decisions;
- Ministers to be given powers to promote energy efficiency and electricity from renewable sources;
- in energy and telecommunications, reflecting the more competitive nature of these markets, a new principal objective for the regulators to protect the interests of consumers;
- in water, reflecting the role of statutory undertakers, the regulator's consumer objective to rank alongside the duties to secure the delivery and proper financing of those functions.

Mr Byers said: "This Bill will tackle the rigged electricity market created when the industry was privatised and put in place a modern framework for utility regulation. We will also tackle fuel poverty. At the beginning of the twenty-first century, people shouldn't struggle to keep warm in their own homes. The Bill will enable use to give statutory guidance to the regulators on tackling these issues and will give us reserve powers to help disadvantaged gas and electricity consumers if we believe it is necessary."

The Bill will also require electricity supply companies to generate a proportion of electricity from renewable sources (see page 5).

Two thirds of coal mines 'at risk of closure'

Two-thirds of Britain's remaining coal mines face closure before the end of next year, unless Government acts to remedy its own failures, according to a new report: *The New Case for Coal* by CLG Energy Consultants. The report suggests that without Government support six million tonnes of deep mine capacity may have to close this year, with similar capacity at risk in 2001.

The report highlights that many of the problems the industry is facing are a consequence of Government failing to fulfil the action programme that it set itself after the last coal crisis, in 1997. Government has, says CLG:

- failed to stop the dumping of Polish coal in the UK,
- failed to stop massive state aids to coal producers in Germany and Spain whose costs of production are four times those in the UK,
- failed to provide fairer electricity trading arrangements with France,
- failed to stop gas fired stations from displacing lower cost coal fired stations in the electricity market.

The author of the report, Colin Godfrey, has over 20 years' experience in the energy sector – with the CEGB, National Power and RJB Mining.

Government energy policy objectives continue to be compromised by the ongoing dash-for-gas, says Godfrey. The expected life of UK gas reserves have fallen from 33 years in 1992 to less than 14 years today and the UK will be increasingly dependent upon imports of gas from Russia, the Middle East and North Africa.

Unless urgent action is taken by Government to support UK coal producers some 30% of remaining deep mined production could close in 2000, with a similar capacity closing in 2001, says CLG.

Coal mines at risk of closure

Can the energy the environment?

Much of the world is following the move, pioneered in the 1980s by the UK, largely to replace prescriptive national energy policies with lighter regulation and liberalised energy markets. Now, ten years after electricity liberalisation, the UK Government Utilities Bill seeks to "put right the deficiencies of the present structure" and tilt the balance back towards consumers and the environment. But can markets ever properly protect the environment? Not without an energy policy designed to restrain them within a strategic framework, argues Professor Ian Fells, in an article based on the John Collier Memorial Lecture given by Professor Fells originally to the Institution of Chemical Engineers.

Liberalisation of the energy market is extending across the world like a pandemic, embracing the former centrally planned economies as well as the European Union. Enthusiasm for the market as a guiding force goes back to Adam Smith in the 18th century but more recently the omniscience of the energy market in controlling supply and demand was extolled by Nigel Lawson, later Chancellor of the Exchequer, in a speech at Cambridge in 1982; "Energy is a traded good... our task is to set a framework which will ensure that the market operates in the energy sector with a minimum of distortion." This led, in the United Kingdom, to a programme of privatisation of the monolithic, nationalised energy industries, starting with gas in 1986, electricity in 1990, coal in 1994 and finally, the nuclear electricity, which had been left out of the initial electricity privatisation because it was thought unsaleable, was privatised, very successfully in 1996.

This determination by the UK to liberalise its energy market has been used as an example by many countries. Prices to the customer of coal, gas and electricity have been driven down to below 1970 figures but, paradoxically, this has been achieved by draconian regulation of industries often referred to as deregulated. This has been necessary because distribution of gas and electricity is a natural monopoly and excessive charges to third parties wishing to use the networks had to be curbed. Also the privatisation process was thought not to have produced sufficient competition for the market to operate well and surrogate competition was provided by the regulators. Marketing, particularly of electricity, via a pool mechanism was also bedevilled by 'gaming' on the part of the major generators such that the Pool price occasionally rose to absurdly high figures and the average wholesale prices of electricity from the Pool has not altered over a decade whilst fuel, generation and distribution costs have halved, despite repeated intervention by regulators! It is hardly surprising that arrangements for marketing electricity are being changed.

The major failures of the market mechanism are:

- environmental costs are not included (with the exception of nuclear power),
- long term investment has been squeezed out by short term gain,
- support for research and development has been a noticeable casualty, with programmes in electricity and gas reduced by 90% or more since privatisation.
- heavy regulation has been needed to provide surrogate competition,
- transport, a huge energy user and environmental polluter, has been allowed to expand unchecked.

These problems are being addressed in the UK and elsewhere with varying degrees of success.

Drivers of the energy market

A major driver of the energy market is the ever-increasing demand for energy, particularly from developing countries where some economies are growing at 10% or more, and is bolstered by the enhanced expectations of the rising populations. With American and Canadian per capita consumption at least an order of magnitude greater than in South East Asia and with 20% of the world population consuming 80% of the available energy, emphasising the disadvantage of the developing world, demand for energy will continue to rise through he next century. An analysis by the Royal Society of London and the Royal Academy of Engineering suggests that future energy requirements will be 1.4 times present demand by 2020 and between two and three times by 2050 (and five times by 2100).

Left to the market this demand will be largely met by fossil fuels, with gas and then coal taking over the major share as oil supply peaks. There is some optimism that gas hydrates might provide a huge additional resource of natural gas. Currently hydrocarbons provide about 80% of world energy with large-scale hydro and nuclear providing around 10% between them, and biomass (fuel wood) the rest. Although, ironically, this renewable resource is the first fuel to start running into short supply particularly in south east Asia and Sub-Saharan Africa. New renewables: solar, wind etc hardly figure in the statistics; wind, for example, provides only 0.15% of world electricity.

Threats to the environment

The consequences of this massive and increasing combustion of fossil fuels is raising the concentration of carbon dioxide levels in the atmosphere from the 270 ppm of the mid 19th century to over 370 ppm today. The dire consequences of the resultant global warming are already being perceived with a temperature rise of 0.6°C

market protect

by Ian Fells, Professor of Energy Conversion at Newcastle University

and a sea level rise of 18 cm through the 20th century. By 2020 the temperature will have risen by another 0.4°C and the sea level rise will be an additional 10 cm. Climatic patterns are changing and there seems to be an increasing incidence of extreme climatic events; hurricanes, storm surges and the like.

This long-term threat to the world's climate, essentially a destabilising of the weather machine, has penetrated political thinking and stimulated a series of international conferences to decide what should be done. The latest COP5 (5th Conference of the Parties) advised by the Intergovernmental Panel on Climate Change (IPCC) met in Bonn last October to try to work out technical details of the commitments made at the Kyoto meeting of 1997. These were reductions in greenhouse gas emissions levels, of which CO_2 is the major player, of 5.2% below 1990 figures by the developing nations between 2008 and 2012.

The US share of this saving is seven percent; as it is already seven percent over its 2000 commitment to reduce green house gases to 1990 figures, the prospects for meeting its 2010 Kyoto commitment seem remote. Germany and the UK seem better placed to meet at least their 2000 commitment (the result of the Rio de Janeiro meeting of 1992). In the case of Germany, closure of the inefficient coal-based industries in East Germany on unification and, in the UK case halving of coal-fired electricity generation and replacement with gas, together with a more confident and successful nuclear industry (30% of UK electricity) have conspired to ensure compliance.

This can been seen as a market success which has only coincidentally improved environmental performance of the two countries. But this success will not be repeated and in the UK government policy is to let the nuclear industry gradually fade away as stations come to the end of their useful life. Carbon dioxide emissions will therefore rise by five percent between 2008 and 2012 if the decommissioned Magnox stations are replaced by gas-fired stations which are currently cheaper to install and run.

the taxation of transport fuels by governments could be seen as an attempt to reduce the continuing explosive growth of cars in particular but, in truth, up to now it has merely been a revenue generating process

The market and the environment

In assessing the costs of different energy supply technologies the cost to the environment of implementing a particular technology is not applied evenly across the board. In the case of nuclear power, decommissioning and waste storage costs are included and reflected in the cost of a unit of nuclear electricity. Not so for coal, oil or gas-fired electricity where decommissioning costs of, for example, North Sea gas rigs are not currently reflected in the gas and therefore electricity price. More importantly, the costs of mitigating the effects of global warming such as improved sea defences to reduce risk of flooding, costs to farmers of irrigation in drought hit areas, migration of starving populations from countries rendered unsustainable by climate changes or even submerged in the South Pacific, are not included. These figures are very difficult to ascertain so they are ignored, but they should be properly included in the cost of electricity generation from fossil fuel stations or added as a credit to clean technologies such as nuclear or renewables.

It should be said that there are environmental costs not associated with global warming which are attracted by renewable energy. Wind farms cause visual pollution, large scale hydro alters the landscape irrevocably, causing changes in farming and fishing and, worse, occasionally dams burst; 300,000 people have died in Hunan Province in China alone since 1944 as a result of bursting dams. All electricity generation technologies have risks as well as benefits. Sequestration of carbon dioxide in geological formations from which oil and gas have been extracted or as a liquid or solid in the deep sea is an expensive business and will only be used as a last resort.

Protecting the environment

Costing the environment turns out to be insuperably difficult. The market, of course, values it at zero and will throw anything into it that it can get away with unless stopped by legislation. The reduction of sulphur emissions to the atmosphere by European legislation, the large combustion plant directive, has been strikingly successful and illustrates the point.

Another technique is taxation and the taxation of transport fuels by governments could be seen as an attempt to reduce the continuing explosive growth of cars in particular but, in truth, up to now it has merely been a revenue generating process. The money obtained has rarely been fed back into public transport or even improved road networks. There are 600 million cars on the world's roads today; estimates of up to 3 billion cars have been suggested for 2020. In industrialised countries such as France and in the UK a 40% increase is probable. Transport is responsible for 25% of current carbon dioxide emissions, just less than the electricity supply industry which stands at 30%.

Unfortunately, control of the number of cars on the road is extremely difficult; the

freedom and provision of private space which car ownership confers is much prized and people are very reluctant to give it up. Indeed, in developing countries the desire to own a car is very strong; China expects a six-fold increase to 60 million cars by 2020. Where change in social habits and expectations is likely to prove extremely difficult, a resort to a technical fix offers the best prospect for reducing transport emissions.

The modern diesel engine is 30% more efficient than a gasoline engine and less polluting with modern clean-up systems.

A move to diesel vehicles giving 100 km for 3 litres of fuel is encouraged by a number of European countries where diesel fuel costs a third less than gasoline. This is an example of taxation being used to achieve a desirable environmental end. The market alone would not deliver such a result where the status symbol of a large and powerful car drives the market, as in the US, where gasoline is less than one US dollar per gallon and the four litre 4 x 4 sports vehicle is the norm. Unfortunately, in the UK the policy is to tax the motorist, whether diesel or gasoline powered, off the road without providing alternative means of transport. This disadvantages the poor and those living in rural areas where deregulation of the bus service has almost destroyed rural public transport.

The next stage in personal transport is the hybrid vehicle with electric traction and a battery kept charged by an optimised diesel or gasoline engine. This reduces carbon dioxide emissions by 40% and provides an extended range over the simple battery car - although a straightforward battery-driven car with a range of 60 miles is ideal for commuting and has a daily running cost of one pence per kilometre. It is preferable if the electricity used to charge the car at night is nuclear or renewable based, but a modern gas-fired power station with a generation efficiency of 55% is also a striking improvement over a gasoline powered car, which only gets 17% of the energy in the fuel to the wheels. This falls to four percent in slow moving traffic!

The next stage is the fuel cell car powered by hydrogen, again preferably produced by nuclear or renewable energy. Such cars already exist, encouraged by states such as California which specify a percentage of cars sold in the state must be zero emission vehicles. The only way that carbon dioxide emissions from transport, and cars in particular, can be reduced is by the use of 'carrot and stick' fiscal instruments.

Both nuclear and hydro systems have high initial capital costs and long construction times which means returns on capital is delayed; planting trees for biomass-based generation suffers from a similar problem

The move to hydrogen-based fuel cells presages the advent of a hydrogen economy. In the Netherlands up to 15% hydrogen is already being added to the natural gas supply so that carbon dioxide emissions are reduced when the gas mixture is burned.

Air transport is also set to increase rapidly over the next 20 years with the number of aircraft doubling. This means that air transport will be responsible for six percent of world carbon dioxide emissions, not a negligible contribution. A move to hydrogen-rich hydrocarbon fuels or even hydrogen itself is contemplated.

Nuclear and renewable electricity

The success of the market, encouraged by regulation, in driving down fuel costs particularly coal and gas, makes the future for nuclear and renewable energy bleak. Although between them large-scale hydro and nuclear provide 35% of world electricity without emitting carbon dioxide, investment in new generation will be in gas or coal-fired stations where generation and investment costs are less and construction times much shorter.

Both nuclear and hydro systems have high initial capital costs and long construction times which means returns on capital is delayed; planting trees for biomass-based generation suffers from a similar problem. But such stations last a long time, typically 40 years for a nuclear station and 100 years or more for hydro stations, and can provide long-term fixed price contracts as fuels costs are low or zero. In the case of gas or coal a modest increase in price, leading to a one pence per kWh increase in the wholesale electricity price, begins to make nuclear competitive but such is the short term investment thinking used by electricity generators with, as they always say, shareholders in mind, that they go for gas or coal and assume the market will keep prices low forever, or at least 30 years or so.

The situation could be transformed by the imposition of a carbon tax, not an energy tax. New renewables, that is, wind, solar, tidal, small-scale hydro, wave, geothermal, ocean and so on together with large-scale hydro are planned to provide up to 12% of European energy by 2010, currently 6%. There is little prospect of further large-scale hydro so relatively mature technologies such as wind power, but with biomass as the biggest provider, will have to achieve an enormous expansion. Figures of up to 25% renewable energy supply are given in World Energy Council scenarios for 2050. A Shell scenario gives 50% renewable energy by 2050 but it does not stand up to perceptive scrutiny and is seen as a maverick prediction although politicians find it attractive in that it apparently reduces the need for a nuclear input. Other scenarios suggest a nuclear input of 14% total energy will be required by 2050.

Looking further ahead to 2100 and beyond it is difficult to see how demand for energy, five times today's demand, can be met without a large scale nuclear input and that will mean moving to the fast breeder reactor. The technology is proven but requires continuous further development to ensure safe and reliable operation. The Russians have run the NS600 fast reactor for 17 years with an availability of over 70%; it is a pity that short-termism caused the close down of the Dounreay Prototype Fast Reactor in Scotland and Super Phenix in France, the argument being that they would not be required for 30 years. It has taken 40 years to develop thermal reactors to their current level of sophistication. Using uranium fuel in the fast reactor with its 60% improvement in efficiency would essentially multiply total

energy reserves of the world by 10.

But it is a matter of pubic perception of the risks and benefits of nuclear power; are the risks of a nuclear accident more acceptable than the near certainty of global warming with its attendant destabilising effect on climate and weather? This comparison is rarely put and the nuclear industry persists in its siege-like mentality of never making public announcements unless forced to; it might be helpful to be more pro-active.

Renewable energy, on the other hand, has a good press but claims made for it are often wildly optimistic and again the market does not deliver renewable energy into the mix unless it is subsidised one way or another via the Non Fossil Fuel Obligation (an unusual tax on fossil fuel electricity hypothecated for renewable and nuclear energy) in the UK, or legislation in other European countries. There is a strong environmental lobby against some kinds of renewable energy. Wind farms are seen as visually obtrusive and tidal barrages disadvantage wading birds, again a question of risks and benefits, but rarely examined in this light.

The Severn Barrage would provide seven percent of UK electricity at four pence per unit using an eight percent discount rate. But the market will not deliver it as the £10 billion price tag is too high for current investment criteria, in that it will not deliver at a 16% discount rate which the city demands, and it would take too long to build, 12 years or so. The facts are that it would last for over 100 years, delivering electricity at 0.5 p/unit once the capital and interest had been paid back after 25 years. But it requires investors, which would have to include the Government in some way, to take a statesmanlike long-term view. The main stumbling block however is undoubtedly the powerful bird lobby who do not want to see the estuary changed.

Large-scale hydro suffers from environmental objections and particularly the fishing lobby; it is rejected as 'unsustainable'.

If the renewable energy component of the energy supply mix is to grow, as it must if we are to meet our Kyoto obligations, and the UK has set itself an even more difficult figure of 20% carbon dioxide reduction by 2010, fiscal incentives, which would include a carbon tax, will have to be introduced and strengthened. The market will have to be manipulated in such a way as to do what it does best and, that is, to deliver lower prices for energy, but without damaging the environment.

in the case of the UK and other developed countries, a 30:30:30:10 fuel mix, that is 30% gas, 30% coal, 30% nuclear and 10% renewables, will begin to deliver reduced carbon dioxide emissions

Why not use energy more efficiently?

The energy producers, whether it be oil, gas, coal, renewable or nuclear want to sell more and so satisfy their shareholders and directors. That is the nature of private enterprise and, for that matter, a legal obligation on a company. There is little incentive to improve the efficiency of energy use if it means selling less of it, perhaps 20% less as is often suggested. But improved energy use is an important plank in government strategy to meet Kyoto obligations. In the UK a levy on electricity is spent on improving the efficiency of energy use and the same may soon be the case for gas. Unfortunately the lower the cost of energy the less the incentive to use it efficiently and invest in new, more efficient systems.

In the UK, having successfully driven the price down, the government now proposes a Climate Change Levy or energy tax to raise the price and so make people use energy more efficiently.

There is some enthusiasm for carbon trading as a cost-effective way of reducing carbon dioxide emissions. In the US, trading has been effective in reducing sulphur emissions and it is hinted that introducing carbon trading, so that the US can buy permits from Russia cheaply, is the only way to get the US to sign up to the Kyoto protocol.

In practice it is proving very difficult to organise carbon trading, though some international companies such as BP have succeeded internally.

Is an energy strategy necessary?

Left to its own devices the market will encourage the growth of transport, and increase electricity supply generation using gas and coal-fired power stations. It will pay only lip service to improving energy efficiency as operators are intent on maximising profits. It will not deliver "secure, diverse and sustainable supplies of energy" as the White Paper *Prospects for Coal* (1993) promised. Countries intent on meeting their Kyoto obligations will have to use fiscal instruments of various kinds and, in the case of the electricity supply industry, set a strategic framework using fuel-specific licences.

In the case of the UK and other developed countries a 30:30:30:10 fuel mix, that is 30% gas, 30% coal, 30% nuclear and 10% renewables, will begin to deliver reduced carbon dioxide emissions. For those countries politically opposed to using nuclear power 40% non-polluting, ie renewables, will be required, a pretty tall order. Human nature being what it is, is only likely to shift ground marginally towards, say, public transport and is unlikely to make any firm move to use energy more efficiently, particularly if it is cheap. Improved technology must be the way ahead; in other words, a technical fix. Some way of financing generic research and development in energy, a noticeable casualty of the privatisation process must be found. The enormous increase in the efficiency of electricity generation by using the gas-fired combined cycle shows just what can be done.

Political rhetoric must be backed up with firm and cohesive actions. The market place is powerful within its confines but it will not deliver our environmental expectations without help, and that means countries will have to develop energy policies constraining the market within a strategic framework; an energy policy, in other words. This will reduce carbon dioxide and other emissions and slow down the rate of global warming.

Indicators of

How do we know if Government energy policy objectives are being achieved? The DTI has developed what it calls "appropriate quantifiable targets" to measure and thus monitor progress. Steve Hodgson takes a look at the graphs.

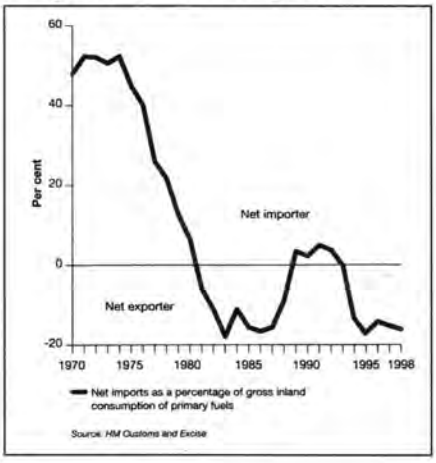
"to ensure secure, diverse and sustainable supplies of energy at competitive prices"

Britain's energy policy, as summed up in less than a sentence by Energy Minister Helen Liddell in her foreword to the Government's 1999 *Energy Report*, has changed little over recent years. And, even so short, it is self-contradictory. For example, the Government has been very successful in achieving competitive (lower) energy prices over the last decade or so, but this has been at the expense of sustainability. Hence the Climate Change Levy, which will begin to nudge prices up again.

Is this progress? In an effort to measure progress made towards it objectives, or perhaps towards some sort of balance between them, the Government has developed a series of quantifiable indicators. These are contained in a new, free publication: *UK Energy Sector Indicators* and, in a shortened form, in an annex to the 1999 *Energy Report*.

Indicators are given for each objective: energy security, diversity of supply, sustainability of supply and use, and competitive prices. I have picked out a few to illustrate the point.

Figure 1:
Energy trade and consumption



Security of supply

Figure 1 shows that the UK's has been a net energy exporter since 1981, once North Sea oil began to flow ashore in sufficient quantities from the late 1970s. It is easy to forget that imported energy accounted for over 50% of UK consumption in the early 70s. The graph shows a temporary return to net imports in 1989-92 due to reduced oil production which followed the Piper Alpha accident. Other wise, security of supply looks good.

The other indicator security included in the *Energy Report* shows electricity supply interruptions decreasing ever so slightly year on year – increasing security.

Diversity of supply

Diversity is considerably more difficult to quantify than, for example security, but it is also central to the current energy policy debate – the Government continues to operate a ban on new gas-fired power stations, principally to slow down moves towards an over-dependence on gas, but also in favour of coal, CHP and renewables.

Figure 2 is an attempt to illustrate diversity of fuels used to generate electricity using the so-called Shannon-Weiner measure, which equals "the market share multiplied by the natural log of the market share for each available fuel overall summed together". The measure places greater weight on contributions of smaller participants in fuel markets, as these provide the options for fuel switching. A Shannon-Weiner value of zero represents a single fuel monopoly.

The graph barely shows the results of the gas moratorium as this came into force almost at the right end of the curve (December 1997), but it does show a generally increasing trend since 1980 – ie towards greater diversity of supply. The peak in 1984 represents the miners' strike, when the oil-burn increased to compensate for lost coal.

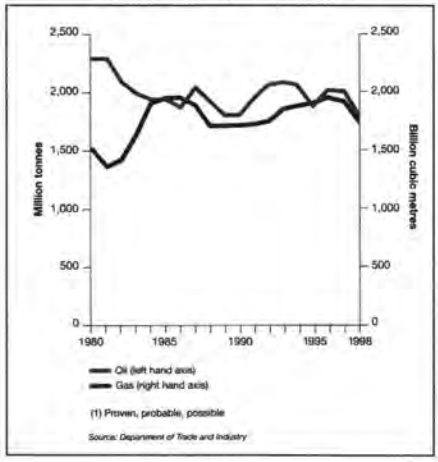
Figure 2:
Diversity of fuels used for electricity generation

However the bigger picture, that of fuels used throughout the economy, shows an almost steady value during the 1990s – here the increased use of gas for power generation translates into less diversity (considering gas' major role in other sectors) and the graph has fallen very slightly since 1995. Diversity is decreasing.

Sustainability of supply and use

For the supply picture, Figure 3 shows the UK's oil and gas reserves (proven,

Figure 3:
Remaining reserves of oil and gas



success

by Steve Hodgson

probable and possible). Remarkably these have both remained roughly constant since the mid 1980s despite record highs in oil and gas production. This is the economist's way of looking at reserves: if new finds and revised estimates of field sizes match production during the year, then reserves are said to be the same at the end of the year.

Both the oil and gas graphs took a turn downwards in 1998, though, perhaps signalling the start of a real cut in reserves and a serious wake-up call to the Government about the prospects for UK self-sufficiency in the future.
The *Energy Report* itself suggests that the UK will be a net importer of gas again from some time between 2003 and 2010.

Looking now at sustainability of energy use, Figure 4 shows trends in carbon dioxide emissions over the last three decades. While GDP has risen by 85% since 1970, carbon dioxide emissions have fallen by 18%. Add the two trends together, and emissions per unit of GDP have fallen by more than half.
But emissions per unit of GDP actually rose again during 1996 and 1998, due to colder than average winters and higher use of coal to generate electricity in 1998, says the *Energy Report*. This indicator may be close to bottoming out.

Other indicators shows the UK's overall energy ratio (energy use per unit of GDP) decreasing steadily at around 1% a year from 1950 (but actual energy consumption rising by 60% over the same period; and sulphur dioxide emissions falling very substantially with time, to a quarter of their 1970 levels by 1998. Good for sustainability.

Competitive prices

Figure 5 shows trends in industrial electricity and gas prices since 1970 – prices are corrected for inflation. Gas prices have varied enormously, the well-remembered price collapse of 1986-87 being just part of the roller coaster. Electricity prices have been steadier – although both are lower now than at any time in the last nearly 30 years. Privatisation and liberalisation have certainly delivered lower energy prices.

Other indicators show more modest falls in domestic energy prices, partly due to the imposition of VAT; and the UK's position in league tables of European and other industrial nation electricity and gas prices – generally towards the low end.

Figure 4:
Trends in the level of carbon dioxide emissions and carbon dioxide emissions per unit of GDP

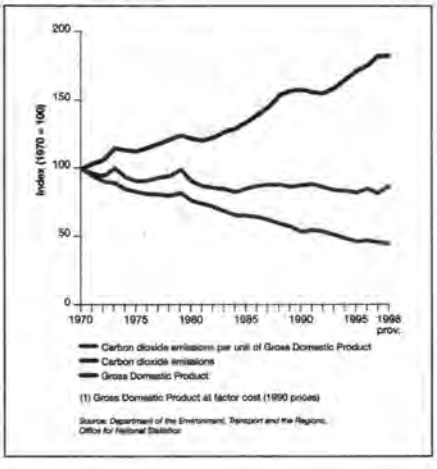
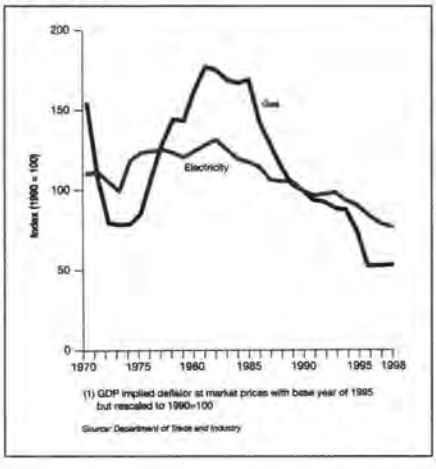


Figure 5:
Indices of industrial electricity and gas prices



Overall, the indicators show a mixed picture. At first glance, security of supply looks good, for now at least; diversity in electricity generation is rising; reserves are holding up; many of the environmental indicators are moving in the right direction and energy prices have fallen – some dramatically.

But a second glance reveals a shifting picture. The growth in gas used for electricity generation is depleting supplies fast and we may be importing gas in as little as three years' time, perhaps reducing security of supply. Commentators are already debating whether Russia and Algeria represent 'stable' suppliers.

Further, the increased gas burn, while clearly helping to cut carbon and sulphur dioxide emissions, is also reducing the UK's overall diversity of energy use. And perhaps the most successful set of indicators, those showing falling energy prices, may see those falls begin to be reversed as the Climate Change Levy arrives and, perhaps, as the price of imported gas begins to rise.

The indicators seem to suggest that moves to burn more and more gas in order to reap environmental and, initially, diversity benefits may have to be limited on security and, eventually, diversity grounds too. That is, if we want to ensure secure, diverse and sustainable supplies of energy at competitive prices.

Copies of UK Energy Sector Indicators are available, free, from Gillian Purkis at the DTI, tel: 0207 215 2697, e-mail: gillian.purkis@epad.dti.government.uk

Copies of the 1999 Energy Report are available for £39.50 from the Stationery Office

Microturbines – contenders for the distributed power revolution?

by Frank Escombe, EscoVale Consultancy Services

There is much interest in the concept of distributed power generation – the replacement of large, remote power stations with lower cost, more efficient and smaller plants sited locally. CHP, renewables and fuel cells have dominated thinking so far. Here, Frank Escombe introduces another possibility – microturbines.

What are microturbines? *Energy World* readers are better placed than most but, even here, those familiar with microturbines are in a minority. The rest are in good company. Just over two years ago, the author was interviewing quite senior executives at one of the world's largest power plant manufacturers. The subject was the future size and structure of the market, and the contribution of smaller scale plant. The discussion turned to the possible role of microturbines. After a confusing ten minutes it dawned on us that we were talking at cross-purposes. The things I had in mind were rated at a few tens of kW, while the manufacturer's perception of a microturbine was a unit rated at perhaps a few tens of MW.

The point of the story is not that a few senior people were poorly informed about one of the dozens of new technologies that could conceivably impact on their business. Most of us are in that position. The point is that, just a short time later, the company in question is now directly involved in the microturbine business – as are several of its competitors.

In a few short years, microturbines have emerged as clear favourites in the battle to unlock the sub-MW distributed generation business. That is a multi-billion dollar prospect in its own right, but the story does not end there. Advocates of the technology see microturbines as key players in conventional and mobile power plant; in new hybrid systems (in conjunction with other power sources such as fuel cells or reciprocating engines); and as vehicular power units. The automotive application is interesting, and was the starting point for many microturbine projects, but will not be considered further here.

How do microturbines work?

The technical envelope of the microturbine can be described as:

- occupying a power range from around 10 kW to 500 kW,
- incorporating turbomachinery, usually based on centrifugal/radial flow designs and typically derived either from automotive turbochargers or military/aerospace auxiliary power units,
- usually with just one rotating unit, with the compressor, power turbine and alternator mounted on a common shaft – most microturbines are generating sets, with no option for a mechanical drive output,
- operation at high speed (from tens of thousands r/m for larger microturbines, up to more than 100,000 r/m for small machines),
- capable of low emission combustion, usually at quite modest pressure and temperature conditions,
- with a recuperative cycle, at least as an option,
- designed for very low maintenance requirements (typically representing fractions of c/kWh within the overall cost of electricity),
- compact construction and light weight – the entire package is small enough to be transported to site in the back of a small delivery truck.

The main features of a typical single-shaft microturbine are illustrated in Figure 1. It operates on the same general principle (the Brayton Cycle) as a conventional gas turbine.

Figure 1 Microturbine schematic
Note: The turbine and compressor are shown using familiar (axial flow) gas turbine symbols. Most microturbines use radial flow technology for which different depictions may be used.

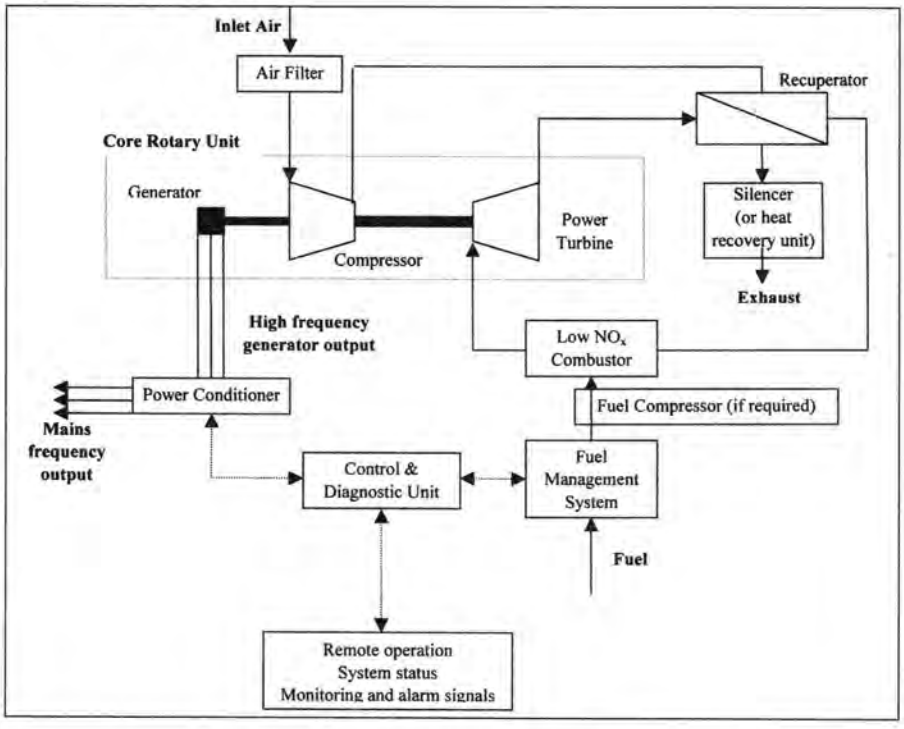


Figure 1 serves to illustrate the main operating principle, but there are several variants. These include: use of a regenator rather than a recuperator and unrecuperated operation.

How good are microturbines?

The microturbine's characteristics are those of a pragmatic, real-world competitor, rather than a cutting-edge technology pushing back performance boundaries to levels that are unattainable by other means.

The microturbine is more expensive than a diesel genset, has higher emissions than a fuel cell and is less efficient than a spark ignition gas engine set. However, the overall package in terms of performance, physical size, emissions, capital cost, fuel economy, O&M costs etc, looks set to make the microturbine the leader within its power range and its target markets .... or so the developers and their backers believe.

Once in volume production, installed costs are projected at less than $500/kW, down to $300/kW or less. This is comparable to figures for large gas turbine power stations. Light weight, small size, absence of cooling systems and simple plug-in heat recovery options promise easy 'through-the-door' installation, even for small cogeneration units. Annual service intervals, and construction from field-replaceable subsystems, promise very low maintenance costs.

Microturbines offer exceptional emissions performance. Some designs will provide single-digit NOx and CO levels from the outset, with catalytic combustion as an even cleaner option before long. This is an important factor. If power plant is to be widely deployed and regularly used near load centres, emissions performance will need to be as good as that of the alternative of modern central power stations.

Efficiency is the microturbine's weakest suit, with 30% (LHV) at 100 kW as a benchmark figure on low pressure natural gas. This is certainly not a show-stopper, and it limits the accessible market in some of the key application areas. These are early days, and the efficiency can be expected to improve by a few points – a useful gain, but not sufficient to catch up with rival technologies, where efficiency levels are also moving ahead.

In situations where efficiency is critical, new types of microturbine will provide more radical improvements. One route is through higher temperature operation using largely ceramic construction. Efficiencies of over 40% at microturbine power levels have already been demonstrated in the laboratory. Another promising area is the use of mixed technology systems, where microturbine/fuel cell combinations are expected to achieve efficiencies of the order of 60% – exceptional by any standards, but particularly at sub-MW power levels.

Looking ahead, we can envisage a family of microturbine products, with different cost and performance characteristics, capable of tackling a broad swathe of power source applications.

How far away are they?

The 20th century answer to this question was typically 'a few years'. However, we are now at the stage where the correct answer is in terms of distance, rather than time. At present, the average distance between an *Energy World* reader and the nearest microturbine is less than 100 km. It's a fair bet that this will be down to 10 km within a year or two. The big questions are: when will it get down to 1 km and whether we will see distributed energy systems making a substantial contribution to power provision. With distributed energy, we are in the realm of 100 m power, rather than the concept of large, distant, central power stations.

Microturbines are real products in series production:

- manufacturing capacity is now in place for 1000s of units per annum,
- the largest assembly facility at present is scheduled to expand in phases over the next few years to 40,000 per annum,
- ambitious plans have been mooted for individual plants capable of 100,000 units per annum (of the order of 10 GW per annum) – sited in developing countries and mainly to serve indigenous markets.

Will microturbines make it?

EscoVale recently published a report on microturbines, forecasting technical and market developments over the period to 2020. This is based on a three-year study on behalf of clients from six continents. The fact that so many companies have already supported this work underlines the intensity and the extent of interest in the subject. It is also a fair indicator that there is enough serious interest to ensure a place for microturbines within the increasingly complex and competitive power plant market.

The microturbine business is a flourishing sector in terms of the diversity of developers. There are now around 30 companies in various stages of product development (and many more involved as component suppliers, investors and marketing partners). A few of the developers can claim to be in production; some have prototype and field trial hardware; others are at an earlier stage, with sub-system evaluation and paper studies that will enable them to be fast followers, if and when the market develops to a level that justifies their participation.

There are bound to be casualties and some difficult years ahead. The market still has to get to know microturbines (and vice versa). The EscoVale report concludes that we are a few years from market lift-off and it is less optimistic than many, regarding the longer term potential – either for microturbines or for distributed energy.

However, we are heading for a world with a $10 billion-per-day electricity habit. Distributed energy does not need a monopoly position to become a huge business. The microturbine looks set to play its part in achieving this, and it should also thrive in a number of other market areas. As to just how many of those mega-factories might be needed to meet EscoVale's forecast of global demand ... well the average distance between an *Energy World* reader and the keyboard that will get an answer from *info@escovale.com* is probably about 1 m.

Fusion power – energy for the

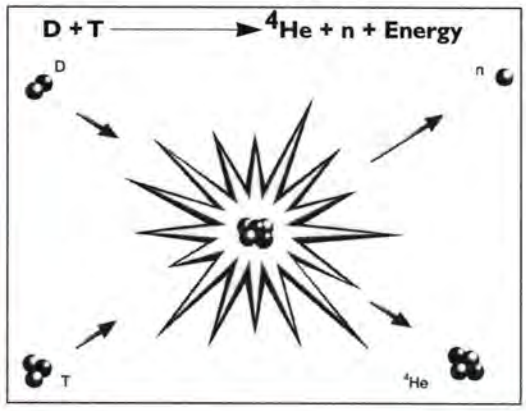
by David Ward, EURATOM/UKAEA Fusion Association, Culham Science Centre, Abingdon, Oxfordshire.

Following the demonstration of substantial amounts of fusion power over the last ten years, the future direction of fusion power development is presently being determined. With power in excess of 1 MW established in 1991, increasing to above 16 MW in 1997, the possibility of an international project, involving nations from several continents, to produce fusion power in the range of hundreds of megawatts is being discussed. This would represent a large step towards the realisation of a new electricity generation technology with intrinsic safety and environmental advantages, writes David Ward.

Fusion power involves the release of energy when nuclei of light elements, typically isotopes of hydrogen, are joined to create heavier nuclei, typically helium. This is outlined further in Box 1. Although one of the fuels envisaged for a fusion power station is deuterium, an isotope of hydrogen found in water, it is not strictly correct that fusion is a process for 'burning water'. The other fuel input for a power station is lithium, a light metal, which is used to generate tritium, another isotope of hydrogen. With the small amounts of fuel required to produce fusion power - each kg of fusion fuel produces 10 million times as much heat as a kg of fossil fuel - there are enormous resources for energy production for future generations.

Box 1: The fusion process

The collision of two nuclei, one of deuterium and one of tritium, leads to the production of helium, the release of a neutron and energy. This is not a chain reaction, where the neutron triggers further reactions, rather the neutron is absorbed in a blanket, containing a lithium compound, that surrounds the fuel.



In the blanket the heat is transferred to a steam cycle for electricity generation and more tritium is produced to fuel further energy production. Although this is not the only possible fusion reaction, it is the easiest to

Conditions for fusion

In order for fusion to occur, the fuel must be at a very high temperature, in excess of 100 million degrees. At this temperature the fuel mixture is a plasma, a gas in which the atoms are fully ionised, and consequently carry electric charge.

There are two main ways of achieving this: by heating the fuel and providing excellent insulation with magnetic fields (known as magnetic confinement fusion, see Box 2), or by very short-lived, very high power heating of a small pellet of fuel, known as inertial confinement fusion. There are ongoing developments world-wide in inertial confinement fusion but these will not be discussed further here.

Having initially achieved the high temperatures necessary for fusion by external heating, a proportion of the power from the fusion reactions remains in the plasma, helping to sustain the temperature. In a power plant, it is envisaged that most of the required heating would come from these fusion reactions, making the process largely self-sustaining and minimising the recirculating power.

Box 2: How are very high temperatures achieved ?

Heating is applied to an insulated body. A contemporary (large) fusion device is comparable in size to a house but has heating powers 1000 times greater, provided by radio frequency waves or high energy beams of atoms. The magnetic field, which restricts the motion of the fuel because of the electric charges carried by the fuel particles, provides insulation typically 1000 times better than found in a house. A future fusion power plant would be bigger and largely self-heated by the fusion reactions.

	Power	Insulation thickness	Thermal conductivity	Temperature
	10 kW	10 cm	0.04 W/mK	20°C
	10 MW	1m	0.001 W/mK	100 million°C

future?

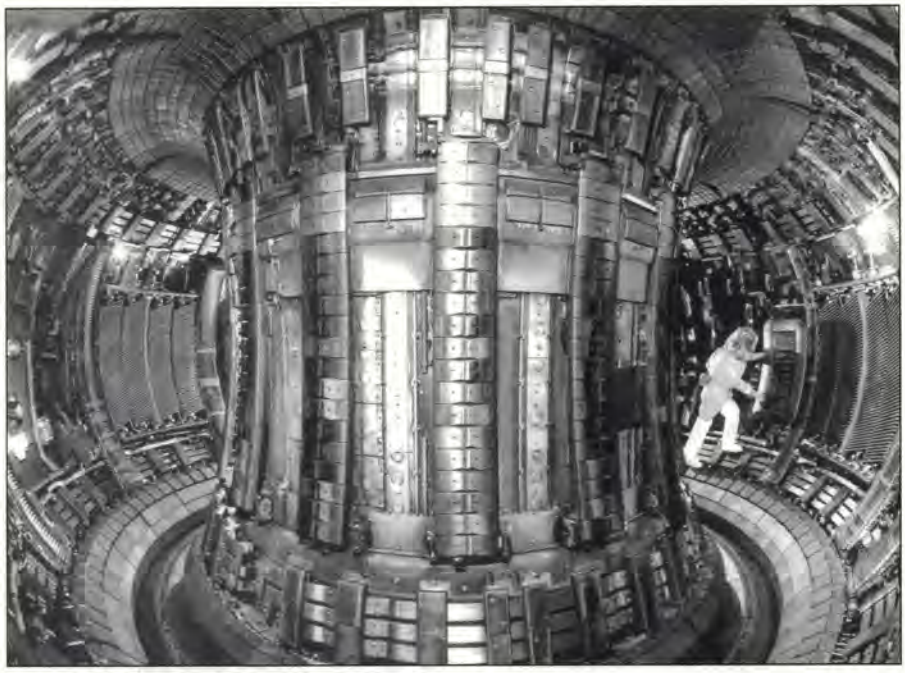
Safety and environment

It is an intrinsic property of fusion that it is possible to design and build a power plant in which no major accident is possible. This intrinsic, or passive, safety stems primarily from the small amounts of energy in the power plant that could drive an accident even in the event of failure of all safety systems. Although the temperature of the plasma is very high, its density is so low that the pressure is only one to two atmospheres. The fuel content of the power plant at any moment is very small, sufficient for only perhaps a minute of power production. In addition, although the structure of the fusion power plant would be activated by neutrons generated in the fusion process, there is little heat from this activation. As a result the safety of the power plant can be achieved passively rather than by design of sophisticated safety systems.

The environmental advantages of fusion are twofold: firstly there is no production of CO_2 or acid rain gases and no danger of enhanced global greenhouse effect, and secondly there would not be a large burden of radioactive waste for future generations to deal with. This second point needs some explanation. Although the structure of the fusion power plant would be activated by neutrons generated in the fusion process, the level and lifetime of the activation is dictated by the choice of structural materials. As a result, it is feasible to design a power plant which produces waste that, within one generation, can be recycled or cleared for re-use, with little requirement for disposal, the activity having decayed to a low level.

Where do we go from here?

Fusion research is an area of very strong international collaboration, exemplified by the world's largest magnetic confinement device, JET, a collaboration between 16 European countries and sited at Culham in Oxfordshire. It was here, as well as at Princeton in the USA, that the high fusion power demonstrations were carried out in the past decade. In addition to the co-operation within Europe there is close collaboration with each of the strong research teams in Japan, Russia and the USA.



Inside the JET fusion experiment

Throughout the 90s there has been an international effort to design a new device that will further advance fusion and, although the enthusiasm of individual nations ebbs and flows with its own perception of the energy market, economic cycle and politics, there remains a strong impetus to construct a machine based on global collaboration. At present it is envisaged that such a machine would produce fusion power in the hundreds of megawatts range

The design of a new device as a world-wide collaboration is based on the tokamak concept, a toroidal (or doughnut shaped) magnetic confinement system first developed in Russia. In such a device the main magnetic field would be provided by superconducting magnetic coils whilst an electric current flowing through the plasma itself provides an additional, vital, component of the magnetic field. The resulting magnetic field winds around the torus in a helical path.

At present, the tokamak design is the most developed and so most appropriate for the demonstration of the production of high fusion power. It is not certain, however, that the tokamak is the most feasible, or economically favourable, design of device in the longer term and work on other related devices continues. These other devices rely on basically the same principles as the tokamak but have significant differences in shape and the way that the magnetic field structure is created. A stellarator, for instance, generates the helical magnetic field entirely externally, again using superconducting coils, and this configuration is widely investigated. Another alternative that is presently attracting much attention is the spherical tokamak which was pioneered at Culham, through the START experiment, and is a compact version of the tokamak.

The question of what the future holds for fusion power has two elements to it. The near-term future of the development of fusion power seems to be towards an increasingly international collaborative development involving much of the industrialised world. The presently foreseen goal for the next 10-20 years is power production in the hundreds of megawatts range at a level much greater than that needed to maintain the fuel temperature.

In the longer term, the level of commercial utilisation of fusion power depends on the developing energy market as well as the achievements in fusion development. At present it appears that the energy market will increasingly depend on low pollution, low external impact systems, without substantial adverse effects on human health or the natural environment. Fusion is such a system. If the existing pressure to reduce pollution requires the replacement of fossil fuel sources as the main provider of the world's power, fusion will provide one of the very few options for baseload electricity generation

The work at Culham is jointly funded by the DTI and by EURATOM.

For further information on fusion or the work at Culham visit the website www.fusion.org.uk or e-mail chris.carpenter@ukaea.org.uk

Energy management in

by Tony Neul, Energy Manager, North East Lincolnshire Council

Commitment from the top, creative partnership with suppliers and maximising the use of external funding – three aspects to North East Lincolnshire Council's award-winning approach to energy management. Here, energy manager Tony Neul describes how the Council has improved its 'corporate' energy use and begun to tackle fuel poverty in the region.

North East Lincolnshire Council has recently been accredited by the Institute of Energy under the Energy Efficiency Accreditation Scheme (see *Energy World* January 2000). This has come in a year which has also seen the authority commended for progress made in domestic energy efficiency.

The Energy Efficiency Accreditation Scheme was originally developed by the Energy Systems Trade Association in conjunction with the Institute of Energy, and is now managed by the National Energy Foundation - it is also endorsed by the CBI. Accreditation is achieved by demonstrating commitment and achievement in three main areas of:

- management policy and reporting structure,
- investment, both actual and planned, in energy efficiency measures, and
- a record of progressive improvement in energy efficiency.

North East Lincolnshire Council scored 87.3 out of a possible 100 in its assessment, which recognised considerable improvement in performance over the previous three years. The Council's current energy and water bill runs at £2.9 million (excluding £400,000 for street lighting) in over 400 sites. This equates to around £44 per council tax payer, or £480 per member of staff - statistics which help to put the problem into context.

Although the Council has financial problems, investment in energy efficiency has averaged £1 million per year, following successful exploitation of external funding sources such as New Deal for Schools. In addition the Council's architectural consultancy take every opportunity to build energy efficiency improvements into design schemes. This investment has exceeded the Audit Commission's guidelines of spending 10% (of total energy budget) annually. The full effects of this investment have yet to be accurately quantified and reported - but significant progress has also been made through the Council's purchasing activities. Tariff savings totalling £155,000 per year have been achieved through careful exploitation of the fuel market.

On the domestic front, the Council has also been commended for progress to date in implementing its Home Energy Efficiency Strategy. This strategy looks at improving the energy efficiency of the 64,000 public and private sector housing stock. The council has recorded an improvement in energy efficiency of 7.4% in the first three years - which is on course to reach the statutory target of 30% improvement over 10-15 years. This improvement represents a potential saving of £2.7 million in fuel bills for the local community.

Gaining commitment

There is increasing pressure on local authorities to set a good example in terms of energy management. The introduction of the Home Energy Conservation Act in 1996 placed a statutory duty on authorities to improve the energy efficiency of residential accommodation by 30% over a 10-15 year period. In addition the Audit Commission continually reviews and monitors how authorities are managing energy throughout their sphere of operation under their 'Environmental Stewardship - Value for Money' audits.

North East Lincolnshire Council is a relatively new unitary authority established in 1996, yet has been successful in adopting energy management best practice in both arenas against a background of constant change. NELC is already on its third chief executive since 1996; there has also been a change of Government and the local political influence has changed since the local elections. 'Best Value' legislation has been introduced and there have been financial problems leading to management reorganisations and restructuring. The future looks no more stable as local government modernisation takes place this year, which will see the end of councillors and committees in their current form – likely to be replaced by a 'cabinet' structure.

To obtain and sustain the required level of commitment and consistency in such an environment is a constant challenge. North East Lincolnshire Council has achieved this through the development of two specific, but inter-related, strategies - one for 'Home Energy' and one for 'Corporate Energy'. In addition, officers have worked to raise the profile of energy management within the council, raising the awareness of senior management and elected members, to ensure commitment is sustained. It was realised at an early stage, particularly in relation to issues such as education and awareness raising, that the strategies should not be applied in isolation and that there were many benefits to be had in making sure they interact.

With regard to its own 'corporate' energy and water use - North East Lincolnshire Council set itself the following

North East Lincolnshire has higher than average fuel poverty levels

the public sector

targets, from a base year of 1996/97, and pledged to measure it's own performance against them.

- Reduce carbon dioxide emissions by 20% by the year 2010.
- Reduce energy consumption in order to achieve or improve upon the target carbon dioxide reduction.
- Reduce water consumption by 10% by the year 2001.
- Increase the proportion of renewable energy consumed to 5% of our total energy consumption by 2005.
- Increase our annual investment in energy efficiency measures to 10% of total energy spend by 2001.
- All staff to have received basic awareness training/advice by 2005. All newly recruited staff to receive basic awareness training/advice by 2000.

Once approved by the Council's Policy Committee, officers had a relatively free rein to implement actions necessary to meet these targets - but to regularly update councillors on progress. The staffing/responsibility structure is probably unique in energy management terms.

The Energy Manager is based within the Environment Department - and has dual responsibility for corporate strategy development and home energy efficiency. The council's Architectural Consultancy has responsibility for monitoring and targeting (M&T) functions, which includes design and maintenance of building services.

The Architectural Consultancy also provides a central energy purchasing function for the authority and is supported by the in-house purchasing consultancy. The strategic direction of energy purchasing is co-ordinated by the Energy Procurement Group which consists of representatives from the above departments and is open for other departments to attend as appropriate. This multi-disciplinary "team" approach is certainly key to the Council's success.

Benchmarks

A great deal of work has been done in order to understand where, when and how energy and water is used. It has taken three years to get to the stage where energy and water data is of sufficient accuracy to begin to record any improvements. A database purchased in 1996 now contains enough information to allow the Council to monitor consumption and compare with the previous year's data to spot any variations. In addition, energy consumption is weather adjusted and normalised, to produce audit commission indicators (NPIs) - identifying poor performers. A building management system has been installed in key sites to support the function with real time information. However, information on consumption only helped to form part of the overall picture. A programme of detailed energy surveys has also been implemented (prioritised by the benchmark data) and a list of investment opportunities produced.

North East Lincolnshire Council Offices, Grimsby

The success of attracting substantial amounts of external funding lies with an innovative approach used by the Council's Architectural Consultancy and Education Department. A 'mobile boilerhouse' designed by the Consultancy was used to take full advantage of the New Deal for Schools funding which is available for improving the energy efficiency of schools. By constructing a portable boiler installation – officers were able to carry out major heating and insulation improvements throughout the winter months, and during the school term, with little or no disruption to the school. Some £1.6 million of external funding was used in this way and will lead to significant reductions in running costs for the schools involved.

Partnership with suppliers

The council has also established an excellent working partnership with the local public electricity supplier, Yorkshire Electricity, the current gas and electricity supplier to the authority. This type of partnership is seen as key to the future success of both strategies.

The Energy Procurement Group has been working towards complete harmonisation of fuel contracts in order to maximise buying power and minimise administration. By building in added value elements to the latest contract the council has secured £5000 of staff training and has also negotiated an element of green electricity into the supply. The staff training, provided by an energy consultant, includes a series of awareness raising workshops designed for each sector of the building portfolio (eg leisure, schools and offices) and will be a first step in creating a network of energy officers throughout the borough.

The renewable energy target was, at the time it was set, viewed as the most difficult to achieve. However Yorkshire Electricity, as with other suppliers, are now offering green electricity at a premium and the council has decided to take advantage of this. By purchasing 1% of additional green energy every year from their supplier the council will reach its 5% target by 2005 and will have helped to support the development of renewable energy in its area.

This partnership approach was also used to implement various initiatives using funding from Yorkshire Electricity's Standards of Performance (SOP) fund. By taking advantage of the Energy Saving Trust's 'Lightswitch' programme the Council and Yorkshire Electricity were able to install

energy efficient lighting controls in five schools last year. This work was supported with teacher training sessions (provided by the Centre for Education and Training in Energy) aimed at developing energy related curriculum activities. Headteachers and caretakers also attended training sessions to learn energy management techniques. This 'whole school' approach to energy management is one which is promoted as best practice and is acknowledged as the most effective way of achieving results in schools. An excellent example of this can be found at Nunsthorpe Junior School in Grimsby, where the pupils carried out their own energy audit and shamed the headteacher into replacing an inefficient hot water boiler in the staff room.

Unfortunately the Lightswitch programme no longer targets schools, but other schools are being encouraged to apply for funding through the Trust's 'School Energy' programme. There are plans next year to pilot a similar whole school scheme which will focus on home energy in the curriculum.

Local fuel poverty

A further successful bid to Yorkshire Electricity for SOP funding has enabled the authority to commission a study into the incidence of fuel poverty in the region (in partnership with NEA – the national fuel poverty charity), and to trial domestic heat recovery ventilation units. The fuel poverty issue is likely to dominate HECA in future years as it is now seen as a Government priority.

The study has shown that North East Lincolnshire has a higher than average incidence (between 25% and 28% of households, compared to the national average of 22.2%) , and it is more likely to occur in the owner occupied and private rented sectors.

Fuel poverty occurs when households need to spend more than 10% of their income on fuel in order to heat their home. In North East Lincolnshire 4.6% of households need to spend between 20% - 30% of their income on fuel and are therefore classified as suffering severe fuel poverty - and 1.6% of households need to spend more than 30% of their income on fuel and are classified as suffering extreme fuel poverty.

The energy efficiency of a property, which is directly related to fuel poverty, is measured using the Government's Standard Assessment Procedure (SAP). Properties are given an energy rating or score from 1 (poor) to 100 (efficient). In North East Lincolnshire the average SAP rating of those suffering extreme fuel poverty is 38, severe fuel poverty is 43 and moderate fuel poverty is 50. This compares to an average rating of 55 for the non fuel poor. Improving the energy efficiency of local housing will therefore be an important tool in tackling fuel poverty.

Fuel poverty is more prevalent with certain categories of occupancy or household Type. The trends in NEL are generally consistent with national trends - single person households being most at risk. There is however a far higher incidence of fuel poverty amongst younger households in North East Lincolnshire than the national average. Fuel poverty is twice as likely in households with a child under five years old.

In response the council has employed an officer to look at the problem of fuel poverty, and over 100 staff and volunteers have attended a training workshop to create a referral network throughout the community. The Director of Housing, as social landlord, has negotiated on behalf of his tenants the best available price for fuel. A fuel poverty forum is also planned, which will consider the report and produce an action plan to take it forward.

Tackling fuel poverty

Two projects looking at the benefits of heat recovery ventilation in council housing are helping to inform the authority on its ventilation strategy. The first project looked at whole house heat recovery units – which were installed in two empty homes as part of comprehensive energy efficiency improvements. The properties are ex-private sector mid-terraced houses located on a mixed tenure estate. The purpose of the trial was to monitor the air quality and health benefits of installing such a system.

Temperature, humidity and particulate levels are currently being monitored in the lounge and bedrooms. It is hoped that by controlling air change rates, and providing 24 hour ventilation, the humidity and particulate levels can be reduced. This should reduce or even eradicate the presence of dust mites – a potential cause of asthma.

The second project looked at the benefits of installing 'through the wall' heat recovery ventilation units in bathrooms and kitchens.

Progress on HECA is being monitored using software provided by the DETR specifically for the purpose. Known surprisingly as 'HECAMON' the software relies on a random telephone survey to establish what energy efficiency measures were installed in the previous year. This measured improvement is then compared with the energy efficiency of the original dwelling and statistically apportioned across the whole stock profile.

The 7.4% improvement recorded in North East Lincolnshire is a result of not only a major investment in the council's own stock, but also as a result of substantial investment by private householders. Councils have been awarded no new money to help the private sector and consequently largely rely on awareness raising and advice delivery. To this end the council is now an active partner in a Lincolnshire wide Energy Efficiency Advice Centre (EEAC) – supported by the Energy Saving Trust. This will support the existing in-house advice service currently in operation – and as a result written tailored advice reports are currently being issued at a rate of 15 households per week.

It is clear that the council has achieved significant progress by seeking external partners in implementing both strategies. Officers are committed to developing even closer relationships with energy suppliers as it is felt that such partnerships will become an increasingly more attractive and cost-effective mechanism to extend the range of energy services that councils currently provide.

Contact Tony Neul on tel: 01472 324714, e-mail: tony.neul@nelincs.gov.uk

Events

March 2000

Energy saver
Course, 7-9 March,
Swindon, £875 + VAT
Details from NIFES Consulting Group,
tel: 0115 984 4944,
e-mail: *training@nifes.co.uk*

Cutting refrigeration costs
Seminar/workshop, 8 March,
Birmingham, free
Details from Sadie Primmer at ETSU, tel: 01235 433 525, fax: 01235 433 737

A world of thermography
Conference, 9-11 March,
Bath
Details from Colin Pearson at BSRIA,
tel: 01344 426511,
e-mail: *ukta@bsria.co.uk*

The changing land of Europe
European conference on renewable energy and agriculture, 12-14 March, The Netherlands
Details from European Media Marketing,
tel: 0181 289 8989, e-mail: *sustain@emmi.co.uk*

Natural gas processing
Course, 13-15 March,
Amsterdam, $1575
Details from The Center for Professional Advancement,
tel: +31 20 638 2806,
fax: +31 20 620 2136

Contract management in the oil and gas industry
Conference, 13-16 March,
Amsterdam$1855
Details from The Center for Professional Advancement,
tel: +31 20 638 2806,
fax: +31 20 620 2136

The future of utilities 2000
Conference, 15-16 March,
London, £849 + VAT
Details from the Adam Smith Institute,
fax: 017 253 2789,
e-mail: *admin@confs.co.uk*

Energy management – getting the data right
21 March, London
Details from C Maude at the Energy Industries Luncheon Club,
tel/fax: 0162 285 8762

Furnaces 2000
Exhibition and conference,
21-22 March, Warwickshire
Details from Gillian Jones,
DMG Business Media,
tel: 01737 768611,
e-mail: *gjones@dmg.co.uk*

Emissions trading
Conference, 22-23 March,
London, £995 + VAT
Details from IIR Ltd,
tel: 020 7915 5055,
e-mail: *registration@iir-conferences.com*

Competitive electricity & gas metering
Conference, 22-23 March,
London, £999 + VAT
Details from IIR Ltd,
tel: 020 7915 5055,
e-mail: *registration@iir-conferences.com*

Third party access in the European gas market
Conference, 27-28 March,
Paris
Details from SMi Ltd,
Tel: 0171 252 2222,
e-mail: *customer_services@smiconferences.co.uk*

Petroleum refinery processing
Course, 27-29 March,
Amsterdam
Details from The Center for Professional Advancement,
tel: +31 20 638 2806,
fax: +31 20 620 2136

April 2000

The gas chain – from reservoir to burner tip
Course, 2-7 April, Wiltshire,
£2,700 + VAT
Details from Alphatania,
fax: 020 7650 1405,
e-mail: *training@alphatania.com*

The future of European power generation
Conference, 5-6 April,
London, £998
Details from the Institute for Economic Affairs,
fax: 020 7253 2798

PowerEx Europe 2000
Exhibition, 11-12 April, Brussels
Details from DMG Media,
tel: 01737 855301, e-mail: *tickets@dmg.co.uk*

Mediterranean gas and power 2000
Conference, 11-12 April,
Tunis, Tunisia
Details from Economatters Ltd,
tel: 020 7650 1430, e-mail: *confs@economatters.com*

Gasification for the future
Conference, 11-13 April,
Amsterdam
Details from the Institution of Chemical Engineers,
tel: 01788 578214, e-mail: *jblack@icheme.org.uk*

Understanding heat treatment
Course, 11-13 April,
Birmingham, £790
Details from the Wolfson Heat Treatment Centre,
tel: 0121 359 3611,
e-mail: *whtc@aston.ac.uk*

Industrial furnaces and boilers
Conference, 11-14 April,
Porto, Portugal
Details from INFUB,
tel: +351 2 9734624,
e-mail: *conference@infub.pt*

UK nuclear waste: finding a way forward
Conference, 12 April,
London
Details from Thomas Telford Conferences,
tel: 020 7665 2315,
e-mail: *frye_s@ice.org.uk*

Commercialising fuel cell vehicles
Conference, 12-14 April, Berlin
Details from Intertech,
tel: +1 207 781 9800,
e-mail: *info@intertechusa.com*

Solving the policy jigsaw
17 April, London
Details from C Maude at the Energy Industries Luncheon Club,
tel/fax: 0162 285 8762

Energy management
Institute of Energy course,
18 April, Bristol, £99 + VAT
Details from Katie Howe,
tel: 0202 7580 7124,
e-mail: *kthowe@ioe.org.uk*

Petrotech 2000
Exhibition, 18-20 April,
Rotterdam
Details from Ahoy' Beurzen bv,
tel: +31 10 293 3213

A Fund to provide support to Members

The Institute of Energy has a Benevolent Fund that has built up over the years, through kind donations from Members, to provide support to Members and their dependents in need of various forms of financial assistance. The Fund is designed to support those facing financial hardship for various reasons and any request for assistance is treated with the utmost confidentiality. Support is very broadly defined by the Rules of the Fund which are determined by the Institute's governing Council. Cases identified for priority assistance include those which will:

- improve quality of life;
- maintain an individual's professional status;
- provide career counselling and grants for retraining; and
- provide educational bursaries for recognised courses of study.

If you believe that you or a member of your family requires assistance as we have described it, please write to the Secretary & Chief Executive in confidence at 18 Devonshire Street, London W1N 2AU. The Benevolent Fund Committee will then be able to assess your case for eligible support from the Fund.

New library service for Members

As part of continuing collaboration between a number of engineering Institutes, we are pleased to announce that InstE members can now access the libraries and information services of the Institution of Gas Engineers and The Institution of Mining and Metallurgy.

The IGE library offers an abundance of books, journals, reports, papers, publications and Internet sources, including access to the international database, Gasline, for anyone researching the history of fuel gas and associated industries. They offer a query service in response to phone, fax, written or emailed requests, or a visit can be arranged. Services also include a tailor made bibliography list, research/information consultancy, photocopies and loan of items.

The IMM library holds an index of articles and 1000 different journal titles, and conference and event papers. They also offer loan of items, photocopies and enquiry services. Additionally, they offer access to their reference database IMMAGE on CD-ROM, which provides information on over 75,000 references from 1979 onwards.

To take advantage of this excellent opportunity, please contact the libraries direct, stating that you are an Institute of Energy member.

The Institution of Gas Engineers: 21 Portland Place, London, W1N 3AF
Tel: 020 7927 9917
Fax: 020 7636 6602
Email:*anita@igaseng.demon.co.uk*

The Institution of Mining and Metallurgy: Hallam Court, 77 Hallam St, London, WIN 7LR
Tel: 01302 320 486
Fax: 01302 340 554
Email:*instmm@cix.compulink.co.uk*

Orbituary: Gordon George Thurlow - Senior Fellow

It is with great regret that we report the death of Dr. Thurlow on January 10th. Dr Thurlow was known to his family and close friends as Gordon, but to his working colleagues as George since in his early days he worked with another Gordon, Doctor Whittingham.

He was a great supporter of this Institute. He joined as a Student in 1948, and was awarded the Studentís Medal and Prize in that year. He became an Associate Member in 1951, a Member in 1959, and a Fellow in 1963. He was Chairman of the London and Home Counties Branch from 1966-1967, and, following his move to Malvern, Chairman of the South Wales and West of England Branch in 1982. He was President of the Institute in 1984-1985, during which time he visited India to re-establish contacts with the membership there, and the USA as part of the Institute's long association with the A.S.M.E.

Election to Council in 1968 was the start of a long period during which he was active on many of the committees of the Institute, and after retirement he continued to travel to London, to support the Institute in its various works. He was Secretary to the Fuel Luncheon Club for many years, retiring only recently.

Following graduation in 1945, he worked for the Bristol Aircraft Company before joining the British Coal Utilisation Research Association in 1947, and the rest of the career was spent on research into coal and its use. He worked initially with Dr. Whittingham, and then succeeded David Gunn as Superintendent of the Boiler Department. Following the merger of the coal research establishments under the aegis of the National Coal Board, after a short period at Hobart House he moved to the Coal Research Establishment, Stoke Orchard. George became Assistant Director, responsible particularly for work on gasification projects, the basis of many "clean coal" applications. After his retirement in 1986 he was a consultant and assessor for the E.E.C. Directorate on Energy.

George was a quiet man who obtained results by co-operation and reason. He was highly regarded and loved by his family and friends. Our thoughts are with his family. That he was much loved was attested by the many who attended his funeral in the beautiful old church of Little Malvern Priory where Gordon worshipped and whose community he served as Treasurer to the P.C.C. for many years. It was a beautiful sunny January day, and we shall always remember you, Gordon, with joy and pleasure.

Doug Willis

Deceased Members

SASSON, Harry Fellow, London & Home Counties
ABBOTT, Gordon Arthur Member, East Midlands
THURLOW, Dr. Gordon George Senior Fellow, Midlands
FELLOWS. Peter Associate, Midlands
USHER, Conrad Member, South Wales & West of England

Energy Mangement - rejuvenation in the regions

The Institute of Energy is currently working with the DETR and a variety of existing Regional Energy & Environmental Managers Groups to investigate how the groups could be improved and rejuvenated as necessary. As many readers will know, the Groups used to be in receipt of DETR funding, however this has not been the case for some time.

The Institute of Energy has liased with a number of Regional Government Offices to co-ordinate a questionnaire for members of Regional Energy & Environmental Managers Groups, and our thanks are extended to those involved. Responses to the questionnaire are showing an interest in more events, improving the quality of events, improving the publicity of the groups and improving links with other groups such as the InstE branches. Respondents were also asked if they would like to gain recognised qualifications and their views of the need for training. Better communication was also considered, including the benefits of having a network website and/or a network newsletter.

The responses to the questionnaire will shortly be collated and submitted in a report to the DETR. The need for this research is a direct result of developments in the field of energy management. The Institute of Energy was a key partner in the development of The National Standards for Managing Energy, sponsored by the DETR in 1996/97 and has been rewarding energy managers and offering career development, specifically designed for this group of professionals, for the last three years.

For more details and to take part in the research contact Maria Adams, tel: 020 7580 7124, fax: 020 7580 4420 or email: *madams@instenergy.org.uk*

A Partnership for Best Practice

Group Members of The Institute of Energy, the Royal Borough of Kensington and Chelsea, have taken advantage of the Institute's involvement in the 'Partnerships for Best Practice' initiative. The Energy Task Force was established at the borough, following an Institute of Energy 'Partnerships for Best Practice' workshop at the end of last year for those interested in saving energy and reducing waste.

The Energy Task Force has developed projects to save energy by switching off computers, in some cases manipulating the availability of the Energy Star mechanism fitted to many new computers. They have also worked on departmental environmental strategies and recycling projects.

If your company would like to increase staff awareness of energy and waste saving issues contact Beatriz Cano on tel: 020 7580 7124,
fax: 020 7580 4420,
email: *bcano@instenergy.org.uk* for an information booklet.

Branch Events

MARCH 2000

MIDLAND BRANCH

Thursday 2 March, 7.00pm
Austin Court.
'Fire and Explosion Hazards & their mitigation' - Dr P Cleaver (BG Technology). Joint meeting with The Safety & Reliability Society. Contact Mr H Freeman, tel: 0121 353 2397
e-mail: *hfreeman@talk21.com*

NORTH EAST BRANCH

Monday 6 March
Joint meeting with IEE in Middlesbrough on Electric Cars. Contact CR Howarth, tel: 0191 222 7303
e-mail: *c.r.howarth@ncl.ac.uk*

EAST MIDLANDS BRANCH

Wednesday 8 March
One day short course in Energy Management. BG Technology, Loughborough. Contact Ms B Cano, Institute of Energy, tel: 020 7580 0008,
e-mail: *bcano@instenergy.org.uk*

NORTHERN IRELAND BRANCH

Wednesday 8 March
Annual Dinner, Culloden Hotel, Cultra. Contact Dr D McIlveen-Wright, tel: 01265 324477, e-mail: *dr.mcilveen-wright@ulst.ac.uk*

NORTH WEST BRANCH

Date to be announced 5.30 for 6.00pm
A talk on Explosive Hazards by B Jones at AEA Technology, Risley. Contact M Worthington tel: 0151 448 6115, e-mail: *Worthington_Maurice_R@lilly.com*

YORKSHIRE BRANCH

Tuesday 14 March, 7.30pm
'The Vauxhall 6 cylinder engine'. Joint meeting with the Institute of Petroleum at Cedar Court Hotel. Contact A Mallalieu, tel: 0113 276 8888. e-mail: *AM@evanstabouniversal.co.uk*

LONDON & HOME COUNTIES BRANCH

Wednesday 15 March, 6.00pm
Brampton Park Golf Club, Cambridge
Paper on 'High Accuracy Energy & Volume Controls'. Joint meeting with The Institution of Gas Engineers.
Contact D Barber, tel: 01494 783142,
e-mail: *Rufusred@aol.com*

SOUTH COAST BRANCH

Wednesday 15 March, 6.30pm
Tour of the National Air Traffic Control Centre at Swanwick near Southampton. Contact T Smith, tel: 01256 768221
e-mail: tim.smith@statoil.com

SOUTH WALES & WEST OF ENGLAND BRANCH

Thursday 16 March, 6.30pm
Young Persons' Short Paper Evening. Jointly sponsored by the University of the West of England. To be held at the Frenchay Campus at the university. Contact A Boulton, tel: 0117 932 3322
e-mail: *a.boulton@talk21.com*

NORTH EAST BRANCH

Monday 20 March
Committee meeting and joint meeting with IEE at Newcastle University on Utility Business. Contact CR Howarth, tel: 0191 222 7303, e-mail: *c.r.howarth@ncl.ac.uk*

LONDON & HOME COUNTIES BRANCH

Thursday 23 March
Branch AGM at The Institute of Energy. Guest speaker: Anna Walker, Director General, Energy, DTI. Contact D Barber, tel: 01494 783142, e-mail: *Rufusred@aol.com*

MIDLAND BRANCH

Friday 24 March
Race Evening at Hollyfields Centre Club Contact Mr H Freeman, tel: 0121 353 2397
e-mail: *hfreeman@talk21.com*

APRIL 2000

MIDLAND BRANCH

Monday 3 April, 7.30pm
The Arthur Rank Centre, National Agricultural Centre, Stonleigh
'Small Scale Biomass Heating in the UK' -
Mr P Teisen (Teisen Products). Joint meeting with Institution of Agricultural Engineers. Contact Mr H Freeman, tel: 0121 353 2397
e-mail: *hfreeman@talk21.com*

SCOTTISH BRANCH

Friday 7 April
AGM & Branch Dinner. Contact J Currie, tel: 0131 455 2253
Email: j.currie@napier.ac.uk

CPD Calendar

MARCH 2000

Monday 13 - Friday 17 March
Five day course on Gas Turbine Driven Equipment at School of Mechanical Engineering, Cranfield University. Contact Mary Howard, CPD Administrator, Cranfield University, tel: 01234 754644, fax: 01234 750728, e-mail: *m.howard@cranfield.ac.uk*

Monday 20 - Wednesday 22 March
A series on one-day CPD short courses on the monitoring of industrial emissions to atmosphere. Westwood Hall Conference Centre, Leeds. Contact Alison Whiteley, CPD Course Secretary, School of Process, Environmental & Materials Engineering, University of Leeds, tel: 0113 233 2494, fax: 0133 233 2511
e-mail: *cpd.speme@leeds.ac.uk*

Tuesday 28 - Thursday 30 March
Short course in Particle Technology: Filtration, Separation and Washing run by The Fine Particle Software Institute. Contact Dr Ing J Svarovska, tel/fax: 01274 546276
e-mail: *lsvarovsky@aol.com*

New Members

NORTH EASTERN

Mr. C. L. Raymond, Associate
Stockton on Tees Borough Council
Mr. G. W. Usher, MInstE (transfer)
DuPont Polyester Technologies
Eur Ing I. M. Arbon FInstE
Engineered Solutions

LONDON & HOME COUNTIES

Mr. S. McKinnell, Graduate
BBC
Mr. M. J. Woolley, MInstE
Royal Borough of Kensington & Chelsea
Mr. R. A. Woollard, Associate
Eastern Electricity
Dr. D. T. Strong, FInstE
BRE Ltd

SCOTTISH

Miss S. L. Plummer, Graduate (transfer)
Edinburgh University
Dr. D. J. Harris, MInstE (transfer)
Heriot-Watt University
Dr. R. Campbell, MInstE
Glasgow Caledonian University
Mr. G. J. Murphy, MInstE
Department of Roads & Architecture

YORKSHIRE

Mr. G. K. Reynolds, Graduate
University of Sheffield
Ms. N. Jones, Graduate (transfer)
University of Leeds

MIDLANDS

Eur Ing J. H. Pooley, FInstE
The John Pooley Consultancy

SOUTH WALES & WEST OF ENGLAND

Professor N. Syred, FInstE (transfer)
University of Wales, Cardiff

NORTHERN IRELAND

Mr. M. Bennett, MInstE
Taylor & Fegan

SOUTH COAST

Mr. A. J. Nelson, MInstE
Mott MacDonald

SITUATIONS VACANT

Bureau Services Professional (in Energy Management)
required by TEAM
(Energy Auditing Agency Ltd).
Please contact Timothy Holman for more details. Email *Tholman@teamenergy.com* or send your CV to 34 The Forum, Rockingham Drive, Linford Wood, Milton Keynes, MK14 6LY.
Website: www.teamenergy.com.

Energy/Environmental Consultant
with 3-5 years experience required by Linden Consulting Partnership, posts are available at both the Midlands and Southern offices.
For more details contact Mrs B Gibson, Linden Consulting Partnership, East Street, Saffron Walden, Essex, CB10 1LR

Experienced Energy Consultant required to manage and expand the consultancy division due to the growth of ECCL's metering division Energy Metering Technology (EMT).
The applicant should be educated to degree level and preferably have CEng status.
Experience in energy consultancy, commercial and man management skills a must.
Please send CV to Kim Potts, Energy Control Consultants Ltd, Lloyd House, 57 High Street, Burnham, Slough SL1 7JX

Friskies Petcare (UK) Ltd wish to offer a twelve month placement in its environmental department.
The position will offer a wide involvement in energy management within the group.
Based in Northwich, the position will appeal to a newly qualified graduate.
Salary negotiable.
Contact Mr. V. P. Davies on 01606 812 850

Project Development Manager/Energy Advisor, to work on the Warm Front project. The postholder will work with community organisations living in disadvantaged areas to develop self-help solutions and take action on fuel poverty and energy issues, through targeted training and support. Application form available from Ecsc, 30 Guildford Street, London, SE1 0HS (send SAE, 39p)

Please note: This space will be dedicated each month to individuals and organisations wishing to advertise situations vacant or situations wanted. Please note that this service is FREE.
For more details contact Katie Howe or Beatriz Cano on tel:020 7580 7124, fax: 020 7580 4420 or e-mail: eworld@instenergy.org.uk

The Institute of Energy Midland Branch

(Registered Charity No. 205936)

The 12th annual Ellis Memorial Lecture
and lunch will be held on
Thursday 18th May 2000
at The Birmingham Botanical Gardens,
when the speaker will be Mr. David Varney,
Chief Executive Officer, BG plc.

The title of the lecture will be:

Natural gas in the fuel mix

***David Varney** has spent several years in both the oil and gas industries. This presentation highlights the differences of the two industries in terms of structure and product and examines the prospect for natural gas in a world market with increasing environmental concerns.*

Further details of this event can be obtained from:
Mr. H. Freeman Hon. Secretary
The Institute of Energy - Midland Branch
1 Knightsbridge Close
Sutton Coldfield
West Midlands
B74 4UQ
Tel: 0121 353 2397
E-mail: *hfreeman@talk21.com*

Regional One Day Introductory Course in Energy Management

In an effort to support those who manage energy in the regions The Institute of Energy has prepared a programme of Regional Courses in Energy Management. The branches of the Institute are working with HQ staff on delivering this ambitious programme designed to provide a refresher course for energy managers or to start those new to managing energy off on the right foot.

The course covers:

- Energy policy
- Investments for energy efficiency
- The National Standards for Managing Energy
- The principles of monitoring and targeting
- Staff awareness and motivation
- Energy management structure and accountability
- Introduction to site services, lighting, bms etc.

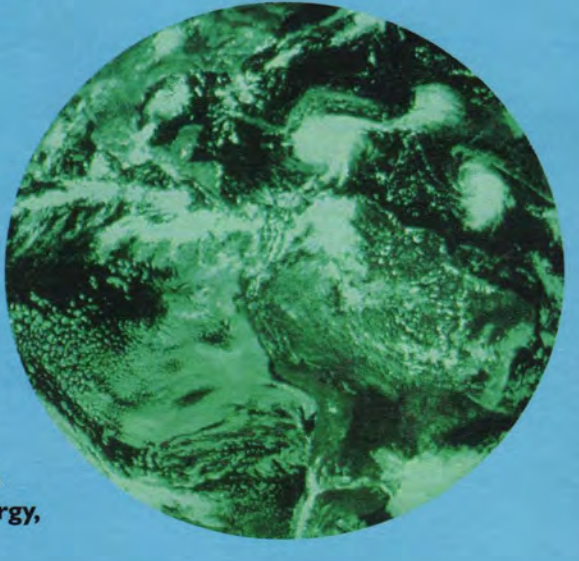
8 March 2000 (Loughborough)
18 April 2000 (Bristol)
18 May 2000 (Sheffield)
31 May 2000 (Warrington)
7 June 2000 (Birmingham)
5 September 2000 (Glasgow)
5 October 2000 (London)

Course Fees: Member £99 + VAT Non-member £120 + VAT
For an information pack contact Beatriz Cano on
tel: 0207 580 7124, fax: 0207 580 4420 or email: *bcano@instenergy.org.uk*

Institute of Energy Melchett Lecture

22 June 2000

Energy 21: Making The World Work



The annual Institute of Energy Melchett Lecture will take place on the evening of 22nd June 2000 in London (venue to be confirmed), following the Institute's AGM and Council.

Walt Patterson, Companion of the Institute of Energy, will be awarded the Melchett Medal 2000 by the President Richard Coldwell for his significant contribution to the energy debate. His Melchett Lecture will attempt to reassess the link between energy and human purpose - what we humans want from energy, whether we can get it and how.

Walt says "We need urgently not only to reassess but also to realign the link between energy and human purpose, to make the world work better for all of us."

To reserve your place at a Melchett Lecture fit for a new millennium see your May 2000 edition of Energy World.