THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

OFFICE OF SCIENCE AND TECHNOLOGY, DTI

LECTURE SUMMARY

THE NINTH ANNUAL ZUCKERMAN LECTURE
Professor David King ScD FRS
The Science of Climate Change: Adapt, Mitigate or Ignore?

Chaired by
The Rt Hon the Lord Jenkin of Roding and The Lord Sainsbury of Turville

Held at The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG
on Thursday 31st October 2002

Sponsored by
Schlumberger Cambridge Research

Opening the proceedings, the Rt Hon the Lord Jenkin of Roding, Chairman of the Foundation for Science and Technology and Joint Chairman for the Zuckerman Lecture, welcomed those present and in particular distinguished visitors from India, Australia and New Zealand and expressed his thanks to the Sponsor, Schlumberger Cambridge Research. He welcomed Professor King, who, after an education in South Africa, had held posts at the University of East Anglia, Liverpool and Cambridge before being appointed Chief Scientific Adviser to the UK Government in 2000. In addition to his scientific specialities he has wide interests in art and photography.

The other joint Chairman for the lecture, Lord Sainsbury, Minister, Office for Science and Technology which was jointly organising the event, expressing his honour in being associated with the introduction of the speaker, thanked The Royal Society and The Foundation for Science and Technology for their part in hosting the proceedings. It had been the tradition for this lecture to be given by a foreign Minister in the scientific field. The break in that tradition was to be welcomed, Lord Zuckerman having himself held the office of Chief Scientific Adviser. The subject of the lecture was a timely one, when global warming increasingly threatened the environment. In welcoming Professor King, Lord Sainsbury looked forward to a lively discussion.

Professor King began by emphasising that the subject was one which crossed many boundaries, national and cultural, and its international importance required scientists and politicians to work together. Illustrating the work of the Hadley Centre in establishing a temperature history of the globe through the measurement of ice cores, Professor King instanced the reduction of the ice-cap of Kilimanjaro from 12.1 sq. km in 1912 to 2.25 sq. km in 1998. It was estimated that this cap would have disappeared by 2015.

Factors contributing to this effect had first been identified by the French mathematician and crystallographer, Jean Baptiste Fourier in the early 19th century. He had coined the term “greenhouse effect” to describe the effect of heat from the sun penetrating the earth’s atmosphere, the resulting warmth being retained by that atmosphere. In itself, that process is benign. In 1860 Tyndall measured heat absorbed by carbon dioxide and water vapour and developed the theory that changes in the carbon dioxide emissions determined the cycle of ice ages. In 1896, Arrhenius (Sweden) made the attempt to estimate quantitatively the effect of carbon dioxide emissions on global temperature, predicting that a doubling in the volume of such emissions would produce a rise in temperature of 5 to 6 degrees Centigrade, a figure close to modern estimates. In an address to The Royal Society in 1936 Callender advised that, based on data from 1882 to date, global warming was taking place, a view that did not then find acceptance. Since 1965, when the White House first ordered a study of the phenomenon, international scientific activity has gathered pace in the UN, the US and various inter-governmental studies.

Professor King illustrated the current state of knowledge by a series of graphs, the first showing carbon dioxide emissions over the last 60,000 years during which the ceiling of 280 parts per million had not been breached until the last century when it had begun to climb to the current figure of 375 ppm. Future predictions considered alternative estimates of rises by 2100 of 550 ppm and 1,000 ppm respectively. Predictions of annual rises in temperature were subject to wide margins of error but ranged from 1.5 to 5 degrees Centigrade. The question to be answered was whether there was a causal relationship. Human activities giving rise to temperature increases comprised emissions of carbon dioxide, methane, nitrous oxide and sulphur. A comparison, for the years between 1860 – 2000, between the computer simulated model and observed results showed close congruence. It was reasonable, therefore, to accept a causal link.

An analysis of the longevity of the carbon dioxide effect shows that stabilisation of this can take up to 300 years, after which it does not increase further. The effects of temperature changes resulting from this have alarming consequences for sea-levels, both as a result of thermal expansion and melting ice-caps. By 2080 Arctic sea ice is likely to have nearly disappeared and Antarctic sea ice to have reduced by 10%. A series of maps illustrated the effect of rises in global sea levels of 3m, 10m and 30m respectively on the North American coastline and on the number of people likely to be flooded in India, South East Asia and Africa. If no attempt to reduce carbon dioxide emissions were made, the numbers likely to be affected in this way could rise to hundreds of millions by 2080. Reductions of emissions to 750 ppm or 550 ppm would have progressively less devastating effects but would still be serious, having economic, financial, social and political implications. If stabilisation at 550 ppm could be achieved, 90% of the effects of sea level rise could be avoided. There were, however, already increased storms and a growing reduction in bio-diversity, e.g. loss of species including depletion of coral-reef organisms could be expected. The options for future policy were to do nothing, leaving the solution to market forces, to mitigate, by reducing the extent

of the effects, or to adapt by managing change. Mitigation and adaptation were not mutually exclusive courses.

A graph of past and estimated future oil production showed that, while the slowing of production imposed by the OPEC producers in the 1970s had delayed the process, exhaustion of world supplies at present rates of consumption could be expected unless alternative sources of energy were developed. Already, by 2009 it was likely that 50% of all oil supplies would be in the Middle East and unit cost of production might rise by $1 a gallon. The total combustion of all the world oil reserves would raise the raise the CO_2 levels above 750 ppm and lead to irreversible loss of global ice, which must not be allowed to happen. Alternative fuel sources, however, were not without complications. Developments in automobile engineering seemed likely to enable cars using hydrogen fuel cells to be commercially available in ten to fifteen years but these would impose additional demands on the national grid.

Economic modelling does not support resort to inaction. A 60% reduction of emissions is needed by 2050. For this it will be essential to secure the co-operation of the US: their consumption of oil per head is 21 tonnes annually, compared with 9 tonnes in the UK. A critical element is the energy mix, GDP is not the crucial factor.

A range of options exist to mitigate emissions:

- Improve efficiency of energy usage;
- Invest in R and D in renewable energy, carbon sequestration and fusion;
- Engage actively in North – South Science Engineering and Technology capacity buildings;
- Avoid exceeding a particular temperature/carbon dioxide global targets threshold.

The 2001 Energy Research Review by the Performance and Innovation Unit (PIU – now the Strategy Unit) had identified six key areas for increased R and D investment:

- Carbon sequestration
- Energy efficiency
- Hydrogen
- Nuclear
- Solar PV
- Wave and Tidal

Work on proposals, including finance, for the establishment of a national research centre to boost energy research in the UK was in hand in the Research Councils.

A key element was the development of nuclear fusion as an energy source. Work on the JET project at Culham was complete. The next stage was the ITER project. A successful fusion power station might be 25-30 years away.

In the UK energy mix, if no nuclear power rebuild was achieved by 2020, the amount of nuclear power on the grid would be reduced from the current figure of 27% to about 20%. Even if the level of energy from renewables on the grid were increased from the current 3% to 20%, the target suggested, perhaps optimistically, by the PIU, our dependence on fossil fuel would be at a standstill.

In the field of possible adaptations, the most recent significant flood in London had been in 1928. Since then the Thames Barrier had been installed. A measure of the flooding that had been averted could be gauged from the frequency with which the Barrier had had to be raised. This had risen to 15 in 2001. The estimated saving in the costs of flood damage far outweighed the cost of installation. Yet 10% of housing stock was now located in flood plains with serious implications for insurance and finance.

It was difficult to estimate the cost of stabilising carbon dioxide emissions. The figure might exceed trillions of US dollars. But the financial implications of the alternatives were incalculable. The disappearance of the Antarctic ice-cap would be likely to result in an increase of sea-levels globally of 100m.

In conclusion, Professor King acknowledged the help he had received from other experts in this field.

In the subsequent discussion a number of points were made in relation to nuclear power:

- Doubts were expressed about the time-scale envisaged in the lecture for the development of fusion. Some reassurance was offered in reply and it was pointed out that different aspects of the programme – e.g. materials testing – needed to be undertaken in parallel;
- More efficient fission plants are now available and should be installed;
- The use of nuclear energy faced substantial political and environmental opposition, attributable not least to the problem of waste disposal. This continued to be a problem, but to a lesser degree with new plant designs and environmentalists needed to take a hard look at their priorities;
- The centre of gravity for the development of fission plants was shifting from the US to Europe and South and East Asia;
- With the development of more efficient plants the public needed to be convinced of their acceptability and reassured about waste disposal.

Taking the example of the Thames Barrier and the difficulty involved in demonstrating the cost-benefit advantages of the scheme, the question was asked whether the existing political structures were capable of providing the necessary impetus. The difficulties were recognised, particularly those resulting from changes of regime, but it was felt that the imperative for change would become increasingly apparent on the political scene. Similarly, on the international level, although responsibility for emissions was greater with the West the relative imbalance was no longer all that great. Stabilising measures would become increasingly necessary in the developing world. The priority must be for the politicians in those countries to be moved to action by their own scientists and for this it was essential to encourage the advancement of higher education; aid at the primary level was not enough.

There was some discussion of the issue of carbon sequestration. This was at present very much in the R and D phase. Various possibilities were under consideration such as compressing carbon dioxide into rock strata or under compression in deep water.

Reference was made to the problems of exploiting wind power in the UK, given the number of wind generators necessary. But no possible alternative should be ignored. Work was similarly progressing on the use of tidal power through the means of a turbine with no moving parts under water.

Other alternative approaches involved the development of adequate computer power, e.g. to re-route container ships so as to shorten journeys by taking advantage of the Arctic route. This was already in hand. Computer capacity was similarly needed to tackle the problem of modelling complex climate systems.

Overall, there was general recognition of the need for adequate financial investment across the board to meet the challenges.

Sir Geoffrey de Deney