ENVIRONMENTAL Scientist

Journal of the Institution of Environmental Sciences

Vol 8 No 5 ● September/October 1999

Editor: Richard Dix ● Assistant Editor: Derek Hall

Established 1971 ● ISSN: 0966 8411

FEATURE ARTICLE

The future of UK nuclear power

Peter Hollins, Chief Executive, British Energy plc

Nuclear's present role is impressive, meeting almost 30% of the UK's electricity needs; it is the largest single source of electricity in Europe – around 35% of the total – and globally, it accounts for 16% of the electricity mix.

Carbon Dioxide

In Britain, nuclear is a success story. Apart from meeting public interest objectives of diversity and security of supply, it makes a major contribution to combating climate change. Worldwide a total of 430 operating nuclear plants avoid the emission annually of 1.8 billion tonnes of carbon dioxide. Last year the UK nuclear industry saved around 63 million tonnes of CO_2, the equivalent of nearly half the emissions from Britain's road vehicles. However, without significant developments in energy policy, its long-term future is in doubt.

A third of the world's 6 billion people have no access to electricity. Taken together with population growth, world electricity consumption could well rise by 50% by 2020, and double by 2050. Rising demand will put massive further pressure on the environment. Developing nations such as China and India are reluctant to cut back on carbon emissions. Their use of indigenous coal resources is essential to improve their low overall standards of living, but their predicament places a greater obligation on the developed world to reduce greenhouse gas emissions.

All this suggests an ongoing role for nuclear energy, along with other carbon-free generation such as renewables. Without nuclear the country would have found it very difficult indeed to meet its Rio greenhouse gas commitment and, thanks to nuclear, we stand a good chance of being able to meet the Kyoto obligations. But that seems to be the limit to forward planning.

Over the next twenty years or so all Britain's existing nuclear stations except Sizewell B will have closed, two-thirds of them by 2012. By 2025 nuclear's contribution will have fallen to a mere 3%.

We propose to run existing stations for as long as it is safe and economic to do so, but without a replacement build programme the large CO_2 savings from nuclear energy will be lost. Energy efficiency, increased renewables and fuel switching will not match current savings from nuclear generation.

Surely such a problem won't be allowed to arise. The government seeks security and diversity

IN THIS ISSUE

of supply and has very firm commitments on emissions reductions. The Trade and Industry Select Committee recently recommended 'a formal presumption be made now for purposes of long-term planning that new nuclear plant may be required in the course of the next two decades'. In response, however, the Government said that it did not foresee any plans for new construction coming through in the medium term.

The economics

The truth is it's currently uneconomic for anyone to start serious planning for a new station, let alone build one. British Energy is a commercial company with an obligation to its shareholders. It is pursuing investment in a mixed portfolio of plant, including gas generation and possibly renewables. Clearly we would not consider new nuclear plant unless it made good commercial sense. The truth therefore is that the fate of nuclear lies in the hands of the policy makers.

> ***'The amount of nuclear waste produced by new nuclear stations – because of their advanced design – would be only a small proportion of that produced by older stations'***

Existing nuclear stations compete effectively in a free market. They are more efficient than ever, and we have kept costs down. The British electricity market expects a rate of return of between 8-14% on new capital investment, and this simply isn't possible under present economic circumstances. A typical gas station of around 800MW can be built within two to three years at a cost of around £300 million. A nuclear station, half as big again at 1200MW, would cost about £1.8 billion and take six to seven years to build – and that six to seven years doesn't take account of the planning process. Building new nuclear plant requires very long lead times but planning law adds massively to costs. This also affects many of the most promising renewables.

What is required to make new build an attractive option is: a benign Government and a more positive perception of the industry by the public; a streamlining of our planning laws; and the introduction of a carbon tax or tradable permit regime (the most interesting area for policy makers).

However, at present nuclear energy is the only large scale type of generation which is required to cover so fully the cost of its environmental impact. We internalise these via provisions for decommissioning and special waste treatment and disposal. At the same time we are making a large contribution to reducing CO_2 emissions. For fossil fuel generators the costs of greenhouse and acid rain gases in terms of global warming, health impacts, effects on agriculture and so on are simply passed on to wider society.

This isn't a controversial point. The only real question is what to do about it. Debate is beginning to focus on curbing greenhouse gas emissions. There are three main options: some sort of tax on energy consumption; a tax on carbon emissions; and carbon trading via a permit scheme.

Climate Change Levy

There's a growing consensus that the proposed Climate Change Levy is a missed opportunity to focus on the real problem. Whilst it has the virtue of simplicity, focusing on broad energy use rather than carbon dioxide emissions, it fails to provide any incentive to switch to less carbon intensive fuels, and actually penalises non-carbon generation such as large scale hydro, nuclear and renewables. But there's a trade-off between complexity and effectiveness and, as energy taxes fail to deliver the hoped for CO_2 savings, we can expect to see growing interest in a carbon based approach.

A carbon tax or carbon trading scheme could have a significant impact on the economics of electricity production because it would target the problem at source. A recent research report from the Corporation of London concluded that 'permit trading is likely to happen… because it provides a cost-effective way to cut greenhouse gas emissions.' The Government are keen to make progress, and recently Michael Meacher asked industry to work with Government to create a pilot system of permit trading. The European Commission will publish a green paper on a permits system next year and an international system should be running from 2008 under the auspices of the Kyoto protocol.

I think Britain, and many other nations, will end up opting for a mixed carbon tax/permit system to provide maximum flexibility. New nuclear plant construction, paid for solely by private investment, might then start to look more economic. I am not arguing for a level of tax which conveniently bridges the economic gap; rather that our competitors should pay for their environmental impact.

Should 'new nuclear' become economic what sort of reactor would we be talking about? British Energy would be looking for a proven reactor design that is internationally licensed. That almost certainly means a PWR, but one that could be purchased off-the-shelf and which is internationally recognised as setting excellent safety standards. Moreover the amount of nuclear waste produced by new nuclear stations – because of their advanced design – would be only a small proportion of that produced by older stations. For example, the construction of an additional eight PWRs over the next 30 years would increase radioactive waste quantities by no more than 5-10%.

Waste

There is a choice to be made on environmental grounds between a PWR, such as Sizewell B, which

will produce 1600 tonnes of spent fuel in its operating lifetime, and the corresponding coal-fired station which would produce 250 million tonnes of carbon dioxide during the same period.

Waste is the main bone of contention – at least in terms of public perception. British Energy welcomed the recent Lords Select Committee report as a real step forward, particularly their call for an integrated approach to waste management and the conclusion that underground storage continues to be the best option for the long term disposal of nuclear waste. These conclusions were reached against a background of a greater understanding of the technical issues. In the meantime, surface storage provides a safe medium-term solution.

The public is getting wiser to the realities of modern energy policy. I believe that nuclear will gain ground as people appreciate the difficult but inevitable choices facing the developed world. In the context of rising demand and of global warming, nuclear will increasingly be seen as a solution rather than a problem.

The Government's role

Yet the real question is not so much about the public, but about government and opinion formers. Are they prepared to show leadership? To explain and justify the need for fiscal change? Frankly, it is on them, not just the nuclear industry, that the future of British nuclear energy depends.

Nuclear energy is climate friendly – we believe it should not be seen as a problem, but rather as part of the solution to balancing the delicate energy/environment equation.

■ *This report of a joint meeting of the Parliamentary and Scientific Committee and the All-Party Group for Energy Studies has been reprinted by kind permission of the publishers of* Science in Parliament*, the journal of the Parliamentary and Scientific Committee.*

ENVIRONMENTAL INFORMATION

The Hon. Secretary's news desk…

Subscriptions 2000

The good news this month is that we will enter the new Millennium at 20th century prices! Council at its October meeting approved the resolution to keep subscription rates at their present level.

This means that to maintain and indeed improve both our level of activity and our service to members we need to increase the size of our membership. Every one can assist with this effort by making the work of the Institution more widely known and by introducing new members.

Nominations for Council

It is now time to make preparations for the elections to Council vacancies in 2000 which will take place at the Annual General Meeting on 8th March. On page 13 you will find a nomination form for membership of Council. All corporate members are eligible to serve and may become candidates once proposed and seconded by two other corporate members.

In order to allow adequate time to prepare voting lists (if necessary) for issue with the AGM papers all nomination forms must be returned to the Hon. Secretary no later than **Friday 10th December 1999**.

Science Council

The Institution has, for some time, been a member of the Council for Scientific and Technological Institutes (CSTI). Membership encompasses most of the main scientific bodies including the Royal Society of Chemistry, the Institute of Physics, the Institute of Biology, the Institute of Mathematics and its Applications, Geological Society and several others.

It may be of interest to members that the CSTI has very recently changed its name to The Science Council and is developing a new structure and constitution.

The Sitefile Digest

A comprehensive guide to UK waste management sites is now available.

Waterlow Specialist Information Publishing's new waste management site directory, *The Sitefile Digest*, reduces the difficulties surrounding the issue of safe and legal waste management. For the first time a listing of all UK sites is available to waste managers in readily accessible format.

The 7,500 site listings are split into Environment Agency and SEPA regions. Each regional section is indexed both by type of site and by type of waste, allowing waste managers to establish site location, cost and capacity immediately. Colour maps for each region also enable easy placement of the required site.

Published in loose-leaf format, *The Sitefile Digest* is updated quarterly by Environment Agency and SEPA regions, ensuring waste managers have access to the most up to date information available. The Sitefile Digest is published by Waterlow Specialist Information Publishing, 6-14 Underwood Street, London N1 7JQ; Tel: 0171 324 2353; Fax: 0171 324 2341. **The normal retail price is £249 but a reduction of 10% to £225 is being offered to members of the Institution.**

RAF

Obituary

It is with regret that we have to record the death of Mr Peter Crook, a recent member from Milton Keynes. Our sincere sympathy is extended to his wife and family.

Forthcoming events, courses and conferences

25-28 October
Environmental Protection 99

Brighton Conference Centre.
Exhibition and conference covering air pollution, energy, waste, contaminated land and noise.
Details: Peter Mitchell, NSCA
Tel: 01273 326313
e-mail: admin@nsca.org.uk

7-27 November
A Sense of Wilderness

Schumacher College, Dartington, Totnes, Devon
£1350
Short course looking at wilderness significance and conservation.
Details: Schumacher College, The Old Postern, Dartington, Totnes, TQ9 6EA.
Tel: 01803 865934
e-mail: schumcoll@gn.apc.org

29-30 November
Air quality, UK and EU legislation and its impact on industry and local authorities

The Scientific Societies Lecture Theatre, London.
£399-699
Two-day conference on air quality issues.
Details: Penny Richards, Bookings Dept, TBC Global Conferences Ltd, Gilmoora House, 57-61 Mortimer St, London W1N 8JX
Tel: 0171 636 6858
e-mail: cust.serv @ibcuk.co.uk.

22-24 March 2000
Working with your stakeholders, resolving conflict and building consensus on environmental issues

Wast Hills House, Birmingham,
£445-845
Three-day management development course in process design and facilitation skills.
Details: Matthew Stubbings, The Environment Council, 212 High Holborn, London WC1V 7VW
Tel: 0171 632 0103
e-mail: matthews@envcouncil.org.uk

5-9 June 2000
Healthy environments – the local challenge

Oslo, Norway
Call for papers. Conference covers local communities' involvement in developing healthy environments.
Details: PLUS Convention Norway A/S, PO Box 1646 Vika, N-0119 Oslo.
Tel: 47 67 56 90 12
e-mail: chaskim@online.no

New members

The IES is pleased to welcome the following to membership of the Institution:

Mrs M. K. Badsha-Swanepoel	Student, University of the West of England
Mr S. R. Ballantine	Environmental Protection Officer SEPA
Mr M. W. H. Brown	Environmental Scientist Wardell Armstrong
Mr C. Callaghan	Technical Consultant Linden Consulting Partnership
Ms A. N. Carden	Student University of the West of England
Mr M. I. Chapman	Postgraduate student University of East Anglia
Mr A. Crosby	DETR, Environment Business & Consumers Division
Miss P. Dixon	Recent graduate University of the West of England
Mr M. D. Ellner	Recent graduate London University – Wye College
Miss K. L. Grimsditch	Recent graduate Manchester Metropolitan University
Dr L. Giusti	Senior lecturer University of Central Lancashire
Mr K. Haynes	PhD student part-time
Mrs D. J. Heaphy	Researcher & part-time lecturer University of Greenwich
Mr J. P. Hollands	Senior Geo-Environmental Engineer Joynes Pike & Associates Ltd.
Mr B. N. Houldsworth	Biochemist/Environmental Scientist IKM Consulting Ltd.
Ms S. M. Jones	Recent graduate University of the West of England
Dr D. A. C. Manning	Reader University of Manchester
Miss J. Marshall	Recent graduate Manchester Metropolitan University
Mr L. G. Psillakis	Environmental Scientist Halcrow Water Services
Mr S. M. Rowland	Recent graduate De Montfort University
Mrs A. V. Shenton	Environmental Adviser Tilcon (South) Ltd
Miss S. L. Smith	Recent graduate University of Glamorgan
Mr I. G. Townsley	Recent graduate Manchester Metropolitan University
Mr D. Williamson	Recent graduate Manchester Metropolitan University

Uncertainties of climate change prediction

R.J. Gurney, NERC Environmental Systems Science Centre

The basic physical principle of the greenhouse effect is well established. The Earth's radiation budget depends on the balance of the incoming short-wave radiation from the Sun, and the outgoing short-wave reflected solar radiation and long-wave radiation emitted by the Earth's surface and atmosphere. Short-wave radiation is largely at visible and near-infrared wavelengths, and the long wave radiation is largely at longer infrared wavelengths. Some atmospheric gases which are nearly transparent for short wavelength solar radiation, absorb and re-emit longer wavelength infrared radiation.

This effect allows solar radiation to short wavelength solar radiant energy to pass through the atmosphere, where a proportion is absorbed by the surface, which is heated. At the same time, the surface emits long wavelength radiant energy, which is absorbed and re-radiated in the lower atmosphere by these gases. As the temperature of the gases is generally less than that at the surface, the amount of energy re-radiated to space is less than the amount originally emitted from the surface, and some of the radiation absorbed by the lower atmosphere is re-radiated back to the surface, further warming it.

This natural effect is called the greenhouse effect, analogously with a greenhouse, and this natural effect keeps the Earth's surface some 30° warmer than it would otherwise be.

The main naturally recurring greenhouse gas is water vapour, but there are many others, including carbon dioxide and methane. Minute dust particles, called aerosols, also have a similar effect. Several of these greenhouse gases are also emitted through human activity, through farming, domestic and industrial activity, for instance, by mobilising some of the large stores of carbon laid down by the biosphere over geological time as oil, coal and natural gas. Arrhenius, a Swedish chemist, was the first scientist to predict that the increased emissions of greenhouse gases was likely to lead to an enhanced greenhouse effect, and therefore more warming of the surface, in a paper published just over 100 years ago. Since then, scientific understanding of the climate system has greatly improved, although many uncertainties remain, so that policy-makers and others are taking seriously the warnings of scientists about possible changes in climate caused by anthropogenic increases in greenhouse gases.

> *'Methane and carbon dioxide have been in the atmosphere from natural sources for millions of years'*

A process has been established to provide peer-reviewed assessments of the state of climate science, and of predictions of possible change. The Intergovernmental Panel on Climate Change (IPCC) has been set up under the auspices of the World Meteorological Organisation and the United Nations Environment Programme, and organises this process. As with any scientific peer review process where there is considerable uncertainty, not all scientists agree with all the conclusions of the IPCC reports, but they nevertheless represent a consensus of the likelihood of predictions to be correct. In this article, I will go through the main arguments and sources of uncertainty.

The greenhouse gases

Atmospheric constituents generated by human activities which affect climate are shown in Table 1, together with their main source and effective lifetimes. Methane and carbon dioxide have been in the atmosphere from natural sources for millions of years and without them, and without water vapour, the most influential natural greenhouse gas, the Earth would be some 30° cooler. Recent concern has focused on increases in the concentrations of these gases and the consequent enhancement of the greenhouse effect leading to a global warming. Measurements of air trapped in ice-core bubbles has revealed that carbon dioxide concentrations have increased by some 25% since pre-industrial times, and methane has doubled over the same period. CFCs are entirely anthropogenic and although new manufacture of these gases has now been virtually eliminated because of the

TABLE 1

The main human-made atmospheric constituents which affect climate

CONSTITUENT	ANTHROPOGENIC SOURCES	LIFETIME
Carbon Dioxide (CO_2)	Fossil fuel burning, land use	100 years
Methane (CH_4)	Agriculture, natural gas	12 years
CFCs	Solvents, refrigerants	100 years
Aerosol particles	Industry, power generation	2 weeks

Montreal protocol for the protection of the ozone layer, concentrations of CFCs are only just beginning to decline slowly.

Like CFCs, atmospheric concentration of carbon dioxide responds only very slowly to changes in emissions. Unlike some gases (sulphur dioxide, for example) whose concentrations respond roughly proportionately to changes in emissions, only emission reductions greater than about 60% would prevent carbon dioxide concentrations from rising.

The increase in the atmosphere of carbon dioxide is less than that expected from the increased emission of carbon dioxide as estimated from oil, gas and coal production figures. The remaining carbon dioxide (about half of the total anthropogenic carbon dioxide produced) is being fixed either in the soil or in the ocean by increased biological activity. One of the sources of uncertainty is that the balance between ocean and land sinks is unknown, and how long they will continue to take up the increased carbon dioxide at this increased rate is also unknown.

'The greatest uncertainty in model predictions comes from possible changes in the behaviour of clouds in a warmer world, which could act to either strengthen or weaken the initial warming'

At the bottom of Table 1 mention is given to aerosols. These small particles scatter part of the incoming sunlight away from the Earth, and thus act as a cooling influence on climate. Sulphur dioxide (SO_2) emitted from human activities such as power generation is oxidised in the atmosphere to form sulphate particles; increasing sulphur dioxide emissions have led to a substantial increase in the burden of sulphate aerosols since pre-industrial times. These particles only last for a small time in the atmosphere, and so generally act to cool the atmosphere in those areas which are heavily industrialised, like Western Europe.

Climate models

Before the effects of a possible change in greenhouse gases can be estimated in detail, we need to understand the natural variability of climate, produced by the interplay of energy, water and other movements in the atmosphere, the ocean, at the land surface and in the ice-covered parts of the planet. Much of the energy in the atmosphere and ocean is transferred in eddies, whose movement is only predictable to a limited extent.

Additional complexity is brought about because the temperature of the Earth is close to the triple point of water, which is therefore present as liquid, solid and gas. The energy exchanges during these changes in phase from solid to liquid to gas allow the transport of energy around the planet to take place rather differently than from the other planets of the Solar System, and introduce additional complexity. Water also allows life to occur, and the energy and water exchanges at the land surface, and to some extent in the ocean are therefore modified by the presence of vegetation.

The way in which we examine the variability of the climate system is to use very large computer models that model the planet's energy and water exchanges and include simplified representations of the atmosphere, the ocean, the land surface, and the ice-covered areas. The models also include vegetation, and are starting to include the atmospheric interactions between other chemicals such as species of nitrogen and carbon.

Climate models nave been developed, originally from weather forecasting models, over a number of decades, into a sophisticated tool for climate calculations. They are based on the known laws of physics describing the motion of energy and moisture and their equations are solved regularly over time (typically at 30 minute intervals) at a number of points forming a grid over the globe. Although the UK Hadley Centre model has one of the highest resolutions, the grid is quite coarse at 2.5° x 3.75°. Processes at sub-grid scales (cloud formation and development, for example) have to be represented ('parameterised') according to variables in the model. This represents a great source of uncertainty: processes are not represented fully in the model.

A climate model has to include the interaction of the atmosphere with the ocean; not just the transfer of heat and water and momentum across the interface, but the formation of deep ocean currents (and surface currents) which transport about half the total amount of heat between equator and poles. Only in the last few years have atmospheric models been coupled to deep ocean models in any realistic way to allow the climate to be modelled. Even now, the coupling process has to include adjustments to prevent the model climate from drifting away from the real climate.

One of the main challenges for climate models is their treatment of feedbacks: processes which follow perturbation such as an increase in greenhouse gases and which can act to amplify or reduce its predicted effect. The melting of sea ice, for example, will reduce the amount of sunlight reflected, and thus enhance the warming in high latitudes. A warmer atmosphere will 'hold' more water vapour (a powerful greenhouse gas) and this too will act as a positive feedback. The greatest uncertainty in model predictions comes from possible changes in the behaviour of clouds in a warmer world, which could act to either strengthen or weaken the initial warming.

Climate predictions

To predict possible climate changes in the future due to anthropogenic greenhouse gas emissions is a multistage process. First, estimates have to be made of future emissions of anthropogenic greenhouse gases; these come from energy, economic and population models. Second, carbon dioxide emissions must be translated into atmospheric concentrations using carbon cycle models; for other gases atmospheric chemistry models are used. Third, the heating effect ('radiative forcing') of concentration changes is calculated. Finally, the climate changes arising from the radiative forcing are investigated using a sophisticated climate model of the type described above, which represents the main processes in the atmosphere, ocean, on land and for ice-covered areas.

Scenarios of future change from

these models are used to investigate the impacts of climate change on, for example, agriculture and food supply, natural ecosystems, human health, etc, although these impacts will not be discussed further in this paper. We now look at some of the stages in more detail, concentrating particularly on the effects of carbon dioxide and ignoring for the time being the other gases. In 1992, the IPCC derived a number of emissions scenarios, including a best estimate 'nonintervention' scenario in which carbon dioxide emissions would increase from the current 7-8 GtC to about 20 GtC by the end of the next century. Human economic performance or limits on carbon dioxide production clearly affect the rate of increase of carbon dioxide, and represents an uncertainty in predictions.

The natural carbon cycle involves the transfer of large amounts of carbon in between the atmosphere, the terrestrial biosphere and the ocean. Superimposed on top of this are carbon dioxide emissions caused by human activities; although these are only a small fraction of the natural cycle, they have led to the 25% increase in carbon dioxide concentrations mentioned above. Using the 'non-intervention' emissions projections, carbon cycle models calculate that concentrations will rise in the future from the pre-industrial value of 280 ppm to about 800 ppm by the end of the next century. Similar projections are available for methane and the other gases.

Climate change

The climate model described above is used to explore changes in climate from a range of future concentrations of greenhouse gases. To make the model predictions more realistic, the model is started in pre-industrial conditions and the known change in greenhouse gases so far is applied; this simulates temperature changes over the past 150 years. Most modellers assume that, from now on, 'equivalent carbon dioxide' (i.e. the concentration of carbon dioxide having the same radiative effect as all the greenhouse gases) will rise by 1% per year; this is somewhat greater than the 'nonintervention' scenario referred to above. When this is used, the future global mean temperature change is about 0.3°C per decade. The simulated temperature rise from the middle of the last century to date is nearly a degree, whereas that observed is more like half a degree.

The next most important climate forcing agent to carbon dioxide is atmospheric aerosols. Although there are no measurements to show how these have changed over the past 150 years, there are estimates of how sulphur dioxide emissions have risen, and these are used to calculate the accompanying rise in sulphate aerosols, When the aerosol cooling effect is additionally applied to the models, the size of the temperature simulations and predictions are smaller by about 30% than those with carbon dioxide alone. Over the last few decades the agreement between observations and simulations including sulphate aerosol is better than the case with carbon dioxide forcing alone, although some of this improved agreement is probably coincidental. When greenhouse gas increases and the ameliorating effects of aerosol emissions are projected into the future, a global temperature rise of some 0.2°C per decade is predicted, although regional changes are very different because of the local effects of aerosols.

The spatial pattern of temperature change will not be uniform. Temperature increase is greatest at high northern latitudes, as the melting of sea ice will allow more solar radiation to be absorbed and thus amplify warming in this area. The increase is also greater over land areas than over the oceans, as the thermal inertia of the ocean slows the warming. There is also a general slower warming across northern mid-latitudes, where aerosols from pollution have their maximum effect. These features are common to all predictions which have so far included aerosols.

'The increase is also greater over land areas than over the oceans, as the thermal inertia of the ocean slows the warming. There is also a general slower warming across northern mid-latitudes'

Superimposed on a slow climate warming will continue to be natural year-to-year variability, which means that, even several decades hence, there will still be cold years, or even cold decades.

Regional climate models have been developed, with a resolution of 50 km, which are embedded in the global model and driven by climate change fields from it. Although such models show more detail in their predictions, and include the effects of topography, for example, credibility of predictions at a regional scale remains low because they are still limited by the global predictions, and thus by their uncertainties. Confidence in the predictions of regional impacts of predicted changes must be even less than in the predicted changes themselves.

Recent possible climate change

There is currently much debate about the extent to which recent perceived changes in weather patterns can be attributed to human activities. To explore this we must first look at how climate may have changed. The longest and most credible global climate record is of temperature; the IPCC uses a combination of land temperatures analysed by the University of East Anglia (UK) and sea surface temperatures analysed by the Hadley Centre. A global-mean near-surface annual average temperature for each year was estimated from global instrumental records for the period 1860 to 1995. Nine of the ten warmest years on record have been in the 1980s and 90s. 1995 was (just) the warmest year of all.

To see if these recent changes are unusual, we would ideally compare them with changes measured over the last 1000 years. Such records do not exist and so we try to use the climate model to simulate them and compare the modelled natural variability with the recent observed changes. This shows that, if the model's simulation of long period temperature variability is realistic, then changes over the past few decades have indeed been unusual. However, the parameterisation of the model, by averaging some of the processes, may also act to reduce some of the actual natural variability, and so the results cannot be conclusive. Nevertheless, the agreement over the last few decades between observations and simulations including sulphate

aerosol is very good, and better than the case with greenhouse gas forcing alone, although some of this improved agreement is probably coincidental.

Better comparison of the model simulations with observations may be made by looking at spatial patterns or fingerprints. Pattern correlations between the observed and 'with aerosols' simulation show that the correlation has become more significant over the past decade. Recent work using the patterns of change to the vertical profile of temperature (using observations from radiosondes on weather balloons) also gives a qualitatively similar result. At the same time, there are changes in instrument recording that mean that the evidence is not yet conclusive.

There has been much investment in the past two decades in satellites for Earth observation. However, the period of record with consistent observations is too short for definitive conclusions to be drawn, particularly as satellite instruments have developed considerably over this period. There is some suggestion from some workers that the satellite observations do not show the cooling in the lower stratosphere that would be expected if there is a surface global warming. However, the radiation models to draw such a conclusion are themselves uncertain, as shown earlier, and so again the evidence is inconclusive.

Sea level rise

As the ocean warms, it will expand and sea level will rise. Using the IPCC scenarios described above, the climate model calculates a sea level rise of some 20-30 cm over the next century. When other contributions (the melting of land ice, changes over Greenland and Antarctica) are added, the IPCC best estimate rise amounts to about 50 cm. As heat diffuses slowly to the deeper ocean it will cause further expansion; hence, at any given time, the observed sea level rise will be only a fraction of that which will inevitably follow. Even if there were to be no further change in climate (which, as we have already noted, implies a 60% decrease in carbon dioxide emissions) sea level rise would continue for hundreds of years. It has been estimated that, if carbon dioxide concentrations were to rise to double their pre-industrial level and stabilise at that level, the sea level rise seen at the time of stabilisation would multiply about sixfold over the next 400 years.

Uncertainties

Although the underlying principle of global warming is robust, uncertainties abound at almost all stages of the process of climate prediction. Nevertheless, continuing research has led to a reduction in these uncertainties, and they can be expected to reduce further in the future. A more comprehensive treatment of feedbacks will be possible as computing power grows, although ultimately the ability of models to represent processes in the atmosphere and ocean depends upon a better understanding of them, which in turn rests on extensive programmes of observations and experiments.

> ***'At any given time, the observed sea level rise will be only a fraction of that which will inevitably follow. Even if there were to be no further change in climate… sea level rise would continue for hundreds of years'***

The climate system is also chaotic, partly because of the non-linear nature of the feedbacks. It may therefore happen that the current coupling of oceanic and atmospheric circulation could change suddenly, and cause very large possible changes in climate. We do know that, in the recent geological past, the Earth has been subject to repeated glaciations and that the onset of these has been very rapid. No climate model currently represents the onset or ending of these glaciations well. However, to put these glaciations in perspective, the global mean temperature during these was perhaps 6°C colder than at present; the current model predictions are for an anthropogenic warming of climate of 2-3°C in the next 100 years. Some of the ocean circulation models do predict a change in the global ocean circulation as the world warms, as changes in density at different temperatures alter the rate of ocean overturning. Such a change in ocean circulation could have a large effect on global climate. This, and other 'surprises' are not modelled well in climate models. We must, therefore, continue urgently to reduce the uncertainties in climate prediction through further observation and modelling.

Conclusions

This brief survey of climate research to estimate the possible effects of a rise in anthropogenic carbon dioxide emission has shown that concentrations of greenhouse gases and aerosols in the atmosphere continue to increase. Some of the greenhouse gas concentrations take a long time to respond to changes in emissions, whereas some of the ameliorating influences, such as aerosols, respond within days to changes in emissions. Climate models predict that global temperatures will rise by about 3°C due to anthropogenic emissions of greenhouse gases, but that this global change is reduced to about 2°C if the cooling effect of aerosols is taken into account. The effect of aerosols is localised, and greatest in the mid-latitude Northern hemisphere. Although evidence is not conclusive, there appears on balance probably already to have been a human influence on climate: in 100 years, the evidence will be conclusive one way or the other, but the natural variability of the climate system makes the attribution of any changes difficult at present. There are, however, large uncertainties in predicting the climate effects of rises in greenhouse gases that are being reduced. Predictions of the possible climate change do not rely on the climate models alone, however, but also on the rather robust understanding of the underlying principles involved. Nevertheless, reducing the uncertainties in prediction is a major intellectual challenge at the end of the 20th century.

Acknowledgment

1 would like to thank Dr. Geoff Jenkins and the staff of the Hadley Centre for their help in the writing of this article.

■ *This article is based on an address to the Parliamentary and Scientific Committee on 24th November 1997. It has been reprinted with the kind permission of the publishers of the committee's journal,* Science in Parliament.

Biosciences research: a compelling investment

Professor Raymond Baker,
Chief Executive, Biotechnology and Biological Sciences Research Council

Whilst the development of the UK economy in the 19th century was driven by social and political factors, the major industries were underpinned by a growing awareness of the chemical and physical sciences. Industrial activity in the 20th century has largely been based on application of research in physics, electronics and mathematics. It is now generally accepted that the explosion of biological knowledge in the late 20th century will have significant impact on quality of life and will lead to biologically-derived products and processes achieving pre-eminence in the global markets of the 21st century. But the winners in this global competition will be countries who can most efficiently generate and translate ideas into novel products or processes and market them successfully.

In the biosciences the UK already has a high quality research base and world leading bioscience companies both large and small. Continuing government expenditure on biosciences research and training in universities and institutes is required to maintain the UK's position in the face of increasing competition from in particular the USA, Germany and Japan.

Biosciences research offers the prospect of improved quality of life in the next century. This results not only from the application of modern biotechnological techniques to develop drugs to treat acute and chronic diseases, including degenerative diseases such as Alzheimers but also to improve the safety and security of food supplies and to develop biological routes to the production of chemicals to replace some of the more environmental-damaging chemical processes. Moreover, the market for products developed using biotechnology is set to increase substantially over the next ten years where a recent study has predicted a six-fold growth in the European market of which 70 per cent of the growth is predicted to come from the agri-food sector. On the back of this, employment associated with the use of biotechnology in Europe is forecast to increase to some three million by 2005.

Within Europe, the UK bioindustries occupy a dominating position. The UK food industry with turnover approaching £60 billion is the UK's largest manufacturing sector and the agriculture sector produces £14 billion output. Many of the world's most important pharmaceutical companies are either headquartered or have substantial research facilities in the UK. The pharmaceuticals/healthcare sector is responsible for a substantial positive surplus in the UK's balance of payments. Many of the most innovative developments in the biosciences are being pursued within biotechnology SMEs where almost a third of all such European companies are based in the UK. However there have been recent signs of significant developments on the continent where over the past two years more biotechnology start-up companies were founded in Germany than in the United Kingdom.

In order to maintain the UK's competitiveness it is essential to sustain and enhance the UK's already formidable bioscience research base. Recent HESA statistics reveal over 8,000 full-time academic staff in the non-medical biosciences at universities in addition to staff working in BBSRC institutes (3,550), MRC institutes (3,000) and other GREs. The high quality of this bioscience research base is illustrated in the analysis carried out last year by Sir Robert May which showed that the UK featured within the top five in the world, and frequently within the top two, in a range of bioscience sub-disciplines as measured by both total citations and the relative citation index (a measure of the quality of the papers).

Opportunities for pursuing research of high quality and potential applicability are now opening up across a broad front driven in large measure by our increasing knowledge of genome structure and function. In pharmaceuticals/healthcare the isolation and cloning of receptors and their integration in high-throughput screens employing combinatorial libraries is revolutionising drug discovery, whilst our increasing understanding of the genome and gene function is expanding the number of drug targets.

Within the agri-food sector research in plant molecular biology, initially on model systems, offers the prospect of increased yields, improved disease and pest resistance and the generation of food products of improved quality and with enhanced storage characteristics. Research in the animal sciences also holds the prospects of improving disease resistance in animals and the control of food borne pathogens.

Earlier work at the BBSRC Roslin Institute on transgenic sheep led to the development of a system, now being exploited by PPL, for the production of alpha-antitrypsin currently under clinical trials for potential use in treatment of cystic fibrosis. More recently research at Roslin, voted 'science breakthrough of 1997' by the editors of the journal *Science*, has developed nuclear transfer technology to clone the first animal (Dolly the sheep) from a fully differentiated adult cell. This work has potential spin-off both in animal breeding and in human healthcare where a new company, Biomed, has already been formed based on substantial funding from 3i.

BBSRC, within its budget of £183 million, is promoting a broad ranging programme of research and training in universities and institutes. In addition to continuing its traditional role of supporting in responsive mode work of high quality proposed by individual scientists, BBSRC has also encouraged the development of portfolios of research projects in areas of emerging scientific opportunity and strategic need. Earlier this year, as a contribution to the EQUAL initiative, BBSRC invited proposals to study the science of ageing aimed at improving our understanding of the biological process of normal ageing at molecular, genetic, cellular, organism and population levels. Bioscientists in universities and institutes have been invited to develop novel

research ideas to attack these problems where it is BBSRC's intention to commit some £5 million later this year, equivalent to funding some 29 three-year research grants.

Other initiatives to be launched this year include a programme, developed after consultation with the BioIndustry Association, to enable functional information to be extracted from genome sequence data, a generic research area of great value to the range of UK bioindustries, and an initiative to improve our understanding of the genetics and physiology of food-borne pathogens, an area of widespread public concern where there is a real need for a deeper fundamental understanding. BBSRC has also funded research for a number of years aimed at elucidating the nature of the infectious agents responsible for the transmissible spongiform encephalopathies where a further call for proposals will be made later this year in coordination with MRC, MAFF and the Department of Health.

Whilst BBSRC takes pride in the high quality fundamental research it supports in universities and institutes, it is also anxious to ensure that the research results generated are captured for the benefit of UK plc wherever appropriate. To this end BBSRC established a Business and Innovation Unit in 1997 to provide a focal point for our efforts over a number of years to encourage exploitation. We have been involved in a number of innovative schemes including initiatives to improve IP management in the research base, and the development of a Young Entrepreneurs Scheme to provide entrepreneurial training to postgraduates and postdoctorals at the start of their careers. There have been many examples of both significant licensing income and new start-up companies emanating from research supported by BBSRC.

In conclusion, the UK possesses a valuable national asset in its bioscience research base. However, to remain internationally competitive, this research base needs to be nurtured both in terms of research grant funding and through provision of sophisticated instrumentation now required to remain at the forefront of world research. In view of the burgeoning opportunities in the biosciences it is perhaps difficult to reconcile the fact that the nonmedical life sciences share of the science budget has shown little change over the last 30 years. There remain major opportunities to employ the biosciences to improve mankind's condition and develop significant life science industries. This perception has been reflected over recent months in the growing trend of previously chemical-based companies such as DuPont, Novartis, Monsanto and Zeneca to build their future businesses around the biosciences.

■ *This is a summary of an address given to the Parliamentary and Scientific Committee on 22nd June 1998. It has been reprinted with the kind permission of the publishers of the committee's journal,* Science in Parliament.

Industry's role in air quality standards

The role that industry must play In strategies to meet the demands of the National Air Quality Strategy (NAQS), was the subject of a conference held in September at the West of England Air Quality Management Resource Centre. It took place at the Centre's base on the Frenchay Campus of the University of the West of England in Bristol.

The event, entitled 'Local Air Quality Management and Industry', attracted delegates from local authorities, companies and other organisations from across the South West and featured a cross- section of speakers. They included representatives from the aggregate and power generation industries, of particular relevance to the region, as well as from the Environment Agency, from consultants, and from the local authorities.

Much of the debate centred on an identification of the ways in which industry specifically impacts on the NAQS; for instance, in respect of sulphur dioxide emissions, which represent one of the seven pollutants targeted for reduction. The relative pollutant problems caused by traffic and industry, and the way in which this varies throughout the country, was also discussed. Accuracy in this kind of differentiation is becoming increasingly important as local authorities reach the end of the review and assessment stage of the NAQS. The next stage will be the identification of Air Quality Management Areas (AQMAs) – those areas in which specific pollutants are predicted to exceed standards and objectives such that specific action is required. This will compel all sectors that play a role in air quality to collaborate closely so that target levels are reached by 2005,

Although industry faces an increasingly stringent array of regulations – the Integrated Pollution Prevention Control Directive is another recent addition – the September meeting did produce some good news. Power stations, nationally, are generally expected to meet the sulphur dioxide objective by the required deadline, Even so, many manufacturers will be required to take more measures to reduce air pollution. The Centre's co-ordinator, Nicky Woodfield, said: 'It was clear from this event that the need to bring the industrial sector into the air quality management process is becoming increasingly important. Local authorities need to involve their major industrialists, particularly where AQMAs are to be designated.'

A workshop to help local authorities in the designation of AQMAs is the subject of the Centre's next workshop, to be held the university on 24th November. A further event takes place on 9th December, when the Centre will link with the South West Division of the National Society for Clean Air (NSCA) for a conference to be staged at Gloucestershire Cricket Ground. While celebrating the NSCA's centenary year, that event will look forward to the future challenges those in charge of air quality management will face in the coming months and indeed years.

Further details are available from Nicky Woodfield, tel: 0117 975 2716; e-mail: nicky.woodfield@uwe.ac.uk. Information about the Centre, and many other aspects of air quality, can be found on the Centre's website: www.uwe.ac.aqm/centre. This recently achieved the greatest number of star ratings in a national survey of air quality websites conducted by Air Quality Management. In particular, the quantity of its information, its links and its usefulness, were all rated 'excellent'.

■ *Nicky Woodfield MIEnvSc, Co-ordinator, Air Quality Management Resource Centre, UWE.*

A new urban environment: is it achievable?

A new set of government initiatives has emerged over the past year to deal with urban blight and give a boost to urban renewal. Regenerative residential development is proposed to bring community life back into depressed urban areas.

Statistical forecasts indicate a demand for significant development of new housing both in the north and the south. The industry, so long in recession, is already gearing up for this expansion and is limited only by the uncertain economic climate.

Can these two pressures interact to provide new urban environments and, if so, what will be their nature?

The underlying reasons for the movement away from urban areas has been varied and complex. However, amongst the most significant of these was the breakdown of the sense of community. Belonging to and taking part in the activities of a living community is fundamental to civilised life. The lack of this sense leads, in the extreme, to feelings of isolation, loss of safety and security and growth in crime rates. These more extreme situations have been exacerbated by the deterioration in family structures and have a particular effect on the elderly. This is a social, rather than a physical problem, and can only be ameliorated by greatly improved facilities.

In any regeneration scheme one of the most important things that people are seeking is the physical closeness of an active community life to which they can relate. This is most likely to occur in small-scale areas – the 'village' or, in urban terms, the 'neighbourhood'. These must be large enough to support reasonable self-sufficiency in terms of employment, education, shopping, and recreation but still retain geographical compactness and short travel distances.

Modern trends in development have been to separate residential areas from employment centres, expanded schools, recreational facilities and most of all shopping. Together with the social effects noted above these are destructive influences.

The post-war era saw the development of new planning principles (New Towns, neighbourhood – Radburn – planning, etc) and strong support for good innovative design at local planning levels. Through the '80s and '90s this initiative has largely been lost. Positive planning initiatives by county and district authorities have been singularly lacking and commercial considerations have been paramount. The only marked advance has been the abandonment of the 'high-rise housing' solutions which have been self-evidently a failure (both socially and structurally!).

We need a positive return to good planning principles of well designed, traffic segregated, low rise, mixed-use housing; clearly identified neighbourhood units with adequate support infrastructures of local employment, education, shopping and leisure; and good local transport. These principles need re-application in the existing urban context with the development of techniques for incorporating a number of significant environmental considerations.

> ***'To simultaneously achieve urban renewal and sustainable development is not beyond the wit of man. It will, however, require vision, political will and a new approach in thinking'***

Marked reductions in car use, with associated reductions in atmospheric pollution, can be achieved if journeys away from the 'neighbourhood' can be avoided. Local provision of schools (particularly secondary), shops (rather than out-of-town hypermarkets), open space and leisure facilities and above all employment can all contribute significantly to this. If 'clean' industry can be attracted to these inner areas this is a further environmental gain.

The re-utilisation of derelict land – brownfield sites – and contaminated land forms a part of regeneration initiatives. (A very large number of urban areas have derelict gasholder sites, which need re-developing.) Some significant efforts have already been made in this direction e.g. Enfield Island in Middlesex, Chatham Maritime in Kent and the Millennium site at Greenwich. What is questionable, though, is whether the other desirable development requirements are being met. Cost of re-development is high, but new thinking in terms of social costs and benefits need to be applied to demonstrate long term viability.

Any large-scale community development will generate significant quantities of waste. Environmental planning should recognise this factor and development strategies incorporate waste minimisation initiatives, recycling programmes and waste disposal programmes which should include the possibility of energy recovery (incineration for example).

Such development will also involve the consumption of raw materials and a continuing use of energy. As far as possible construction should be 'sustainable' with the use of reclaimed materials where possible and the incorporation of energy saving and environmentally friendly features in the design.

A significant drawback in the achievement of the 'environmentally sustainable urban community' is cost. Redevelopment of derelict areas and remediation of contamination are costly processes. The provision of facilities to make individual communities relatively self-sufficient (as recommended above) is rarely as economic as those currently in use. A new attitude to the assessment of cost, which recognises social costs and benefits as well as purely capital investment, is needed together with the demonstration of long term viability. The techniques have been with us for many years but their use is rare!

To simultaneously achieve urban renewal and sustainable development is not beyond the wit of man. It will, however, require vision, political will and a new approach in thinking to bring it about.

R.A. Fuller

This section of the Journal is in response to the growth of news, information and activities which underpin the Education Committee of the IES.

Special prominence is given to student activities and projects, national and international initiatives, campus developments and research in order to capture the diversity, wealth and vitality of modern environmental education.

Readers are invited to send articles and letters to:
■ Derek Blair, School of the Environment, University of Sunderland. Benedict Building, Sunderland SR2 7BW.
■ Tel: 0191 515 2737.
■ Fax: 0191 515 2741.
■ E-mail: derek.blair@sunderland.ac.uk

New impacts upon entry for environmental sciences beyond 2000 AD

New structured entry qualifications for Environmental Science courses in HE are being proposed by UCAS as part of a new tariff system. Environmental Science, which has recorded four continual years of decline in applicants and declining popularity nationally, has now to consider along with other subjects how this new proposal may affect popularity and delivery at the pre-university stage. Little time is given for the changes are scheduled for September 2000.

The UCAS tariff will cover A Level, Advanced Subsidiary, Advanced GNVQ, Key Skills and industrial units of A/AS/GNVQ. Considerable. progress and agreement has already been reached apparently and final consultation with HEIs via questionnaire was concluded for 20th September.

Similar developments are in progress for Ireland, Scotland and Wales.

The new system had its origins in Qualifying for Success. Qualifying for Success reinforced the idea of a national qualifying framework with three categories – general, vocationally-related and occupational.

It also introduced new A, AS and GNVQ level qualifications based on a structure of 3-, 6- and 12-unit awards. One important impact immediately will be the reduction in number of different syllabi. Also, only three unitary awarding bodies will remain after the mergers of former examination and awarding bodies.

How these important structural changes will affect curriculum developments is anyone's guess. Preliminary enquiries by the IES cannot establish how or who is addressing this issue for environmental science.

An Advanced Subsidiary (not Supplementary) as a stand-alone qualification, half of A level will be set and assessed at the end of one year of an A level programme. A levels will have six-unit structure and be modular. Advance GNVQ will be available in 6- and 12-unit awards in all subjects with the possibility of 3-unit awards.

New key skills covering numeracy and literacy, IT, problem solving and working with others, will not be mandatory but will be included in post-16 programmes with signposting of opportunities evident in new A/AS/GNVQ specifications.

The government thinking is that post-16 students should undertake a broader and more voluminous programme of study, beyond the traditional three A levels. Such modifications may benefit the interdisciplinary study of the environment as they encourage greater combinations of subjects, in theory.

Questions about the academic content of HE courses broadly related to Education for Sustainability are testing educationalists now. This new proposed restructure raises further serious questions at a critical time for Environmental Science. New specifications for Environmental Science will have to be developed not only to reflect the contentious and persistent educational question as to what should be included in the core but also to capture the vital ingredients of Education for Sustainability.

Perhaps the difficulty of defining a core is a factor in the slowdown and decline in environmental science reflected in UCAS figures since 1996. Perhaps the 'science of sustainability', however defined, provides a thematic and conceptual focus for a response to that challenge, as some believe. If sustainable development is becoming mainstream to government policy and programmes as Prime Minister Blair indicated in a speech in the summer of 1999 – 'The whole government is committed to making sustainable development a reality… together we m ensure our economy, our society and our environment grow and develop in harmony' – then all citizens should benefit from educational programmes which address sustainable development.

The IES sees the educational challenge for the heart of environmental science in the millennium as serious and the new tariff now an additional consideration.

Derek Blair

■ *Source:* The New UCAS Tariff. *Development Unit, UCAS, Sosehill, New Barn Lane, Cheltenham GL52 3LZ.*

Professional practice for sustainable development

Professional Practice for Sustainable Development is a major new initiative in which a dozen professional bodies, including our own, have come together to develop training materials which will equip professionals with the confidence and competencies they need to deliver sustainable development through their everyday work.

All the professions have a key role to play in sustainable development, from engineers and planners through to lawyers, managers, educators and accountants. Yet because it is a new issue, sustainable development has not yet become a routine part of professional practice.

The expected outcomes of the project are:

- to develop a sustainable development framework appropriate for professional institutions to use as a basis for continuing professional development; and
- to develop, test and publish training materials relating to the framework. The materials will be appropriate to the needs of the institutions and might be in the form of printed or electronic manuals, guidelines or information packs.

The project is aimed at the over-30s – people who will not be exposed to the excellent new sustainability materials being introduced into higher education. This brings to mind a quote by famous atomic physicist Max Planck: 'A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it.' Hopefully, we will not have to wait that long for sustainability to be accepted as a mainstream part of every professional's acumen! The pragmatic approach being adopted by the project means that the materials being developed will be relevant, useful and practical, and will become part of continuing professional development programmes involving hundreds of thousands of professionals throughout the UK.

The institutions participating in the project are:

Chartered Institution of Building Services Engineers
Chartered Institution of Water and Environmental Management
Institute of Wastes Management
Institution of Chemical Engineers
Institution of Civil Engineers
Institution of Environmental Sciences
Institution of Mechanical Engineers
Royal Institute of British Architects
Royal Institution of Chartered Surveyors
Royal Society of Chemistry
Royal Town Planning Institute.

The project is being facilitated by a partnership between The Institution of Environmental Sciences, The Natural Step (part of Forum for the Future), the Council for Environmental Education, WWF-UK, and the Environment Agency.

We aim to define some core concepts by Christmas, and then will begin to produce CPD materials during 2000. The draft principles of sustainability are being worked on during November and December. If you would like to input to this process, call the project manager:

Edwin Datschefski
Tel: 0171 628 0992
email: edwin.d@ukonline.co.uk

Election of members to Council 2000

I ..... **Membership No** .....
(PRINT NAME)

nominate ..... **for election to Council of the Institution of Environmental Sciences.**

Signature *(proposer)* .....

Seconded by ..... **Membership No** .....
(PRINT NAME)

Signature *(seconder)* .....

I ..... **hereby confirm that I am willing to stand for election to Council as proposed.**

To be returned by Friday 10th December 1999 to:
The Hon. Secretary, IES, PO Box 16, Bourne, PE10 9FB.

Job Openings: Saudi Binladin Group in Saudi Arabia

Saudi Binladin Group – Operations & Maintenance Division is an ISO 9002 certified company with 9500 employees of 37 different nationalities at numerous projects/sites. The main business activity is operations, maintenance, project management, programme management, electromechanical works in large infrastructures. It is an operating company of Saudi Binladin Group, one of the largest private employers in the Middle East with 37,000 employees. SBG has offices around the globe and many joint-ventures with North American companies.

SBG – O&M entered into the environmental business line in 1998 and is currently expanding aggressively.

SBG – O&M currently has a five year contract with the Royal Commission of Jubail & Yanbu in Yanbu Industrial City (west coast of Saudi Arabia) for a comprehensive Environmental Monitoring Programme & Laboratory. Disciplines covered include air, water, wastewater, hazardous waste, permitting, marine biology etc. Four years still remain on the contract plus a good opportunity of renewal for a further five years.

SBG – O&M is bidding for a multi-million US$ and new three year contract project with the Saudi Meteorology & Environmental Protection Administration (Ministry of Defence & Civil Aviation) for operations, maintenance, management, training to commence March/April 2000.

Advertisement One

We are seeking for sixty-three professionals in environment and meteorology to work in this contract with lucrative package, i.e. good tax free salary, paid housing, medical, transportation allowance, 40 day vacation, air ticket to home once a year, etc.

Posts: require a BSc, MSc and/or PhD in Environmental Sciences/Engineering, Meteorology, etc with at least 3-5 years of relevant experience in industry and/or governmental agency, teaching, research with good communication/interpersonal skills, computer literate, planning, instrumental analysis, etc.

For Info Systems/Computer related jobs, a BSc or MSc in Computer Science is required with experience in programming, systems analysis, data base development/management, etc. For the Librarian, an MLS degree with technical library experiences. For Technicians, an Associate degree preferable. For other positions, appropriate related degree and experience required.

The positions are:

1. Manned Observation Stations
   Meteorologist (6)
   Specialist (2)
   Forecasters (4)
2. Information Management Systems
   Numerical Prediction Systems
   Specialist (Meteorologist-computer)
   Application programmes specialist
   Computer (9)
3. Geographic Info Systems
   G.I.S Expert (1)
   Remote Sensing Specialist (1)
   Specialist – Systems Analyst
   Data Entry Operator (2)
4. Scientific Data Base Management
   Data Base Manager
   Meteorology Database Development Systems Analyst
   Programmer
   Data Entry Operator (2)
5. Scientific Documentation
   System Librarian
   Library Assistant
6. Monitoring Management Support System
   Analyzer
7. Network System (NETC)
   Chief Engineer
   Technicians (3)
8. Telecommunications
   Technicians (5)
9. Marine Water Quality Development
   (Environmental Impact Assessment Programme)
   Pollution Specialist (1)
   Pollution Inspectors (2)
10. MEPCS
    Marine Environment Pollution Control System
    Marine Environmental Expert (1)
    Marine Environmental Specialist (2)
    Chemist (1)
    Computer Specialist (1)
    Satellite Picture Specialist (1)
    Environmental Inspector (1)
11. Environmental Lab
    Environmental Lab Manager
    Environmental Chemist
    Lab Analyst/Technicians
12. Air Quality/Pollution (APMP-3)
    Air Specialist (Chemical Eng. or Meteorologist)
    (APMP-4) Air Pollution Control Eng. Specialist (Chemical Eng.)
    Stack Sampling Technician
13. Pollution Emergency Response
    Programme (OSCP-5)
    Marine Pollution Expert
14. Environment Awareness & Coordination (ESONCS)
    Programme Coordinators (2)
    public relations
15. Training Manpower
    Meteorology Expert (1)
    Meteorology Specialist (1)
    English Language Teacher
    Technical Secretary

Advertisement Two

We are seeking four professionals in environmental disciplines (project staff 14), to work on this contract which includes a lucrative package, i.e. competitive tax free salary, free housing, medical, transportation allowance or a company car, 40 day vacation, air ticket home once a year, etc.

Requirements: BSc, MSc, and/or PhD in Chemical Engineering, Environmental Sciences/Engineering, Chemistry, etc, with at least 3-8 years of relevant experience in industry and/or governmental agency research. Good communication/interpersonal skills, computer literate, planning, instrumental analysis, air quality monitoring stations/systems, water quality, hazardous waste, permitting etc.

The positions are: Project Manager; Air Specialist; Chief Chemist; Permit Reviewer

The contract (if awarded) is renewable or you can join our company because we are expanding our business line in environmental protection. Currently we have an Environmental Project at the Royal Commission of Jubail & Yanbu at the Yanbu Industrial City, and we are expanding our Water Testing Laboratory into a comprehensive Environmental Laboratory. We are also seeking O&M contracts in water & waste water, sewage treatment, desalination, etc. For the Head Office, we are currently seeking for a Safety Specialist (English/Urdu or English/Arabic speaking Muslims since he has to go to the Holy places for audits, training, etc). BSc/MSc degrees with 3-5 years experience in HSE.

If you are interested in the above challenging positions, and/or if you know any of your colleagues/friends/relatives, who may be interested, please send the résumé/CV to:

Dr Kazi F. Hussain, Manager – Training, Safety & Environmental Affairs,
Saudi Binladin Group – O&M Division, PO Box 6807, Jeddah 21452, Saudi Arabia.

E-mail: KHussain@SBGOM.com
Fax: (9662) 691-7391 Attn: Dr Kazi F. Hussain. Phone: (9662) 683-6887 ext. 273

Full details of all these appointments are available on the IES Web site: http://www.greenchannel.com/ies

Diary dates 2000

10 January	GP Committee	13.00
8 March	Education Committee	10.30
8 March	AGM and Council	13.30
10 April	GP Committee	13.00
5 July	Education Committee	10.30
5 July	Council	13.30
1 November	Education Committee	10.30
1 November	Council	13.30

New IES address

Please note the Institution's new postal address:

PO Box 16,
Bourne,
PE10 9FB

Telephone/fax: 01778 394846.

IES Web Site:
http://www.greenchannel.com/ies

Email: ies@greenchannel.com

Occasional papers available now from IES

Waste management

- From waste to woods – planting trees on landfill
- From waste to woods: trees on landfill and their place in landscape
- Enhanced landfill strategy
- Waste minimisation: the long term benefits
- European study on EISs of installations for the treatment and disposal of toxic and dangerous waste
- Mercury fall-out from crematoria

Education and training

- Environmental courses undergo a quality assessment
- Student environmental declaration
- On-line information systems in environmental sciences courses
- Global environmental charter and network for students

Business and industry

- The tourism challenge
- The tourism debate and environmental scientists
- Enjoying environmental science as a career
- The Brent Spar and the best practical environmental option

National and local government

- Transport policy, environmental pressures and the new UK government
- Local Agenda 21 – making it work

Price: £5 per paper including p&p
(£3 per paper for members)

Contributors

The *Environmental Scientist* aims to provide a forum for members' contributions, views, interests, activities and news, as well as topical feature articles. Articles up to 3000 words should be submitted to the Editor three weeks prior to publication in the last week of January, March, May, July, September and November. Editor's address: 25 Kennedy Avenue, Huddersfield, West Yorkshire, HD2 2HH; telephone 01484 426796, fax 01484 546640.
Views expressed in the journal are those of the authors and do not necessarily reflect IES views or policy.

Advertising

Advertisements should be submitted to reach the Institution by the 7th of the month of publication.
Rates: £50 (half page); £25 (quarter page); £12.50 (eighth page). Full page adverts at £100 can only be accepted under special circumstances, subject to space being available.

Published by the Institution of Environmental Sciences, PO Box 16, Bourne, Lincs PE10 9FB. Tel/Fax: 01778 394846.
Web Site http./www.greenchannel.com/ies E-mail ies@greenchannel.com.
Design and origination by Davies Communications, 0171-482 4596.
Printed on recycled paper by Uniprint Ltd, 36 Jaggard Way, Wandsworth Common, London SW12 8SG.