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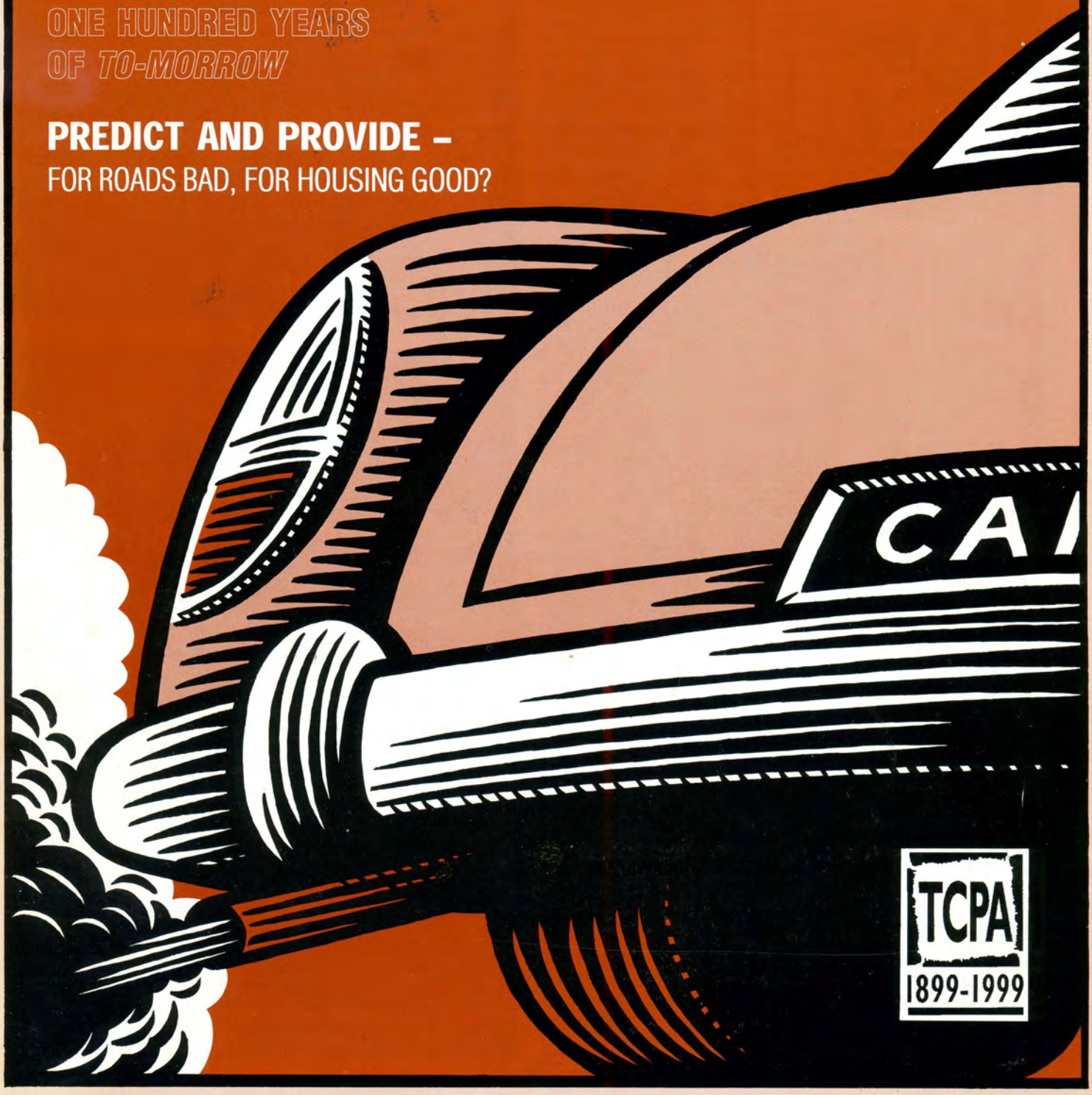
Town & Country PLANning

GREENHOUSE EMISSIONS –
TIME FOR CONTRACTION AND CONVERGENCE

ONE HUNDRED YEARS
OF *TO-MORROW*

PREDICT AND PROVIDE –
FOR ROADS BAD, FOR HOUSING GOOD?



Guest Editor **Mayer Hillman**, Senior Fellow Emeritus at the Policy Studies Institute, introduces a Special Section of *Town & Country Planning* on Climate Change

WHY CLIMATE CHANGE MUST TOP THE AGENDA

Over the last ten years research has revealed beyond reasonable doubt that the planet has a limited carrying capacity for greenhouse gas emissions if serious destabilisation of its climate due to human activity is to be prevented. In light of this, there must be a substantial reduction of these emissions if the welfare of a significant proportion of the world's present and future populations is to be protected.

In recognition of the need for urgent international action on this issue, world leaders met in Rio in 1992 and again in December 1997 in Kyoto. While the Rio and Kyoto negotiations can be seen as important staging posts on the road to achieving the necessary emission reductions, both the inequity and insufficiency of the targets set on each occasion are all too apparent.

Governments of the so-called developing countries have, of course, questioned the proposition that their targets should be commensurate with those of the developed countries, on the grounds that their current use of fossil fuels is so much lower.

More recently, they have also quite reasonably produced a trump card. They have pointed out that the source of the problem is not just *current* patterns of fossil fuel use: in determining the contribution of each country, it is unfair to ignore past patterns, as the critical emissions accumulate and remain in the atmosphere for a long period. It is becoming ever more obvious that a moral approach is called for, but it also has to be politically feasible. We then have to translate the overall reduction of 50-70 per cent in emissions called for in the Intergovernmental Panel on Climate Change (IPCC) Working Group reports over the last eight years onto an equity base.

As I calculated in 1990, the average reduction in greenhouse gas emissions *per capita* in Western European countries would have to be less than 1 tonne, i.e. more than 90 per cent below the level at that time (and in meeting that target only a system based on a ration of 'carbon vouchers', some of which would be tradable, has a realistic prospect of success).[1]

Set against this, the agreement reached in Kyoto for an overall *5.2 per cent* reduction on 1990 levels in developed countries' emissions between the years 2008 and 2012 falls far short of what is needed (the Kyoto agreement includes a European Union target of 8 per cent and, within this, a UK target of 12.5 per cent, including a 20 per cent reduction in carbon dioxide emissions).

The difficulty for affluent countries whose governments are aiming to respond adequately to the IPCC recommendation arises from the fact that their relative material prosperity has been achieved either because the impacts of their fossil-fuel dependent activity (not least that entailed in road and air travel) have been unwittingly overlooked, or because the draconian measures required to achieve a sufficient reduction have been considered electorally too dire to introduce.

Many arguments have been put forward against sharply limiting activity based on fossil fuel consumption.[2] Under scrutiny, none provides adequate answers to the scale of the problem:

- *'There is as yet insufficient scientific certainty to say that the Earth is necessarily in the grip of global warming accounted for by fossil fuel use and deforestation.'* In fact, other than among those with a vested interest in denial, a substantial consensus exists among climate scientists that it *is* occurring.
- *'Existing and proposed reductions in fuel consumption and pollutants through operational economies and technology will prove adequate.'* This ignores evidence that the rate of growth in consumption over the last 30 years far exceeds the gains that have been achieved in efficiency – witness what has happened in road and air travel.
- *'A system of eco-oriented taxation on the 'polluter-pays principle' introduced to adequately reflect environmental costs is a more realistic means of achieving the required reductions.'* Not only would such an approach be socially regressive in a way that the present Government could not support, but it also implies a right to pollute if payment has been made.
- *'Political realism suggests that no party could conceivably have a prospect of being returned at a general election if its manifesto included a commitment to adopting policies on delivering cutbacks in carbon dioxide emissions of over 90 per cent.'* One may wonder whether the import of this statement is that we should therefore scale down the required target to a more politically palatable level!
- *'Political realism also suggests that it is hopeless for any one country to act unilaterally as this issue needs to be addressed internationally.'* This line of defence was laid to rest in Kyoto, where an obligation was imposed on signatory member states to deliver their targets through *nationally* determined measures.
- *'Considerations of the economy and employment override ecological*

Lancashire County Council

Critical emissions remain in the atmosphere for a long period – so we must act now

'The Rio and Kyoto negotiations can be seen as important staging posts, but both the inequity and insufficiency of the targets set on each occasion are all too apparent'

concerns, which can be effectively dealt with by paying the costs of damage caused by climate change.' It is, however, obvious that, even if such an approach were theoretically possible, affluent countries would not fund the construction of barrages to protect the world's highly populated delta regions and low-lying islands, nor would they absorb the ecological refugees displaced by famine and drought.

- *'Excessive greenhouse gas emissions can be countered through the creation of reservoirs to store carbon and through carbon sequestration by planting new forests.'* Given current levels of emissions each year, and those forecast for the future, the scale of effective activity would have to be immense.
- *'There are no alternative fuels that can realistically be substituted for many fossil fuel-dependent current activities, and therefore reductions should be sought in other sectors where this problem does not exist.'* This implies that we have an inalienable right to go on, for instance, using the car for most journeys in low-density and rural areas, and flying to get across the Atlantic, *irrespective* of the damaging effects.
- *'Significant carbon dioxide reductions are already being achieved by many industries in their practices, for which reason they should be commended for their contribution to meeting ecological goals.'* This is highly disingenuous given that the primary aim of their activity is to promote energy-intensive activity.

In coming to terms with these arguments and counter-arguments, the Government has adopted two largely irreconcilable stances.

On the one hand, it has shielded itself behind the often repeated observation that, in democratic societies, changes that do not command public support cannot be imposed. In turn, this has induced a degree of public complacency on the subject and an easily assimilated and comforting perception that the application of present and future scientific advances, combined with no more than modest changes to current lifestyles, will indeed prove sufficient to avert serious ecological damage.

The coalition of government (with electoral considerations to the fore) and industry (with its narrowly focused profit-making aims) is in effect, and with our tacit connivance, tempting us into a Faustian compact whereby our near universal wish for continuous – also known as 'sustainable' – growth, without irremediably catastrophic consequences, can be assured through the medium of technology.

Like devotees of religion who place their faith in an all-loving God looking after his children's welfare, we are being called upon to have total faith in the ingenuity of humankind, equipped with ever expanding scientific skills, to deliver answers that will *assuredly* deliver that growth and avert those consequences.

We urgently need to move beyond the rhetoric of sustainability and take the path towards living within the planet's limited capacity to absorb greenhouse gases. It is difficult to believe that burying our heads in the sand to avoid facing reality is an appropriate posture.

Defining moment

The articles in this Special Section of *T&CP*, written by distinguished experts and authorities on the subject, is aimed at sharply pushing us up the learning curve by obliging us to come to terms with our unsustainable patterns of activity.

The articles focus on providing answers to the questions of how serious the problem of anthropogenic (i.e. human-induced) climate change is; what can be done to reach international agreement on effective action on this; and what realistic strategies can be adopted to avert serious ecological damage.

The concept of *'contraction and convergence'* (developed by Aubrey Meyer, founder and Director of the Global Commons Institute) – i.e. reducing greenhouse gas emissions to a safe level and achieving this on a *per capita* basis within a timetable determined by scientific evidence – is becoming widely acknowledged within the political community worldwide as the only realistic basis upon which agreement can be reached to enable climate change to be countered effectively.

Those who doubt that governments are prepared to act accordingly may wish to reconsider their views in light of the steadily growing momentum towards acceptance of the concept.

In the run-up to the Fourth Conference of the Parties to the UN Framework Convention on Climate Change (FCCC) in Buenos Aires in November 1998, GLOBE International (the international network of parliamentarians from over 100 countries) has passed resolutions in the United States (supported for the first time by some members of the US Congress) and in Southern Africa advocating the concept as the necessary requirement of success at the UN FCCC. The Heads of State at the Summit of the Non-Aligned Movement (NAM) of 113 developing countries in held Durban, South Africa, adopted a resolution which implicitly supports contraction and convergence. And in mid-September the European Parliament, supported by the European Commission, adopted, with a ten-to-one majority, a resolution advocating it.

In the light of the issues, evidence and arguments set down in this Special Section, it is all too clear that we are at a defining moment in history. The shadow of climate change hangs over us, and yet we continue to subscribe to the idea that only through economic growth can there be any real prospect of improvements in material standards and the quality of life.

The magnitude of the problem is daunting and its implications lie far outside our experience – and it is therefore disastrously prone to dismissal. But if we do not deliver our fair share of the reduction, there can only be two outcomes: either those who do not yet use their share of greenhouse gas emissions – mainly people living in developing countries – must be *prevented* from doing so; or, together with future generations, we must witness and bear the costs of escalating damage from climate change – as well as the burden on our consciences. ■

Special Section on Climate Change

- **Sir John Houghton** summarises current scientific knowledge on climate change, derived from assessments made by the IPCC, and looks at action that could be taken to mitigate the effects of global warming.
- **Alberto di Fazio** shows that relying on efficiency gains and technological shifts alone reflects a serious underestimation of the magnitude of the greenhouse effect and all its consequences for the ecosystem, society, health and future generations.
- **Tim Reeder** outlines the risks to the UK environment – and to its economy and the lifestyles that depend on it – from climate change, and shows how essential it is that we reduce emissions in order to prevent enhanced global warming.
- **John Gummer MP** raises issues of morality and global justice, arguing that combating climate change makes a moral stance a practical necessity, and that the global institutions required to that end may have to override national ones. He concludes by allying himself with those arguing that the only solution lies in international agreement on reducing emissions to a safe level and programming this on a *per capita* basis.
- **Tom Spencer MEP** summarises the Global Commons Institute's model of 'contraction and convergence', which combines equity with efficiency and enables international management of global greenhouse gas emissions. He alerts us to how critically dependent current negotiations are on the US Senate ratifying the Kyoto Protocol.
- **David Fleming** puts forward the case for applying the principle of contraction and convergence and outlines the mechanisms needed. He demonstrates the advantages of a system of 'Domestic Tradable Quotas' in which everyone has an equal entitlement of carbon units to cover their needs, and shows how this could be introduced over a period of time.
- **Mayer Hillman** discusses the likely implications for individuals of living on an equitable basis within the planet's capacity to absorb greenhouse gas emissions, and outlines what is then entailed in modifying those aspects of our lifestyles dependent on the use of fossil fuels.

Notes

1 M. Carley, I. Christie and M. Hillman: 'Towards the next Environment White Paper'. *Policy Studies*, 1991, **12** (1), Spring

2 M. Hillman: *The Implications of Climate Change for the Future of Air Travel*. Written statement for the Heathrow Terminal 5 Inquiry. Government Office for London, May 1998

Drawing on the work of the Intergovernmental Panel on Climate Change, **Sir John Houghton** summarises current scientific knowledge on climate change and its impacts, and looks at action that could be taken to mitigate the effects of global warming

GLOBAL WARMING – THE SCIENCE AND THE CHALLENGE

The 1990s have seen some of the warmest years on record

The greenhouse effect

That the Earth's surface is kept warm by the 'greenhouse effect' has been known for nearly two centuries. But it was just over 100 years ago, in 1896, that Svante Arrhenius, a Swedish chemist, made the first calculation of the average rise in temperature to be expected at the Earth's surface if the atmospheric carbon dioxide concentration should double. His estimate of 5-6°C was not far out, just a little larger than current estimates, which fall in the range 1.5-4.5°C, with a 'best' value of 2.5°C.

The Earth absorbs radiation from the Sun, mainly at the surface. A balancing amount of energy is then radiated to space at longer, infra-red wavelengths. Some of the gases in the atmosphere (particularly water vapour, carbon dioxide and methane) and clouds absorb some of the infra-red radiation emitted by the surface and themselves emit radiation from higher altitudes at colder temperatures. The Earth's surface is thereby kept about 30°C warmer than it would otherwise be. This is known as the 'greenhouse effect', because the glass in a greenhouse possesses similar optical properties to the atmosphere.

Increases in the concentration of the 'greenhouse gases' will tend to lead to further warming of the surface and the lower atmosphere; this is the 'enhanced greenhouse effect'. Its approximate magnitude can be simply estimated from radiation energy balance calculations; for more detailed information, sophisticated computer models have to be used which take into account the influences of the atmospheric and oceanic circulations.

It was in the late 1960s that scientists began to realise that the rate of increase of the amount of atmospheric carbon dioxide, due to the increasing rate of burning of fossil fuels, was such that significant global warming would occur. Associated with the warming would be substantial changes in the Earth's climate. By the late 1980s, wide concern was being expressed about the likely impact of climate change and it became a subject firmly on the political agenda.

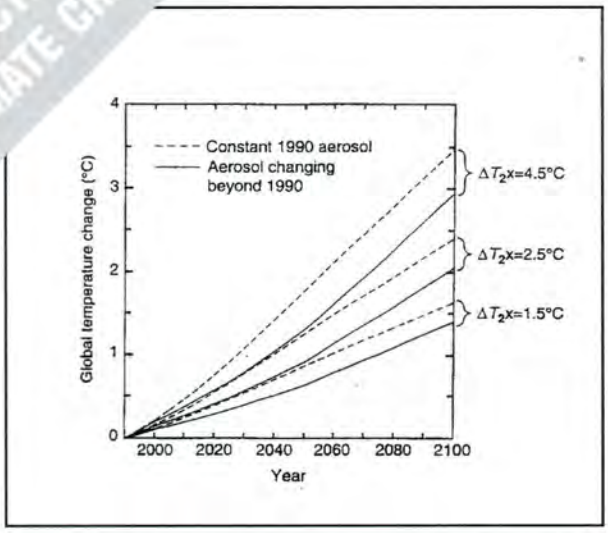
Since the last ice age, generations of human beings have organised their activities to take advantage of locally available resources of food, fuel, fibre and forage. Human settlements, their agriculture, water use and commercial activities have adapted to the current climate (i.e. temperature and rainfall, and their variability).

Any large, rapid change in climate will affect these activities and the resources on which they depend, and will require rapid, and probably costly, adaptation to re-establish the match between climatic resources and human needs.

Climate extremes are an important manifestation of the natural variability of climate. During recent decades, different parts of the world have experienced extreme temperatures, record floods, droughts and windstorms.

There is no strong evidence that these events are outside the range of the variability of the natural climate similar to that experienced over the last few centuries. However, their impact serves to emphasise the *vulnerability* of human communities to climate variation and extremes. This is well illustrated by the unparalleled losses experienced by the insurance industry during the later years of the 1980s and in the 1990s as a result of extreme weather events.

Over the past century the global mean surface air temperature has increased by between 0.3°C and 0.6°C, although the increase has not been uniform. Since the 1970s, there has been a relatively steady global average warming totalling about 0.3°C; the 1990s have seen in 1990, 1995 and 1997 the three warmest years on record (1997 is the warmest), with slightly cooler years between 1990 and 1995 because of the effect of the dust from the Pinatubo volcanic eruption in 1991. The Meteorological Office's Hadley Centre has recently reported the first quarter of 1998 as the warmest three-month period on record.



Projected global mean surface air temperature changes from 1990 to 2100 for the 'business as usual' scenario (the IPPC's IS92a scenario), showing the range of uncertainty in the modelling simulations (represented by values of the 'climate sensitivity' of 4.5°C, 2.5°C and 1.5°C) and the effect of including aerosols as a well as greenhouse gases in the analysis

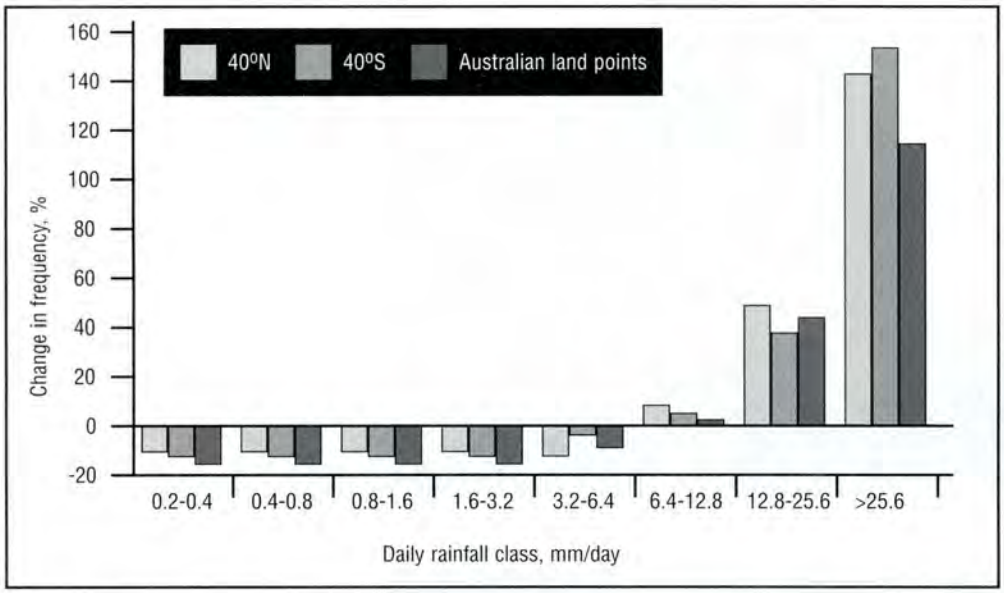
The IPCC and its assessments

The Intergovernmental Panel on Climate Change (IPCC) was formed in 1988 to provide assessments of future climate change and its likely impact. Its first report, published in 1990, provided the scientific basis for the United Nations Framework Convention on Climate Change (FCCC) agreed at the Earth Summit held in Rio de Janeiro in June 1992 and signed by about 160 nations.

To assist in the Convention process, a new comprehensive report was produced by the IPCC at the end of 1995. Its writing and reviewing has involved many hundred scientists from many countries – in fact, a large proportion of the world's scientists who are involved in the field of climate change. The policy-makers' summaries of the sections of the new report were agreed at meetings at which delegates from about 100 countries were present, as well as representatives of non-governmental organisations and the scientific community.

The 1990 IPCC Assessment concluded that there was insufficient evidence to argue that an anthropogenic climate 'signal' (i.e. one resulting from human activity) had emerged from the 'noise' of climate variability. Since then, including the effects of aerosols within climate models has substantially improved the agreement between models and observations. Our knowledge of natural climate variability has also improved since 1990, so that more realistic statistical studies have been possible.

Recent studies have therefore been more positive, and the 1995 IPCC Assessment includes the sentence – agreed after a long and lively debate – 'The balance of evidence suggests a discernible human influence on climate.'



Changes in the frequency of occurrence of different daily rainfall amounts with doubled carbon dioxide concentration, as simulated by the Australian CSIRO model. The frequency of low rates of rainfall tends to decrease, while that of high rainfall rates tends to increase

Greenhouse gases and future anthropogenic climate change

Significant climate change over the next century is expected because of the increase in 'greenhouse gases'. The main greenhouse gases which result from human activities are carbon dioxide and methane. However, estimation of the likely future climate change is complicated by the effects of anthropogenic aerosols, which reflect sunlight and so tend to cool the Earth's surface (see the panel below, left).

The atmospheric concentrations of carbon dioxide and methane have risen by about 30 per cent and 145 per cent, respectively, since pre-industrial times, largely because of fossil fuel use, land use change (for example deforestation) and agriculture. Carbon dioxide is responsible for about two-thirds of the enhanced greenhouse effect to date due to the increases in greenhouse gases.

Emissions of carbon dioxide into the atmosphere due to human activities currently amount to about 7 billion tonnes of carbon per year. Estimates suggest that if there are no controls or constraints because of environmental reasons, emissions could rise to perhaps 20 billion tonnes by the year 2100. Under these circumstances, the carbon dioxide concentration in the atmosphere would approximately double from its current level of about 360 parts per million by volume (ppmv) by 2100.

Other greenhouse gas levels (for instance methane, the anthropogenic sources of which are mainly due to cattle, rice cultivation, the oil and gas industry and landfill) would also increase. Under this scenario, an increase of global mean temperature of

Aerosol effects

Estimation of the likely future climate change is made complicated because of the effects of anthropogenic aerosols (microscopic particles in the atmosphere), which originate especially from the sulphur-containing gases emitted from power stations – effluents which also give rise to the acid rain problem. These aerosols reflect sunlight and so tend to cool the Earth's surface. However, they are very short lived (a few days) and are thus concentrated near industrial regions. Nevertheless, their effects on the climate, even far from these regions, can be considerable.

Locally their cooling effect can be comparable in magnitude to the warming effect of the increase in greenhouse gases. Estimates of their effect averaged over the globe suggest that they have acted so as to reduce the rise in global average temperature due to the increase of greenhouse gases to date from about 0.9°C to about 0.5°C. However, it is important to realise that their effect on the climate is not confined to the regions where they are concentrated, and consequently their impact on climate change is not a simple offset to that of the greenhouse gases.

Because of the acid rain problem, emissions of sulphur-containing gases are being severely controlled, especially in North America and Europe. However, they are rapidly growing in Asia, although controls can also be expected there in due course. Some of the study results quoted in this article would be significantly changed if aerosol concentrations over Asia grew substantially.

about 2.5°C (in the range 1.5-3.5°C) can be expected by the year 2100 (see the diagram at the top of the facing page).

In comparison with the temperature changes we commonly experience, this does not seem a very large rise. But it is a rise in the *average over the globe*. Between the middle of an ice age and the warm periods in between ice ages, the global average temperature changed by only about 5-6°C. So 2.5°C over a century is a large and rapid shift in the context of climate change; it would in fact represent a change more rapid than has been experienced by the Earth at any time during the last 10,000 years.

The impacts of climate change

Expressing climate change in terms of the increase in global average temperature is not very meaningful for most of us. What about its impacts on our lives? The main impacts of the expected climate change are *a rise in sea level*, *changes in rainfall* and *changes in temperature extremes*.

The expected rise in sea level of about 0.5 m (in the range 0.2-1 m) by the year 2100 stems mostly from the expansion of water in the oceans because of the increased temperature and from the melting of glaciers; the contribution from changes in the ice sheets in the Arctic and Antarctic is expected to be small. As more of the ocean warms, sea level will continue to rise for centuries, even if greenhouse gas concentrations are stabilised.

Adaptation, at a cost, to such a rise will be possible in many coastal regions. However, adaptation will be extremely difficult, if not impossible, in some particularly vulnerable areas, such as the delta regions of large rivers in Bangladesh, Egypt and Southern China and the many low-lying islands in the Indian and Pacific Oceans.

The situation in many of these areas will be exacerbated because the land is sinking (owing to tectonic movement and ground water extraction, for example) at a similar rate to the expected global warming induced sea level rise. Substantial loss of land will occur in these areas, and many millions of people are likely to be displaced (6 million people live below the 1 m contour in Bangladesh, for instance).

A robust result from all climate change models is that in a globally warmed world the hydrological cycle will be more vigorous.

This means that there will be an increased tendency to heavy rainfall, leading to an increasing possibility of floods in some places. It also means, because of the interaction of the more vigorous hydrological cycle with the atmospheric circulation, an increased tendency to less rainfall and hence periods of drought in other places (see the diagram, centre left).

For instance, in continental areas at mid-latitudes in the Northern Hemisphere – for example in North America and Southern Europe – summers are likely to be warmer, with increased evaporation from the surface and possibly with less average rainfall; drought conditions can therefore be expected to occur more frequently and sometimes to be more prolonged. In Southern Asia, more intense monsoons can be expected, with increased tendency to floods (although if large anthropogenic aerosol concentrations were present over Asia, this effect could be reduced).

A major impact of global warming is therefore likely to be its effect on water supplies.

Demand for water has been rapidly increasing in nearly every country and especially in those where it is extensively used for irrigation. There are already significant tensions in regions where the water from major river systems is shared between nations.

It is not surprising that the Secretary General of the United Nations has suggested that in the future wars are likely to be about water rather than about oil!

Studies of global food supplies in a globally warmed world tend to suggest that the global quantity of available food supply might not be affected by very much – some regions might be able to grow more while others may grow less. However, the *distribution* of food production will change. The regions likely to be most affected with reduced food production are those in developing countries in the sub-tropics where there are rapidly growing populations.

Other impacts of the likely climate change are on human health (increased heat stress and more widespread vector-borne diseases such as malaria) and on the health of some ecosystems (for example forests) which will not be able to adapt rapidly enough to match the rate of change.

These impacts of anthropogenic climate change will generate substantial social and political implications, and also implications for world security. Of especial concern is the potentially large number of environmental refugees that may be created in some of those substantially disadvantaged developing countries most seriously affected (studies have suggested 150 million by the middle of next century).

Tim Ockenden / PA News

Large numbers of environmental refugees may be created in substantially disadvantaged developing countries

The UN Framework Convention on Climate Change (FCCC)

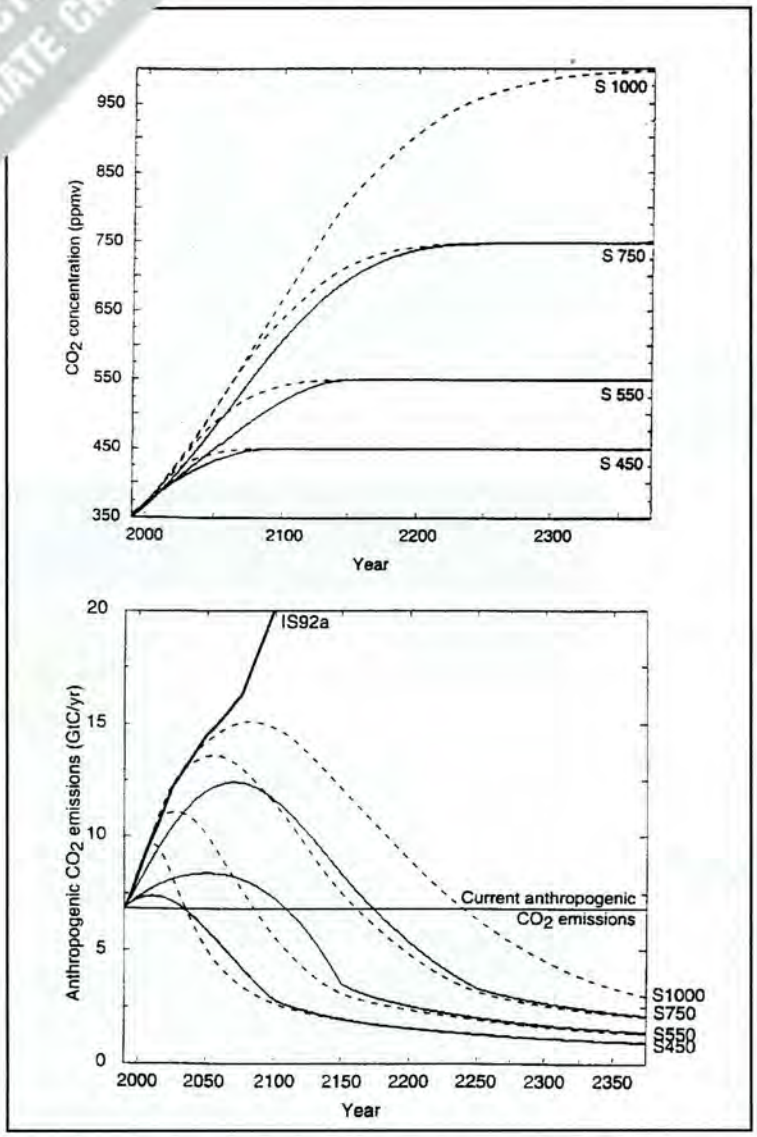
The FCCC agreed at the Earth Summit at Rio, in its Objective stated in Article 2, puts action regarding climate change in the context of sustainable development. It states: 'The ultimate objective of this Convention... is to achieve... stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.'

The first Conference of Parties to the FCCC was held in Berlin in April 1995; it was agreed that a plan of action should be prepared for agreement by the Parties in 1997. In December 1997, the Third Conference of the Parties, held in Kyoto, Japan, agreed an international protocol for the control of greenhouse gas emissions. Under the Kyoto Protocol, developed countries agreed to reduce annual emissions of six main greenhouse gases (carbon dioxide, methane, nitrous oxide, hydro-fluorocarbons, petrofluorocarbons and sulphur hexafluoride) by an average of 5.2 per cent below 1990 levels over the period 2008-2012. The EU agreed a target of 8 per cent, the USA 7 per cent, and Japan 6 per cent; within the average, some developed countries, such as Australia, Norway and Iceland, are allowed increases. The Kyoto Protocol is due to be ratified by March 1999. However, the recent DETR document setting out the rationale and scope of the UK Climate Impacts Programme noted that successful implementation of the Kyoto Protocol alone 'will only reduce the projected temperature rise in 2100 by a few tenths of a degree, so temperature would continue to rise by at least a further 0.5 degree' (*Climate Change Impacts in the UK: The Agenda for Assessment and Action*. DETR. May 98).

Mitigating climate change

To mitigate the effects of global warming action is required to increase the sinks which remove carbon dioxide from the atmosphere (by reducing deforestation and increasing afforestation, for example) and to reduce the emissions of both carbon dioxide and methane from anthropogenic sources (for example by increased energy efficiency and by the development of energy sources which have much lower carbon dioxide emissions).

'The UN Secretary General has suggested that wars in the future are likely to be about water rather than oil'



Upper graph: Carbon dioxide concentration profiles leading to stabilisation at 450, 550, 750 and 1,000 ppmv (current concentration is 360 ppmv) – two different profiles are shown. Lower graph: Carbon dioxide emissions leading to stabilisation at different levels following the profiles shown in the upper graph.

The dashed curves in both graphs initially follow the 'business as usual' scenario (the IPPC's IS92a scenario). In the process of achieving a given stabilisation level, larger emissions in early years imply lower emissions in later years

As expressed in the Objective of the Framework Convention on Climate Change, agreement has already been reached by nations that the projected emissions of greenhouse gases should be reduced so that their atmospheric concentrations stabilise.

For methane it is easy to estimate what this would mean: stabilising methane at today's concentration, for instance, would require a reduction in anthropogenic emissions of about 8 per cent. For carbon dioxide the situation is more complex (see the diagram above). For stabilisation at any level up to 1,000 ppmv, the maximum value studied, emissions next century would have to be substantially less than 'business as usual' and would eventually need to be reduced to well below today's level of emissions.

The Objective goes on to explain that the choice of stabilisation level of greenhouse gases at which to aim must be such as to 'prevent dangerous anthropogenic interference with the climate system'; the choice is also to be made in the context of sustainable development. It will essentially be a political choice advised by scientific, technical and economic information. However, it is already clear from impact studies (most of which have been made for carbon dioxide concentrations of about 550 ppmv – about double its pre-industrial value) that politicians and decision-makers are likely to be looking at levels below 550 ppmv. This implies that carbon dioxide emissions should not rise much during the first half of the 21st century and should decrease substantially below today's levels during the second half (see the carbon dioxide concentrations diagram on the left).

Can the world's energy industry contemplate the changes required? A detailed study of energy generation and use next century conducted by the World Energy Council (WEC) describes an 'ecologically-driven' scenario associated with a profile of carbon dioxide emissions similar to the 450 ppmv stabilisation curve shown in the diagram on the left. The WEC shows how this can be achieved – particularly by strong drives to develop the use of energy sources with much lower carbon dioxide emissions and to increase energy efficiency (estimates show that for the average building increased efficiency can easily result in a 30 per cent or more reduction in energy use at little or no cost, or in many cases with cost savings).

Under this scenario, by the year 2020 developing countries, as they industrialise, are projected to roughly double their energy use and their carbon dioxide emissions, while developed countries are projected to reduce their energy use by about 10 per cent and their carbon dioxide emissions by about 30 per cent. Estimates put the annual cost of realising such a scenario at 1 per cent or less of global world product (GWP), which is considerably less than most of the estimates which economists have made of the damage likely to result from climate change impacts.

Achievement of such a scenario will not be easy and will require commitment from all sections of the community. The challenge therefore is to scientists to improve the base of knowledge regarding climate change and its impacts; to governments to commit themselves to action adequately to address the problems of climate change and its mitigation; and to industry to develop and market the technologies required to reduce anthropogenic greenhouse gas emissions. Commitment is also required from all of us as individuals to take seriously the challenge of environmental stewardship.

Furthermore, the matter is an urgent one. As the WEC points out, 'the real challenge is to communicate the reality that the switch to alternative forms of supply will take many decades, and thus the realisation of the need and the commencement of the appropriate action must be *now*'. ■

Sir John Houghton *is Chairman of Working Group 1 of the Intergovernmental Panel on Climate Change and a member of the UK Government Panel on Sustainable Development, and was formerly Chairman of the UK Royal Commission on Environmental Pollution and Director-General of the UK Meteorological Office. This article is based on a Technology Lecture given to the Royal Society.*

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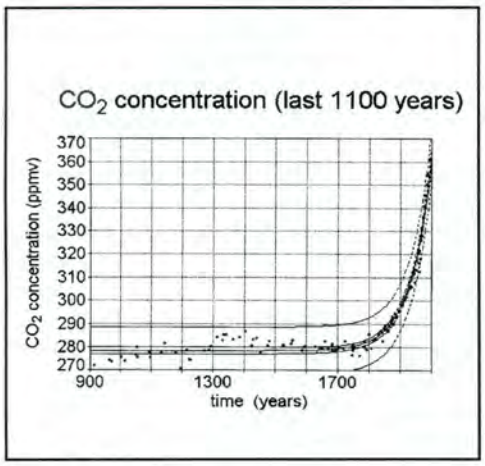
2 J.T. Houghton: *Global Warming: The Complete Briefing.* Second Edition. Cambridge University Press, Cambridge, 1997

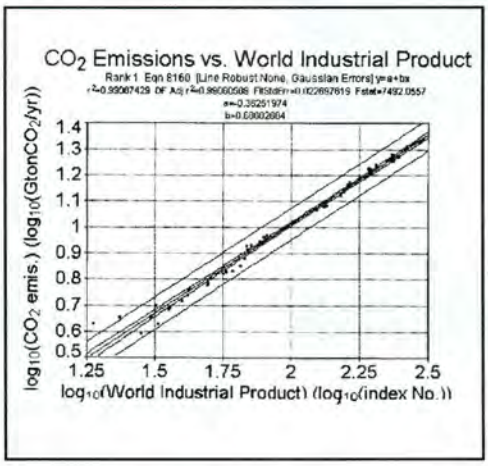
3 *Energy for Tomorrow's World – The Realities, the Real Options and the Agenda for Achievement.* World Energy Council, 1993

Alberto Di Fazio argues that natural laws dictate that policies based solely on making efficiency gains will inevitably fail to offer a solution to problems of climate change

SO YOU RECKON THAT EFFICIENCY WILL SAVE US? (WELL, THINK AGAIN...)



Natural CO_2 variations and the anthropogenic increase after the Industrial Revolution, showing a best-fit curve to the data. The continuous lines above and below the fit are the 99 per cent confidence levels (inner lines) and the 99 per cent prediction levels (outer lines) (Data from IPPC, CDIAC. Statistics by GDI)



CO_2 emissions against WIP, showing a strong, impressive correlation (correlation coefficient 0.995) (Data from CDIAC, World Bank. Correlation and statistics by GDI)

'We have been putting carbon dioxide back into the atmosphere at a rate up to a million times faster than it was removed. Climatic equilibrium is thus being perturbed at an unprecedented rate'

Since the Industrial Revolution, the world (or rather part of it) has witnessed a great expansion in science, technology and economic activity. Mechanised production, coupled with economic investment and scientific and technological development, produced exponential growth in the world industrial product, or WIP – a global scale version of GDP (gross domestic product).

WIP is expressed not in mere monetary terms, which depend on the contingent market price, but in an inflation-free 'physical equivalent' of a pool of goods, materials, fuels etc. vital to human technological and economical development. It is thus a 'real-terms' measure of global economic growth.

WIP growth has accelerated over the last 100 years, and the overall trend (interrupted only temporarily by wars and/or oil shortages) has been a rising exponential with an extremely rapid doubling time of around 17 years. Economic growth has, of course, led to, or been founded on, a growing need for raw materials, increasing pollution, and – most fundamentally – a fast increasing need for energy.

Up to now the contribution of the developing countries to the growing pressures on raw materials and energy have been low compared with the developed countries, despite an exponential growth in population, mainly within those developing countries. But within the next two or three decades the consumption rates of some leading developing countries are likely to become comparable with, or even greater than, those of the currently industrialised countries.

More than 95 per cent of the energy used by humankind is obtained by burning fossil fuels (oil, gas and coal). Furthermore, burning these carbon-based fuels inevitably produces carbon dioxide (CO_2). The exponential growth in WIP has therefore been accompanied by a corresponding exponential increase in the rate of CO_2 emissions into the atmosphere, and consequently by an exponential increase in atmospheric CO_2 concentrations.

The correlation coefficient between economic growth (WIP) and the increase in CO_2 emissions has been evaluated by the Global Dynamics Institute (GDI) in Italy, using data from the World Bank and the Carbon Dioxide Information Analysis Centre, at 0.995 – an astoundingly high figure given that a coefficient value of 1 equates to total statistical correlation.

The *Second Assessment Report* of the Intergovernmental Panel on Climate Change[1] details a whole series of impacts on the environment, economy and human health that are the likely consequences of climatic changes induced by increased CO_2 concentrations in the atmosphere. In particular, if we continue in a 'business-as-usual' manner, in the next century the atmospheric sea level temperature will reach levels not seen in the last 35 million years.

It is worth emphasising the speed of the process of input of CO_2 in the atmosphere.

The equilibrium temperature attained by the atmosphere depends on the atmospheric concentration of several greenhouse gases acting to produce what is known as the natural greenhouse effect. This is responsible for the present average global temperature of about +15°C, instead of about –20°C as it would be otherwise.

Palaeo-climatological data indicate that about 100-180 million years ago most of the planet's carbon was found in the atmosphere, in the form of CO_2. The surface of the Earth was covered with forests. The temperature was about 10°C warmer than it is now, the sea level was around 70-90 m higher than it is now, and there were practically no ice caps in the polar regions.

In other words, it took 100-180 million years for processes of photosynthesis, deposition and putrefaction to remove a large portion of the carbon from the atmosphere, store it in plant tissue, and convert it to the fossil fuel reserves that

we have been using in the 200 years or so since the Industrial Revolution. So we have been putting CO_2 back into the atmosphere at a rate up to a million times faster than it was removed. Climatic equilibrium is thus being perturbed at an unprecedented rate, raising the possibility of a 'runaway' or otherwise devastating enhanced greenhouse effect.

Efficiency gains – a dead-end?

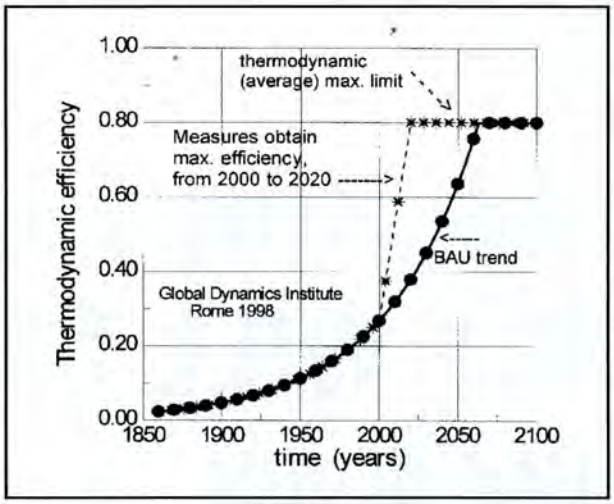
The rapid scientific and technological development of the last two centuries has also been associated with increases in the efficiency of the energy generation process. Improved machinery has extracted more and more 'work' per quantity of fossil fuels burnt by reducing the proportion of thermal energy wasted in the process.

Work and potential energy are fundamental ingredients in the generation of economic wealth; and GDP and WIP are dependent on the usable forms of energy available. Usable energy per unit of fossil fuels burnt provides one measure of efficiency in fossil fuel use; another is world industrial product per unit of emitted CO_2 (measured in dollars per tonne of carbon dioxide emitted). This latter is the variable beloved by economists and politicians, although it hides some crucial physical facts that invalidate most of the current economic analyses on efficiency gain policies thought to be useful in combating climate change.

The graph above shows how efficiency has increased over recent decades, driven by technological development and economic growth. But how long can efficiency continue to improve? The categorical – almost religious – answer from most mainstream economists is *'forever'* – a view shared by most politicians too (making it strongest ideology in global politics).

But the benefits of this so-called 'efficiency gains' policy are a myth, as can be demonstrated quantitatively.

In the process of drawing up policies for CO_2 emissions reduction, economic institutions such as the International Monetary Fund and the World Bank, as well as several governments, are emphasising the possibility of reducing emissions without forsaking the massive use of fossil fuels, and without limiting or reducing the growth of WIP. The argument is that by increasing the economic efficiency of energy production, and thus increasing the industrial product per unit of emissions, we can achieve the same WIP while burning less fossil fuel, and thus emitting less CO_2. By extension, if we could increase efficiency sufficiently, WIP could continue to grow while emissions fell. In principle – and purely in economic terms – this seems to be more than obvious. *But, alas, it is not so.*



Thermodynamic efficiency of generating energy from fossil fuels, corresponding to the economic efficiency in energy generation from fossil fuels. Curve marked by full circles is the 'business as usual' trend; starred curve denotes outcome of measures to maximise efficiency under scenario A

Economic efficiency, defined above as world industrial product per unit of emitted CO_2, is actually directly proportional to thermodynamic efficiency; and it is well known – and dictated by the Second Law of Thermodynamics – that thermodynamic efficiency can never be 100 per cent. In the real world, it is in fact limited to values of at best 60-80 per cent.

This natural law places a severe constraint on efficiency gains, and this in turn limits the amount by which emissions may be reduced with an increasing WIP – with an exponentially growing WIP (doubling every 17 years, as noted above) emissions turn out to be reducible only by a *very limited amount.*

In fact, present thermodynamic efficiencies, achieved after 150-200 years of industrial and technological development, range between 15 per cent (characteristic of the thermal engines installed in modern motor vehicles) and 50 per cent (the best presently obtainable from experimental high-temperature gas turbines). So it is apparent that only very modest reductions in emissions will be produced by efficiency gains alone.

'Policies based solely on making efficiency gains – including those based on a shift to natural gas – cannot effect any significant mitigation of the coming climate crisis'

To quantify just what may be achieved by raising economic efficiency alone the GDI has developed a program (GDIEVO97) to simulate the emissions and the resulting CO_2 concentrations for various scenarios of continued use fossils fuels use under an assumption that WIP will grow under 'business-as-usual' (BAU) conditions, i.e. that governments do not try to slow down their countries' economic growth rates.

However, to study the *maximum reduction possible* the simulations also presuppose the maximum possible reduction of coal and oil usage in favour of natural gas – which produces the lowest emission levels per unit of energy released.

In performing this calculation, the GDI has optimistically assumed that:

- the industrial sector (responsible for around 16 per cent of CO_2 emissions), the thermo-electrical power generation sector (accounting for around 23 per cent) and the residential sector (accounting for around 16 per cent) could be run *entirely* on natural gas; and
- within the transportation sector only the land traffic fraction (accounting for around 73 per cent of all transportation sources, and thus around 16 per cent of total CO_2 emissions) could be run on natural gas.

These highly optimistic assumptions allow us to simulate scenarios following a switch from the present contributions to CO_2 emissions due to coal, oil, and natural gas (respectively, 34.6, 42.3 and 23.1 per cent) to the 'best' attainable split in terms of emission levels per unit of energy – namely 10, 12.3 and 77.7 per cent for coal, oil and natural gas, respectively.

For all the scenarios the maximum attainable thermodynamic efficiency was assumed to be 80 per cent. But the physics of any kind of machine or energy generator is such that this is an *extremely optimistic* assumption. Moreover, the practicality and costs of implementing the required new technologies (for consumers and producers alike) and the feasibility of actually implementing the new technologies within the proposed time-frames make the scenarios considered even more optimistic.

The graphs in the panel on the right show the simulation results for different start dates for policies of increasing efficiency – the maximum reduction would, of course, be attained *only* if the shift to natural gas were applied *immediately*. In fact, any delay would increase the emissions, so reducing any gain, eventually to vanishing point if the delay were too long and economic growth too fast.

The graph above shows the evolution of thermodynamic efficiency as it is pushed to its physically allowed maximum, under the assumptions of scenario A.

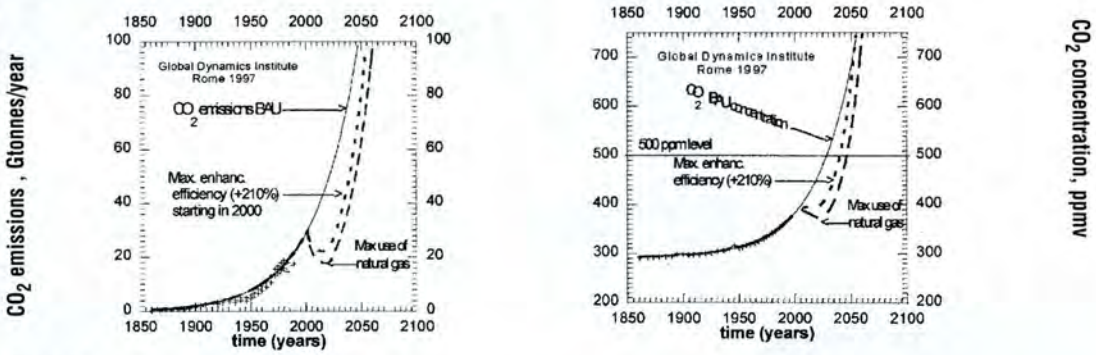
Efficiency alone is not enough

The results are very clear and instructive and show that the policies based *solely* on making efficiency gains – including those based on a shift to natural gas – *cannot effect any significant mitigation of the coming climate crisis.* Of course, increasing efficiency is a positive

Scenario A

Policies aimed at increasing efficiency start in the year 2000, and succeed in maximising efficiency in 20 years (a 210 per cent increase in efficiency in 20 years). A gradual shift to the use of natural gas is effected over the same period. The drastic efficiency gain measures achieve a delay of only 24 years in the time taken to reach an atmospheric CO_2 concentration of 500 ppmv (parts per million by volume).

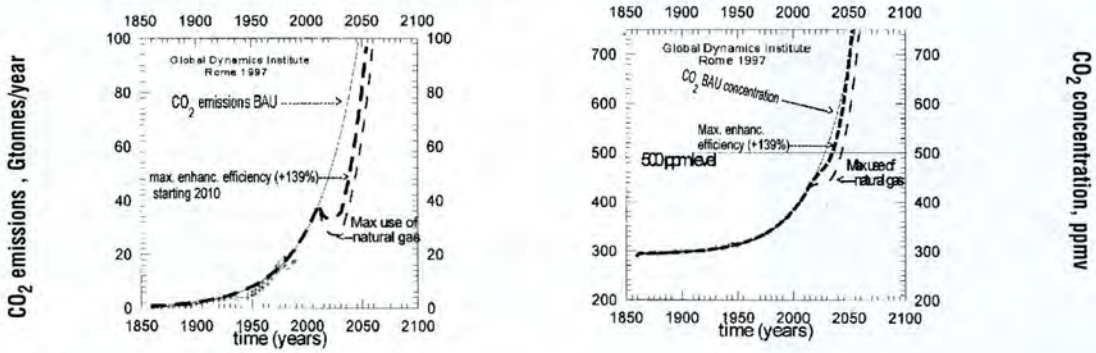
a Emission trajectory *b* CO_2 concentration



Scenario B

As for scenario A, but starting in the year 2010, as implied by the Kyoto Protocol. The ten-year delay in starting to push the efficiency gains to their natural limit reduces the maximum attainable increase in efficiency to 139 per cent. The delay in reaching an atmospheric CO_2 concentration of 500 ppmv is reduced to less than 19 years.

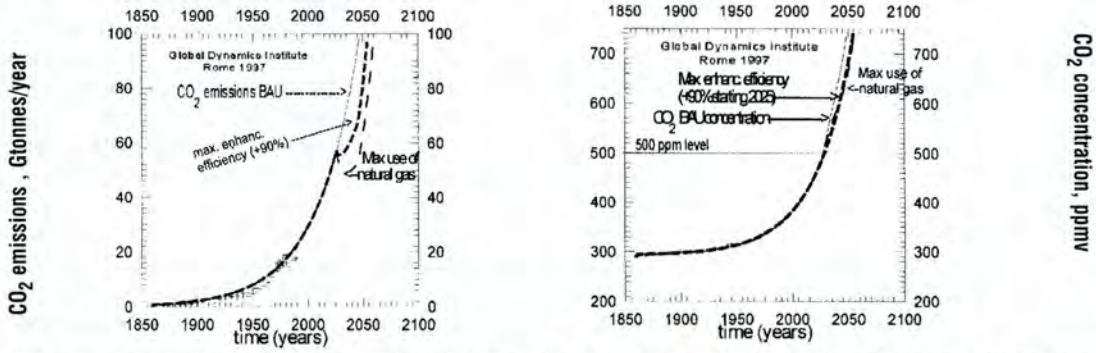
a Emission trajectory *b* CO_2 concentration



Scenario C

As for scenario A, but starting in 2025, as proposed in scenarios[2] in which 'business as usual' (BAU) is permitted to continue for now on the assumption that improvements in technology will allow much faster and lower-cost reductions 'in the future'. Such a large delay, combined with the limit imposed by the Second Law of Thermodynamics, lowers the maximum obtainable efficiency gain to a mere 90 per cent.[3] The efficiency gains (delayed by 25 years compared with scenario A) result in a negligible delay in reaching an atmospheric CO_2 concentration of 500 ppmv.

a Emission trajectory *b* CO_2 concentration



In all the graphs, the unit used for emissions is gigatonnes of CO_2 per year - multiply by 12/44 for conversion to gigatonnes of carbon per year (the unit used in the IPCC *Second Assessment Report*)

factor, but it is not in itself a determining factor in solving the problem.

The inevitable conclusion is that *either we switch to non-fossil fuel sources of energy or we limit the world industrial product, or we do both in some proportion.* Nature offers no other choice, and nor does technological know-how or the market.

It is clear that if they rely on efficiency gains and technological shifts alone, governments and economic institutions in the negotiation process will certainly underestimate the resulting magnitude of the greenhouse effect and all its consequences on ecosystems, society, health, and the very future of our species.

Notes

1 *Second Assessment Report.* Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, 1996

2 See Wigley, Richards and Edmonds, *in Second Assessment Report.* Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, 1996

3 T. Wigley, R. Richards and J. Edmonds[2] probably did not take into account that, while in 30 years from now the technology may have improved, for emissions to be abated with 'business as usual' growth in the economy efficiency gains greater than the maximum possible under the Second Law of Thermodynamics may be required

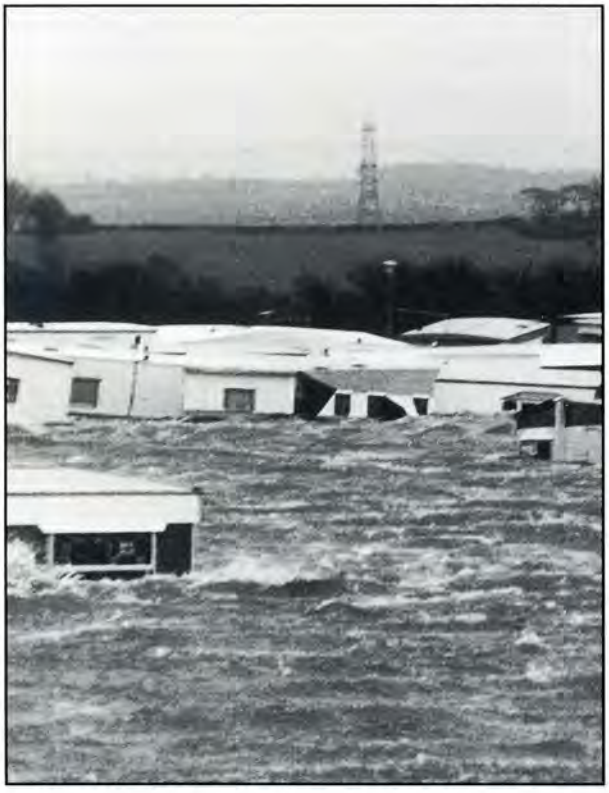
Alberto Di Fazio *is a theoretical astrophysicist working at the Astronomical Observatory of Rome. He also directs the Global Dynamics Institute, a new institute of Italian scientists working on climate change, accredited at the Conference of the Parties to the UN Framework Convention on Climate Change.*

SPECIAL SECTION: CLIMATE CHANGE

Tim Reeder outlines the risks from climate change to the UK environment and to the economy and lifestyles that depend on it, and emphasises the need to reduce greenhouse gas emissions to prevent enhanced global warming

THE UK AT RISK

Lancashire County Council



'The frequency of thunderstorms and intense rainfall events could lead to greater incidence of flooding while not necessarily benefiting soil moisture and groundwater recharge'

'Hot summers like that of 1995 could occur once in every three years by 2050 in southern England (they currently occur only once in 100 years). This could lead to problems for water supply

In assessing the likely impacts of climate change on the UK environment, we must examine the basic elements on which the current state of the environment (and in turn economy) depends and how will they be affected.

The 1997 *Regional Impacts* report from the Intergovernmental Panel on Climate Change (IPCC)[1] broadly confirms the findings of the UK Government's Climate Change Impacts Review Group (CCIRG).[2] This sets out likely effects over the next 50 years:

- *Fresh water:* Major effects will result from an increase in extreme events such as droughts and floods. Scotland will be more prone to floods and south east England will be prone to droughts. The current average water cycle may change significantly, with consequent effects on rivers, lakes, groundwaters and activities dependent on them.
- *Land and soil:* Land will be at risk from rising sea levels, which are predicted to rise by up to 50 cm by the year 2050, with obvious consequences for activities in low-lying coastal areas. The risk of flooding could be significantly increased by probable increases in storm frequencies and wind strengths.

Most of the UK's soils will be prone to drier conditions, with clay soils in particular becoming less water retentive. The whole of Britain will be more prone to soil erosion.

- *Wind and air:* Problems of low-level ozone will be exacerbated by more frequent occurrences of high-temperature inversion events in cities. Otherwise, the main effect of climate change will be in terms of air movement – i.e. wind. Wind speeds are likely to increase, with adverse consequences for soil moisture, agriculture, forest damage, coastal flooding and the built environment.
- *Sunlight and temperature:* The 1996 predictions show a warming across the UK by the year 2050 of up to 2.0°C in winter and up to 1.8°C in summer. There will be a possible reduction in cloudiness and therefore a consequent increase in sunlight in southern Britain in summer.

The medium term – the issues

Where will these impacts be felt over the next 50-100 years? The following outlines some examples.

The *water sector* will be perhaps the most affected. Hot summers like that of 1995 could occur once in every three years by 2050 in southern England (they currently occur only once in 100 years). This could lead to more frequent drying-up of rivers and problems for water supply companies. In contrast, the frequency of thunderstorms and intense rainfall events could lead to greater incidence of flooding while not necessarily benefiting soil moisture and groundwater recharge.

Natural habitats – including wetlands both in the south and in the uplands of the north and Scotland – will be at risk. This will in turn threaten existing rare species. Coastal mudflats and salt marshes will be inundated by the sea. They will then cease to act as wildfowl reserves or natural sea defences.

Low-lying good *agricultural land* will be threatened by coastal flooding and saline intrusion. Agriculture as a whole may benefit from longer growing seasons, but could suffer from droughts and require more hard pressed water resources for irrigation.

Low-lying industrial land – including the sites of nuclear power stations – will be at risk from coastal flooding.

Health services could see a reduction in winter deaths, but an increase in problems from poor air quality and high temperatures in summer.

The *insurance industry* could be faced with much higher claims arising from flooding, wind damage and subsidence.

The medium term – adaptation strategies

We are at an early stage in attempting to plan for adaptation to the effects of climate change. Current climate change scenarios have a high degree of uncertainty – the whole field cannot be covered in an article of this length. The Government's United Kingdom Climate Impacts Programme (UK CIP) is setting up a co-ordinated framework whereby all stakeholders can input and benefit from common information and improved scenarios.[3]

While this is getting going, how should operational local-level organisations react? The following is a recommended strategy given current uncertainties.

First, *current plans should be assessed* against a range of current climate change scenarios for 25-year periods up to 50 or 100 years ahead. Decisions on whether to change current plans will depend on the vulnerability of the activity, planning lead times and the reliability of the prediction. An assessment of the current state of uncertainty of climate change scenarios is given in the panel on the facing page.

One example is water resource planning, which is currently taking a precautionary approach involving increasing contingencies in planning, because – although the subject is highly vulnerable to climate change – scenarios are too varied and uncertain to make major alterations in strategy as yet.

Many planning decisions will probably result in similar precautionary or 'no regrets' conclusions at this stage.

In contrast, global sea level rise predictions are less uncertain, and it is possible that the tidal defence strategy in London and elsewhere may be reviewed to take into account current scenarios in view of the very long planning lead times.

Secondly, it will be important to *monitor the actual impacts* of climate change on the environment. Even if research and development results in improved predicted scenarios, they will remain inherently uncertain. The need to monitor the actual progression of global warming will be of prime importance, and attempts will have to be made to use techniques such as moving averages of data over short periods for reassessing planning processes.

The previous Government already moved towards this in the water resource paper *Agenda for Action*,[4] which guided the Environment Agency and water companies in reassessing reliable yields for major supply resources using recent data.

The long term

The previous section deals with the current approach to climate change adaptation and suggests sensible strategies over the medium term. This is necessary since climate change would continue to occur over the next 100 years and beyond even if we stopped greenhouse gas emissions virtually overnight.

The following highlights the need to reduce greenhouse gas emissions not only to mitigate the effects on the UK and the rest of the world in the near and medium term, but also to prevent the very serious long-term risks from the continual emissions of greenhouse gases. These latter risks have not been illustrated widely.

Models to predict climate change over the long term are very uncertain. However, enough work has been carried out to suggest that unless action is taken to reduce emissions and stop deforestation, over the next few centuries carbon dioxide concentrations could build to 1,000-2,000 ppmv (parts per million by volume) from the current 360 ppmv. The 1,000 ppmv end of the range would result from burning all known fossil fuels reserves by the year 2400 but conserving forests; the higher level would be the result of burning all fuels by 2100 and burning most forests.

The graph below shows that, even given the restricted scenario, the simulated global temperature is higher than any 'natural' temperatures found over the last 40 million years, and that the rate of change of temperature is unprecedented even on a geological timescale.

It is obvious even to newcomers to the subject that this scenario is highly unwelcome. Current predictions given such a scenario are that the most likely end result will be the delaying by several thousand years of the next glaciation. However, the possibility of an irreversible greenhouse effect in which the Earth ends up similar to Venus is now less unlikely than was previously thought.

The solution

The risks to the UK are significant in the medium term and serious in the long term. The only solution is to reduce the emissions of greenhouse gases to a level that will prevent the concentration in the atmosphere rising to levels at which global temperature rise becomes unacceptable. The Kyoto commitments will make an important first step in this process – however, the proposed limits will at best make only a marginal difference to the rate of growth of total global emissions.

The UK should make every effort to meet and then improve on its share of the Kyoto agreement. At the same time, the international process must be pursued to ensure that greenhouse gas emission limits become effective on a global basis.

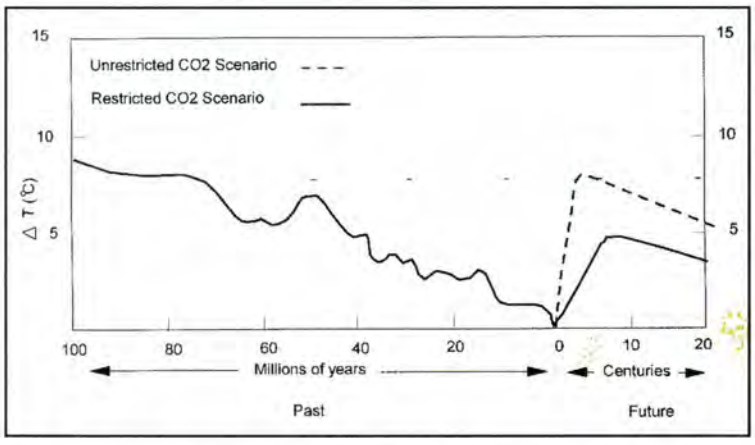
At a local level it is essential that the issue is promoted actively and that awareness of potential climate change impacts is widened as a first step to achieving a change to more sustainable lifestyles involving less use of fossil fuels. The issue of climate change mitigation or control is perhaps the best example of thinking global and acting local. ■

Tim Reeder *is Environmental Surveillance Manager for the Thames Region of the Environment Agency. Views expressed here are those of the author and do not necessarily represent those of the Environment Agency.*

'The possibility of an irreversible greenhouse effect in which the Earth ends up similar to Venus is now less unlikely than was previously thought'

Subjective assessment of reliability of seasonal climate change scenarios for 2050

Factor	Confidence in changes for the UK	
Rate of net sea level rise	High	in range 25-50 cm
Seasonal temperature change	Medium/high	in range 1.0-2.0°C
Seasonal potential evaporation change	Medium/high	in range 0-20 per cent increase
Seasonal rainfall change	Medium/low	in range ±15 per cent in seasonal rainfall
Cloudiness	Low/medium	in range ±2 per cent
Wind speeds	Low	in range ±2 per cent



Global temperature change estimates, derived from Climates of the British Isles, edited by M. Hulme and E. Barrow
Curves on the left of zero represent broad estimates of past global temperature changes from the oxygen isotope record; curves on the right represent global warming estimates as described in the text assuming a medium climate sensitivity

Notes

1 *Special Report on Regional Impacts of Climate Change.* Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, 1997

2 *The Potential Impacts of Climate Change to the UK.* Climate Change Impacts Review Group. HMSO, London, 1997

3 *Climate Change Impacts in the UK: The Agenda for Assessment and Action.* UK Climate Impacts Programme. Department of the Environment, Transport and the Regions, London, 1998

4 *Water Resources and Supply: Agenda for Action.* Department of the Environment, London. Oct. 1996

'Although the rich have the primary responsibility, there is no way in which we can go it alone. We will just have to share equitably the limited access to energy' imposed by the planet

THE MORAL DIMENSION

John Gummer argues that fighting climate change makes a moral stance a practical necessity, and that rich nations will have to share equitably the limited access to energy which the capacity of the planet imposes

'There are no global solutions without some element of global justice... We who have caused the problem must be the first to solve it, even if others will soon be major contributors to pollution'

Global warming transforms the concept of interdependence from the realm of philosophy into the immediate world of practicality. It is clear to all of us that we cannot face the issue on a national or even a regional basis. If global emissions are a cause of world climate change then only a global solution will be effective. It is in that sense that climate change refers to the moral climate too.

If man's actions are changing the climate then it is the actions of all men. Pollution in Indonesia has the same effect as pollution in the US. In this no man is an island – not even those two archetypal island races: those of the United Kingdom and the United States. Both have been accustomed to act as if defence of our national sovereignty precludes the kind of common action which accords to others a significant say in our internal affairs. Even in our relations with our nearest neighbours on the Continent, Britain concedes the sharing of sovereignty with bad grace.

On these global issues we are compelled to share with those whom once we ruled and whom we still tend to patronise. When it is difficult to get wholehearted British co-operation with democratic nations with whom we share history, culture and religion, it is doubly difficult to insist that we share with those of whose government we disapprove and whose public morality we suspect.

Worse still is the position in the US. After all, Britain's is a prejudice based upon a past imperium; the US attitude stems from its *present* world dominance. With the defeat of the Russian Empire, the US is now able to call the tune unchallenged, except, perhaps, by the European Union. For Americans to recognise that they have to share power on terms of equality if they are to solve world problems is psychologically like asking Queen Victoria to take King Cetywayo as an equal partner in protecting the future of Southern Africa.

Indeed it is worse even than that. It is not just a psychological problem – it is a real practical difficulty. The US has 4 per cent of the world's population and yet produces 25 per cent of the world's emissions. There is therefore no doubt that engagement in the solution to the global problem of climate change will involve commitment to very significant changes in the US before it will be possible even to begin a dialogue with developing countries.

That is because there are no global solutions without some element of global justice. Poor nations will not be prepared to change their patterns of growth unless rich nations have been prepared to change theirs. We who have caused the problem must be the first to solve it, even if others will soon be major contributors to pollution. We have grown rich on our emissions; they have benefited much less. Even to acknowledge that is a hard thing for many. It is indeed harder for the rich man...!

Sharing equitably

Yet, although the rich have the primary responsibility, there is no way in which we can go it alone. We will just have to share more equitably the limited access to energy which the capacity of the planet is now seen to impose. Fighting against climate change therefore makes a moral stance a practical necessity.

We certainly will not get the developing nations to limit their emissions if we do not share with them our technology and our wealth. If they do not join in, then any reductions in the emissions which we make will be outweighed many times over by the growth of their industrial and domestic use of power. The recognition of our

'Moral responsibility, which civilises the free economy in our nation states, has at last been found necessary in global solutions... justice has to be at the heart of containing climate change'

interdependence has become a new imperative in our growing globalisation and the consequences of that are immense.

Not that it is before time. Already we have begun to create global systems that recognise that we have a global economy. Modern banking knows few frontiers. Free trade is now seen as a universal good. Its dictates lie behind many of the demands made on economies in crisis as a condition of rescue. It is also the driving force behind the creation of the World Trade Organisation (WTO),. to which almost every nation belongs and to which we have all ceded a huge slice of our sovereignty.

It is notable that such loss of sovereignty has been much more acceptable to the UK and the US because of our ideological commitment to free trade. Ideas do change attitudes. If we had a greater commitment to justice then we might more readily create the kind of global institutions that these global challenges demand. However, free trade is perceived as a way of making us richer, whereas justice would make us share our riches.

That is not to denigrate free trade. Open markets create wealth and opportunity in poor countries as well as in rich. Protectionism and regulated economies do seem to impoverish, however good the intentions.

That said, the Anglo-Saxon economic model has been established globally with few, if any, of the counterweights which have always moderated its operation before. It has not been adopted in a nation state in modern times except within a moral framework. The rule of law; democratic accountability; the protection of the weak and vulnerable; employment rules which outlaw exploitation, slavery, child labour, discrimination and harassment; protection of the environment and of public health – these have all been part of the package.

Yet there is hardly a vestige of any of these imperatives when the Anglo-Saxon economic model is transferred compulsorily to the world stage. The WTO demands the right to control retrospectively environmental agreements it believes constitute restraint of trade. The US managed to ditch French demands that some labour practices were unacceptable and should not be allowed within the system. Even in Britain, only the intervention of the Prime Minister stopped us refusing to uphold even the most elementary of human rights as exceptions to the untrammelled operation of the free market.

Filling the moral vacuum

It is of course proper that we should be pretty leery about attempts to reintroduce protectionism and market distortion under the guise of moral standards. The French, in particular, have an effective line of this kind. Yet the alternative has been to say that any moral imperative constitutes an unacceptable interference in the internal affairs of a sovereign state.

It is evidently perfectly alright to insist that tariffs are lowered, excise duties harmonised, trade discrimination outlawed, and health, safety and biological protection laws overturned, but apparently quite wrong to restrict trade with nations which allow environmental destruction, the exploitation of women and children, the elimination of endangered species, or systematic economic exclusion of whole groups on grounds of race or religion.

The global free trade system works by occupying a moral vacuum. So many countries have reasons to fear any more civilised stance that the free market purists have been able to maintain their insistence that free trade alone is the only good. What the Kyoto negotiations have established is that free trade is not enough. Pursued to its ultimate, it will destroy itself and us with it. If the wealth which the free market creates is bought at the expense of ever-increasing pollution then the devastating effect on the climate could be such as to imperil the planet upon which we all depend.

As so often in life, we don't know for certain, but the probability is such that it has concentrated the minds of the leaders of the world so that they were prepared to sign up to the historic precautionary protocol of Kyoto.

In the hard bargaining with which that protocol was framed there were two distinct phases. The first is well known. The US was full of fine words about what had to be done but wholly lacked the will to take the leadership role which befitted the world's biggest polluter. The EU was at last living up to its position as the world's greatest trading grouping and seeking to establish a world order capable of countering a global threat. The head-on clash produced a much less satisfactory result than we had hoped, but it is a start and it can be improved.

It was, however, in the second phase that the real revolution began. The world was so relieved that the talks did not collapse utterly that it hardly noticed that India had introduced the notion of a coming confluence of emissions. It was a simple concept really. If the world is endangered by more than a particular level of emissions then the world must enter a period of self-restraint.

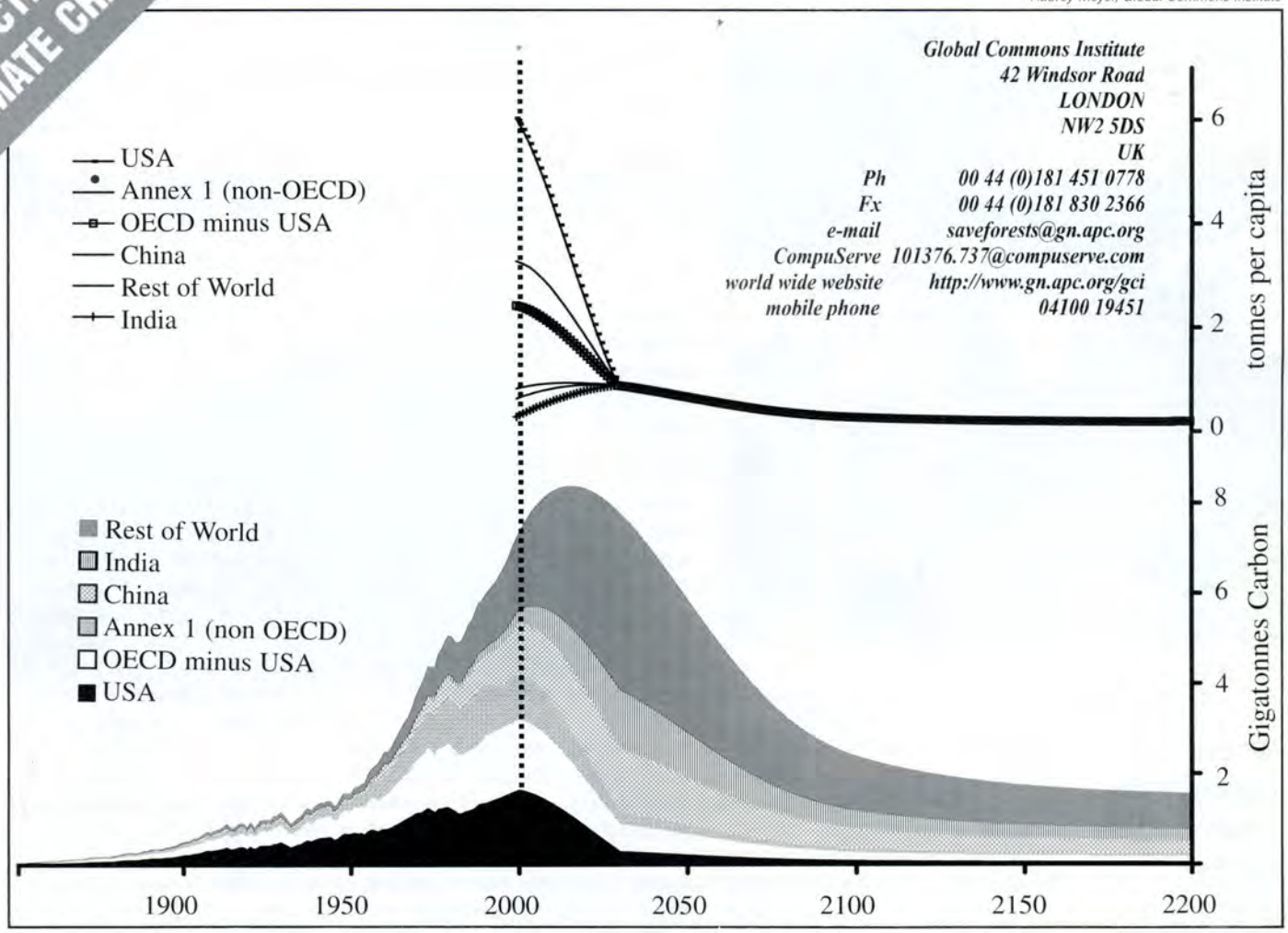
At the moment the industrial nations produce almost all the problem so they will have to do all the cutting. Soon, however, the developing nations will be catching up. They will have to play their part too. But they cannot be expected to be restricted permanently to a lower per capita use of energy than that of the rich countries. Therefore there will have to be convergence of per capita emissions.

There will of course also have to be a trading system to enable permits to be bought from those who do not use all their entitlement. That is the US solution. However, the US seems not to have understood that a world trading system of its preferred kind presupposes a moral context in which the rights to the world resource have been equitably shared and not peremptorily grabbed. For the first time equity enters the global market place. Moral responsibility, which civilises the free economy in our nation states, has at last been found necessary in global solutions. Not even an add-on extra, justice has to be at the heart of containing climate change.

Kyoto was indeed a new beginning – perhaps in ways the world had not dreamed of. Accepting the brotherhood of man turns out to be the only practical way of ensuring the survival of the planet. It would have been better if we could have accepted that when it was a matter of faith. Instead we are driven to it by the hard facts of life. ■

The Rt Hon. John Gummer, *Secretary of State for the Environment 1993-1997, is MP for Suffolk Coastal, and was member of the UK delegation to the Kyoto Summit .*

Aubrey Meyer, Global Commons Institute



Contraction and convergence: regional breakdown from the Global Commons Institute's 'contraction and convergence' model, for carbon dioxide contraction to 450ppmv and per capita convergence by 2030

CONTRACTION AND CONVERGENCE

Tom Spencer MEP looks at the Global Commons Institute's model of 'contraction and convergence' – an approach which 'can empower us all to interact intelligently and launch the political initiatives needed for the task ahead'

'The diagram also holds out the precious possibility of hope... if only we have the wisdom to agree a global cap on emissions'

If a picture is worth a thousand words then a diagram may be worth ten thousand. That was certainly the case for me when I first saw the Global Commons Institute's (GCI's) 'contraction and convergence' diagram in the foyer of the Second Conference of the Parties to the United Nations Framework Convention on Climate Change (FCCC) in Geneva in 1996.

The diagram, shown in two variations above, illustrates the contraction and convergence in national, per capita emissions necessary to reduce atmospheric greenhouse gases to a set level in an equitable fashion.

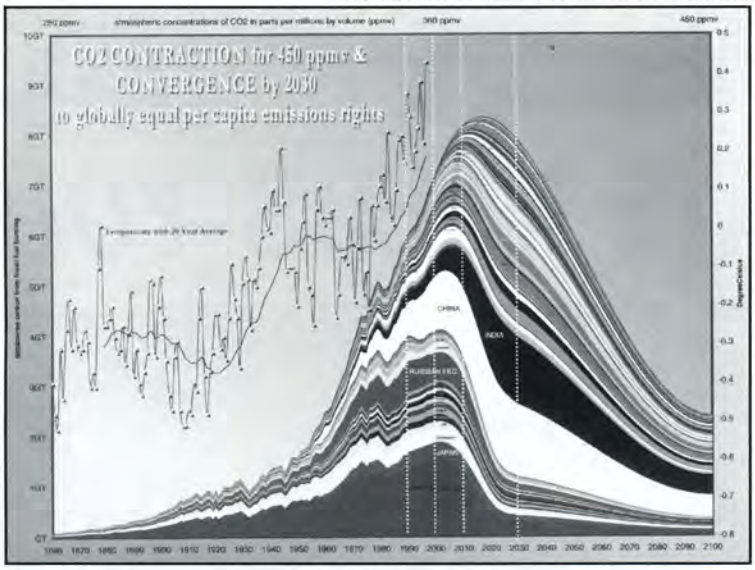
I was struck by the elegance and the flexibility of the presentation. In a single picture your mind is forced to deal with the relevant timescale of 1860 to 2100. The years up to 1990 show clearly the correlation with the increasing temperature of the planet and demonstrate dramatically the historic responsibility of individual nations. The second half of the curve, showing the dramatic contraction of emissions to the year 2100, illustrates just what a massive effort humanity will have to undertake to correct the mistakes made from ignorance in the past 100 years.

However, the diagram also holds out the precious possibility of hope. Sanity can prevail if only we have the wisdom to agree a global cap on emissions and then to divide permitted emissions among ourselves on the basis of equity. Climate change is not an irreversible disaster: combating and coming to terms with it will be difficult, but we need not be paralysed by the fear of failure.

We must be constantly on our guard against the professional pessimists defending the fossil fuels industry. They have argued both that nothing needs to be done because there is no problem and that if there is a problem the only way to respond is to adapt to the inevitable. This is special pleading.

It is similar to the lobby's abuse of the scientific arguments. It is in the nature of science as it has developed since the 17th century that it is formed of a succession of testable hypotheses in which there can be no absolute certainty. All one can do is accept the overwhelming view of the world's

Aubrey Meyer, Global Commons Institute / GLOBE International



The full country-by-country emissions profiles output from the GCI 'contraction and convergence' model, for carbon dioxide contraction to 450ppmv and per capita convergence by 2030

climatologists that anthropologically created climate change is a reality.

The precautionary principle must prevail on this of all subjects, where the future habitability of the planet is at stake.

Flexible framework

The key to the diagram is to recognise its status as a flexible framework model. Within the model one can change the dates and adjust the targets as the situation develops in the next century.

The beauty of the model is that it holds out the prospect of combining equity with efficiency – equity in terms of historic responsibility, and efficiency in terms of spending our money where it will do the most good. There is room inside the model for the impact of emissions trading, for advances in technology, and for the working of a creative capitalism inside a properly defined market.

There is no space in this discussion for old ideological debates of the 'North versus South' or 'public versus private sector' variety. The whole species will have to pool its creativity. It is not a question of 'either/or' but of 'both'. The problem for diplomats is to envisage a global solution for a global problem while recognising that all their traditions are nationally based. Success is only possible once there is a common vision of how it is to be achieved.

There is a parallel here with nuclear arms reduction talks which took 17 years to complete. Nobody should think that re-engineering all the economies of the world is going to be a simpler task than removing the threat of nuclear Armageddon. The nuclear test treaties reached a critical moment with Ronald Reagan and Mikhail Gorbachev's negotiators' 'walk in the woods'. At that moment a common language was established as to how success might be achieved.

It is my view that the 'contraction and convergence' model can provide that common language and clear the way for political action.

The political viability of the model is demonstrated by its impact on the current impasse over the ratification of the Kyoto Protocol by the US Senate. The Senate declines to ratify unless it sees evidence of a 'global solution to a global problem'. This must mean the involvement of Non Annex 1 (i.e. developing or non-industrialised) countries in the mechanism of the Protocol, not least in emission trading. It will not be enough for the US to try to push a few small dependent countries into participation.

Real participation must include China and India. The Chinese decline to accept any commitments until the balance of historic responsibility is recognised. Only 'contraction and convergence' can provide the reassurance needed to commit China and India to action.

As we approach the Fourth Conference of the Parties to the FCCC in Buenos Aires in November 1998, diplomatic action will intensify. We need to bridge the gap between Europe and America and the even greater gap between the developed and developing worlds. Such bridge-building is only possible if we agree to operate within the same intellectual framework.

Three cheers for the elegant diagram that can empower us all to interact intelligently and launch the political initiatives needed for the task ahead. ■

Tom Spencer MEP *is President of GLOBE International.*

'The contraction and convergence model can provide a common language and clear the way for political action'

GLOBE's proposals

Based on analysis originally put forward by the London-based Global Commons Institute, GLOBE International, under the leadership of Tom Spencer MEP, is proposing a four-stage process for building a framework for agreement and action. It is worth noting immediately that it has also now been proposed by the Africa Group of Nations and is broadly consistent with the positions of India and China. The UK Government has also now tendered it as a part of what needs to inform the future development of the FCCC. The four-stage process is as follows:

- First, countries would set an internationally agreed global ceiling on carbon dioxide concentrations in the atmosphere for the next century.
- Second, countries would agree a global 'carbon emissions contraction budget' for each year of the next century in order to stabilise global carbon dioxide concentrations within the agreed ceiling. The ceiling and budget are held under review.
- Third, countries would agree to allocate the carbon dioxide budget among each other as the result of international per capita emissions paths converging by an agreed date.
- Fourth, to reduce global emissions at the least cost, the resultant allocation of emission entitlements would be tradable among the parties to the arrangements.

The resulting process of *'contraction, convergence, allocation and trade'* would thus see those in the North, where per capita emissions levels are typically high, 'leading' by cutting emissions *in situ* or paying a social-ecological market premium for their over-consumption to those in the South.

Meanwhile, Southern countries, where per capita emissions levels are still typically low, could be leading by immediately using revenues from the sale of their surplus emissions entitlements to engender post-fossil-fuel dependent social and economic development.

Under such arrangements we would create a virtuous cycle of financing a sustainable playing field through the efficiency – not merely the equity – of levelling it at the same time. This is putting money to work for a global good that is otherwise unachievable.

■ Global Legislators Organisation for a Balanced Environment (GLOBE) International, 50 rue du taciturne, B-1000 Brussels, Belgium. Tel. (+32) (0)2-230 6589. Fax (+32) (0)2-230 0104

SPECIAL SECTION: CLIMATE CHANGE

Withdrawal from our dependency on fossil fuels will be unquestionably the greatest intentional change in the technology and structure of the industrial economy ever undertaken and will require a tremendous collective effort – and 'Domestic Tradable Quotas' could make it happen, argues **David Fleming**

YOUR CLIMATE NEEDS *YOU*

'The industrial economy has to reinvent itself with a completely new way of meeting its energy needs'

'The scheme would guarantee that national targets for reducing carbon emissions are actually met; furthermore, it would be fair, and it would be effective in keeping fuel prices low'

Within a century, fossil fuels must be phased out almost entirely, and most of this reduction must take place within the first 50 years. The industrial economy has to reinvent itself with a completely new way of meeting its energy needs.

This sets a new agenda for public policy, which will require *collective* action far removed from the individual decisions of the market economy. An instrument which has been developed for this purpose is 'Domestic Tradable Quotas'.

The Domestic Tradable Quota (DTQ) scheme would give everyone an equal per capita entitlement of 'carbon units' to cover domestic needs for fuel for all purposes, including private transport. Industry would tender for the carbon units to cover its needs. Individuals and firms would trade their holdings in the market. The total quantity of carbon units available would be gradually reduced.

The claim that is made for the scheme is that it would guarantee that national targets for reducing carbon emissions are actually met; furthermore, it would be fair – and it would be effective in keeping fuel prices as low as possible.

How the quota market would work

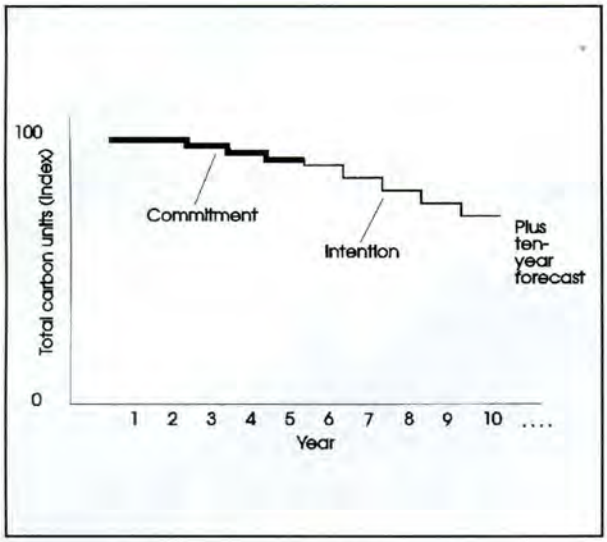
The first step in the DTQ scheme is to measure atmospheric carbon dioxide emissions in terms of the fuels that consumers and industry actually buy. A 'carbon unit' is defined as 1 kg of carbon dioxide. Sample calculations of the carbon units associated with the main fuels and electricity are set out in the table on the right.

In the DTQ system these carbon units would be traded in the market as an electronic currency using the technology of credit cards. They would be surrendered – as 'virtual' ration coupons – to cover the purchase of all types of fuel and domestic energy. The greater the carbon emissions associated with the fuel or electricity, the more carbon units would have to be surrendered. The whole transaction and all the calculations needed would be carried out using technology which is already commonplace for credit cards and direct debit systems.

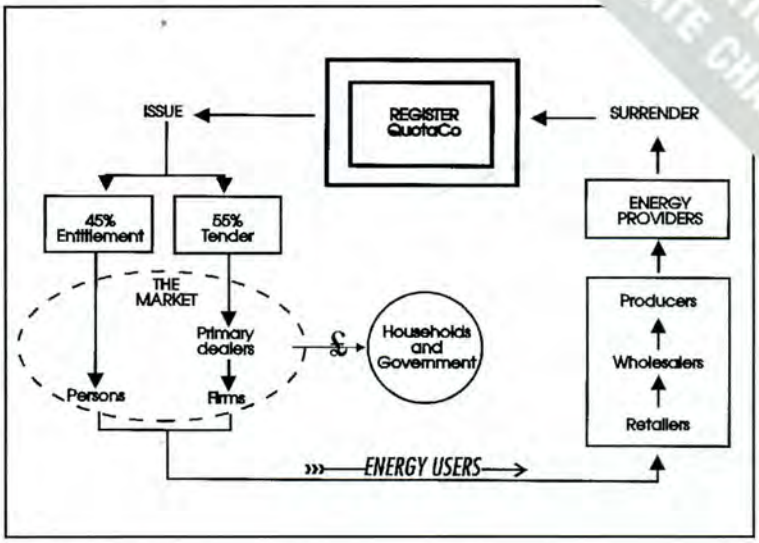
The key stages in the working of the DTQ model, as sketched out in the diagram on the facing page, are as follows:

- *At the start of the sequence is the 'register' – a computer database holding individual carbon unit accounts for all users:* The register (also known as QuotaCo) is based on the registration of shares in collective investments such as unit trusts. All transactions affecting ownership of carbon units would be reflected in changes in the register.
- *Carbon units are issued onto the market in a rolling supply through two separate channels – the 'entitlement' and the 'tender':* Initially a year's supply of carbon units would be issued, to be topped up by weekly supplies on a rolling basis. At present, households are responsible for about 45 per cent of carbon emissions: in the DTQ system this percentage of carbon units would be issued to all adults on an equal per capita basis as their *entitlement* (children's carbon usage would be covered by the existing system of child allowances). People who used less than their entitlement quota could sell their surplus; people who used more would buy their additional requirement through the market.

The other 55 per cent of carbon units would be issued through the *tender* to commercial and industrial companies and to the public sector, using the system already established for the tender of government debt instruments – which are purchased by banks and brokers, who then distribute them to their customers. In the case of DTQs,



The carbon budget – 'commitment' and 'intention'



The market for DTQs

Translating emissions into fuels

Fuel	Carbon units (kilograms of carbon dioxide released)
Natural gas	0.2 per kilowatt-hour
Petrol	2.3 per litre
Diesel	2.4 per litre
Coal	2.9 per kilogram
Grid electricity (night)	0.6 per kilowatt-hour
Grid electricity (day)	0.7 per kilowatt-hour

'The quantity of carbon units is fixed: if one person uses a lot, there is less for everyone else, and it means that everyone's carbon consumption is everyone else's business'

this would be applied on a larger scale. The tender would be distributed from the banks and brokers to organisations using direct credit systems (for the units) and direct debit systems (for the payments). The Government revenue earned by the tender could be reinvested in the costs of reducing the economy's dependence on fossil fuels.

- *Carbon units are then bought and sold on the secondary market:* Adults would receive an income from selling any part of their entitlement of quotas which remained unused. Firms and households alike would thus be given a powerful incentive to increase their energy efficiency. Trading revenues would be earned by the market-makers – quoting bid and offer (buy and sell) prices. Purchases and sales of units would be made (for instance) through automatic teller machines (ATMs), or over the counters of banks and post offices and energy retailers, or by direct debit arrangements with energy suppliers, who would automatically debit customers' carbon accounts at QuotaCo in the same way as they debit their current accounts at banks.
- *When purchasing fuel, consumers surrender carbon units, however acquired, to the energy supplier:* Not all individuals and organisations will have units to offer at the point of purchase – for example, foreign visitors, people who have forgotten their transaction card, people who have used all their quota, people who sell the whole of their quota in advance, and small firms and traders that don't bother to make regular purchases of units through their banks.

In such cases they would have to buy units at the time of purchase, in order to surrender them as part of the purchase transaction. There is a slight disadvantage for individuals trading in this way, as they would pay for units at the market's offer price and surrender at the bid price, so it would cost them a bit more than it would if they used their entitlement. This is an advantage, since it acts as incentive to keep people actively in the scheme.

When retailers sell fuel to customers, they receive carbon units which exactly cover those sales, and they then pass them on without extra cost when buying that fuel from the wholesaler. But retailers also need additional fuel for their own business – for transport, lighting etc. To make these extra purchases, they must surrender additional carbon units to their energy suppliers, and they have to buy them on the market in the same way as any other business buying units for its own use.

- *Finally, the primary energy providers surrender units back to the register (QuotaCo) when they pump, mine or import fuel, and they recover units from the wholesaler (or electricity producer) that buys from them:* This would close the loop.

The carbon budget

The 20-year carbon budget, which determines the number of units issued, is set over three periods (as illustrated in the diagram above). Period 1 is a five-year binding *'commitment'*, which cannot be revised; this is a requirement for an orderly market. Period 2, the five-year *'intention'*, is inflexible, but not absolutely binding; the presumption is that there will be 'no change', but it can be revised for stated reasons at an annual review. Period 3 is a 10-year *'forecast'*, which is indicative only.

The carbon budget is highly significant. First, it ensures that the targets for reducing carbon emissions are actually achieved.

Its second advantage is that it sets a long-term signal. Installing the new technologies that will be needed and changing land use and lifestyles to cope with a drastic reduction in transport will all take time. People will therefore need to take action *now* in the light of their knowledge of what prices will be in the future.

However, it is very hard to issue a long-term signal with a tax, for several reasons. Chancellors of the Exchequer, with good reason, do not like committing themselves to a specific tax rate for the long term; economic cycles make the fixed price inappropriate (too high in a downturn, too low in an upturn); and it is impossible to be sure how the market will react to any particular price – and its response will, in any case, change as the market learns how to adjust to the reduced dependency on fossil fuels.

For DTQs, with their fixed quantity and flexible prices, none of this is a problem. The carbon budget provides a long-term signal; there is automatic price adjustment, so that the price of carbon units would fall if demand for them were to fall for any reason (for example, as a consequence of success in reducing the demand for fossil fuels); and in this way there are built-in rewards

and punishments in the form of lower (or higher) prices in response to how well (or badly) the economy does in reducing carbon emissions.

The carbon budget would also have the major political advantage that it could help to take governments out of the firing line of controversy as the economy is guided down the pathway of reducing carbon emissions. The carbon budget could be set by an independent body – like the UK's Monetary Policy Committee. This would protect the government of the day from having to defend the carbon budget itself, and it would protect the carbon budget from the political process.

The government would have the unambiguous role of working with the public to meet tough commitments and helping households and firms to achieve the reduction in carbon emissions with least pain – with the right technology, the right legislation and the right expertise.

The government therefore does not need to take the responsibility – except in defining the terms of reference – for setting the carbon budget itself; it can concentrate on helping the economy to achieve the targets which the independent body has set.

Advantages of tradable quotas

There are considerable advantages to a system of tradable quotas:

- *Effectiveness:* DTQs establish a powerful motivation to reduce carbon emissions. There is a double incentive of the revenue reward to adults who use less than their entitlement, and the additional costs for those who use more. There is the transparent focus on actual carbon reduction – and not just on juggling tax commitments. The long-term signal allows and encourages consumers to make changes in the light of their clear knowledge of what carbon availability will be in the future, and the intensified year-on-year signal relentlessly keeps the pressure up. And there is the distance between the government and the carbon budget, removing the programme as far as possible from political muddle.

Above all, there is the collective motivation. This arises, essentially, because the quantity of carbon units is fixed: if one person uses a lot, there is less for everyone else, and it means that everyone's carbon consumption is everyone else's business. This is a mandate for a popular, indeed populist, programme. It has to become the objective of everyone to want to reduce carbon emissions, not only as a personal effort but to help others to do the same. This interdependence is critical.

- *Equity:* DTQs are an intuitively obvious instrument. They distribute the burden of reducing carbon emissions fairly, through the equal per capita entitlement. They are local economy friendly. Many local economies are building their competence on the basis of direct reciprocity and local currencies, such as LETS (Local Exchange and Trading System) schemes; they are competence-rich, but cash-poor. It would be a major handicap to them to be loaded with a heavy environmental tax. There is also an equity benefit in the evident match with the per capita framework of models for international reductions in carbon emissions (notably the 'contraction and convergence' model, outlined elsewhere in this issue[1]).
- *Efficiency:* If the claim that DTQs are more effective than carbon taxes in stimulating collective effort is correct, it follows that, for any given quantity of carbon emissions, fuel prices will be lower under DTQs than under a carbon tax – maybe much lower. DTQs are also efficient in the sense that there is reduced need for rebates and exemptions, since an energy-hardship allowance is built in through the entitlement. They also have the advantage of being portable: carbon units apply equally across all fuels, automatically adjusting to their carbon content – with, for instance, a zero rating for solar energy and a high rating for peak-time, coal-powered electricity.

The decisive efficiency of DTQs, however, is that they are a real economic instrument, not a form of price-fixing: they allow the market to set the price, and to allocate the available carbon units in the most efficient way.

Here to stay

In our response to climate change we are playing with fire. Fossil fuels are the defining resource of our whole civilisation. Switching away from the use of fossil fuels will require more than some pretty economic instrument. Certainly the economic instrument used will need to be pretty, but it will also need to be the right one.

Carbon taxes are a proper instrument for now, in order to start the process of discouraging the extravagant use of energy. But for the deep reductions that lie ahead, a much sharper, more effective approach is needed.

The withdrawal from dependency on fossil fuels will be unquestionably the greatest *intentional* change in the technology and structure of the industrial economy ever undertaken. Previous transformations – such as the development of water and sewage systems and hygiene standards in the 19th century – responded to the positive opportunities presented by new technologies, and they answered an evident need. In contrast, in the coming 'carbon transformation', we will have to learn how to live without the key technology and resource on which our economy and society has depended so far.

'In the coming 'carbon transformation', we will have to learn how to live without the key technology and resource on which our economy and society has depended so far'

There are unanswered issues of technology and administration in the DTQ model, but these are tactical matters rather than problems of fundamental design.

Those practical issues may be about to be researched properly. At a two-day European Commission workshop in Brussels at the beginning of July this year, a group of experts in climate change policy unpacked the idea of DTQs and held the bits up for critical examination.[2] At the end of the workshop, the chairman asked whether there was anyone who did *not* believe that DTQs merit concerted and serious research. The silence that followed said it all. ■

***Dr David Fleming**, Director of The Lean Economy Initiative, writes on environment and economic policy options for the next century.*

'The withdrawal from dependency on fossil fuels will be the greatest *intentional* change in the technology and structure of the industrial economy ever undertaken'

Notes

1 T. Spencer: 'Contraction and convergence'. *Town & Country Planning*, 1998, **67**, Oct., pp.300-301

2 'Domestic Tradable Quotas Workshop'. Brussels, Belgium, 1-2 Jul. 1998 (*Workshop Proceedings* available from The Lean Economy Initiative, 104 South Hill Park, Hampstead, London NW3 2SN, price £2 inc. p&p)

Mayer Hillman looks at the likely implications for individual lifestyles of living within the planet's capacity to absorb greenhouse gases

CARBON BUDGET WATCHERS

The introduction to this Special Section of *T&CP* indicates that if the world's climate is not to be seriously destabilised, average annual *per capita* carbon dioxide emissions from all direct and indirect fossil-fuel-using activities must not exceed 1 tonne. Other articles offer evidence of awesome social, economic and environmental consequences in the event of failure. The current UK average is about 10 tonnes.

Earlier this year, Derek Osborn, Chair of UNED-UK, stated that 'we shall all have to learn again how to simplify lifestyles so that we consume *less* [emphasis added] energy in our homes, our work, our transport and our leisure'. He was clearly under-playing the gravity of the situation! Standing in the way of delivering the 90 per cent reduction is the near universal wish to raise material standards of living by promoting economic growth, much of it dependent on the use of fossil fuels.

Both the previous and the present Government have acknowledged the importance of climate change. They have made attempts, with varying degrees of success, to promote practices which are less environmentally damaging: for instance motorists are exhorted to drive in an energy-efficient way; and householders and industry are advised how to save energy and how it will benefit them.

However, neither Government has seen a need to launch a major campaign aimed at increasing public awareness of the fact that all these practices, desirable though they are, will make only a limited contribution to the required reduction, and that huge cutbacks in fossil-fuel dependent activities are essential. They have given the impression that, by efficiency gains and changes to fuels with lower carbon dioxide emitting content, we will be able to meet the target agreed in Kyoto.

Nor has the public been warned of the inevitably far greater and more difficult reductions to be achieved in the decades thereafter. Instead, people have been led to believe that the Kyoto target, while attainable, is 'ambitious'. This misleading image of the gravity of the situation is compounded by the failure to develop a means of enabling people both to relate their everyday pattern of activity to the production of greenhouse gas emissions, and to understand that they are accountable for a share of industry's fuel-dependent activities.

Those people who could be minded to live within an equitably determined and ecologically sustainable limit – and thereby demonstrate the feasibility of living within the planet's means – do not know whether or to what extent their current lifestyles are exceeding their *per capita* 'ration' of emissions. They are unable (let alone encouraged) to make reliable connections between the fuel-dependent components of their daily lives and economic activity and the resulting emissions.

Such an exercise is likely to be salutary. Even within the limited data already available, it is apparent that nearly everyone exceeds the 1 tonne annual limit – which equates to an average household limit of around 2.5 tonnes.

The current UK annual household emissions average of 24 tonnes includes about 5.5 tonnes for domestic uses, the majority for heating, and a similar 5.5 tonnes for transport, the majority for car use. To this must be added the share of emissions from non-domestic energy consumption, such as industrial, commercial and agricultural activity, the operation of power stations and refineries, and so on. This more than outweighs the domestic and transport contribution. Clearly, a household 'ration' of 2.5 tonnes will only stretch to the most essential of energy-intensive activities.

The significance of this figure is illustrated by the impact of overseas holidays, now increasingly commonplace. With current aircraft fuel efficiencies and typical seat occupancy rates, a round flight from London to New York for a family of four accounts for emissions of about 4.8 tonnes – nearly double the *total* annual fossil fuel usage that an average household could be allowed on an equity base if the world's climate is not to be destabilised.

Personal carbon budgeting

To help wean the public from leading lives oblivious to the contribution they are making to climate change, we need a comprehensive user-friendly inventory upon which *personal* carbon budgeting could be determined. Such an inventory could follow a procedure similar to that adopted by organisations such as WeightWatchers, whose members are provided with a booklet listing the number of calories in each item of food or drink, or a system of points for saturated fat and calories. This enables them to measure their consumption against a chosen or medically prescribed limit.

A *'Carbon Budget Watchers'* inventory would quantify the carbon dioxide emissions associated with each aspect of daily life – a kilowatt-hour of electricity generated with the mix of fuels in current use results in the emission of about 0.8 kg of carbon dioxide, for instance, and the use of 1 litre of petrol results in over 2 kg.

The process of determining personal or household figures could be aided by the gas and electricity suppliers informing their customers of the number of kilograms of emissions covered in their quarterly bill. Receipts for petrol and for other forms of travel could likewise include the relevant figure. In addition, consumer durables could be labelled with the emission figures covering both manufacture and use.

Politicians are fearful of the electoral consequences of requiring people to curtail activities, such as travelling long distances by air, which they enjoy and which they have been led to believe are benign in their environmental effects. There is, for example, little appreciation of the consequences of the air travel industry's prediction of an annual 5 per cent rate of expansion. Clearly, the task of managing the transition to lifestyles and patterns of development with greatly reduced use of fossil fuels represents an enormous challenge to us as individuals as well as to politicians acting in *bono publico*.

We may attempt to anaesthetise our consciences by recycling our household waste and by supporting the view that we have an obligation to ensure that our children inherit a healthy planet. But we cannot go on indefinitely putting forward what we know to be spurious arguments against taking the issue of climate change as seriously as evidence indicates we should. We must face up to the need for significant modifications to our lifestyles.

Time is running out. If we continue our tacit support for ever-increasing economic growth – or effectively support it by taking air trips to exotic locations, for example – we are at the least deluding ourselves that there will not be steadily increasing social, environmental and ecological impacts for us and our children. In that respect, we are inescapably culpable. ■

'We cannot go on indefinitely putting forward what we know to be spurious arguments against taking the issue of climate change as seriously as evidence indicates we should... Time is running out'

Note

1 D. Osborn: 'Kyoto and after'. *Connections* (UNED-UK Quarterly Newsletter), Feb-Apr. 1998, pp.1&16

Dr Mayer Hilman *is Senior Fellow Emeritus at the Policy Studies Institute, and is Guest Editor of this Special Section of Town & Country Planning.*