Energy: Security and Sustainability

Our present production and consumption of energy is unsustainable, from the point of view of resource limits and environmental impact, and the direct and indirect effects are very likely to lead to major conflicts. The recent government Energy White Paper (Ref 1) sets out quite challenging aspirations for reducing greenhouse gas emissions (though whether the commitment throughout all government departments to fully implement these aspirations is there is less clear). However, the White Paper is woefully complacent on issues of the energy security and its geo-political implications.

Energy Demand

The USA is the world's largest consumer of energy, and has one of the highest per capita consumptions, about 5 times the world average. It has large coal reserves, but is a major importer of oil (importing 60% of its oil) and of gas. The UK and most West European countries energy consumption per capita is about 21/2 times the world average, India's per capita consumption is about 1/20 that of the USA and in many countries of Sub-Saharan Africa, commercial energy consumption is negligible. Currently, demand for oil is increasing at 2% per year. Projections by the International Energy Agency (IEA) which might be described as "business as usual" are for major increases in energy consumption, particularly by rapidly developing economies in countries with large populations like China and India (both of which have large coal reserves). China's total energy consumption is likely to exceed that of the USA within a decade, and its demand for gas will put pressure on the Eurasian gas market.

The UK will become a net importer of gas by 2005, and by 2020, imports could rise to 90% of demand, and we are expected to become a net importer of oil relatively soon. The UK Offshore Operators Association has said oil production could drop to 2/5 of the present rate by 2010.

Transport is a significant fraction of overall energy demand, around 25% of the total in most industrialised countries. Road and air transport are the fastest growing sectors of energy use, and both are dependent on oil. Road transport uses 65% of US oil consumption.

Energy supply.

Currently, fossil fuels (coal, oil and gas) supply most of the world's energy demand, with nuclear energy and large scale hydropower also making significant contributions. The ratio of global proven reserves to current consumption are, approximately, for coal 400 years, gas 60 years and oil 40 years (proven reserves are reserves recoverable with reasonable certainty at near current prices). Probable reserves, (defined as the potential output assuming high, but not prohibitive prices and no insuperable barriers to exploitation), for conventional oil

and for gas are about twice as great. However, the critical factor is not the total reserves, but the rate at which oil or gas can be extracted, in relation to potential demand. Oil industry analysts (refs 2, 3) point out that the rate of discovery of major new oil fields in the 1980s and 1990s were far less than in the 1960s, and that most of the major oil fields are near, or have passed the point where half the oil has been extracted, (the “mid point peak”) after which it is progressively more difficult and uses a higher proportion of the energy output to extract the oil. On current trends in demand (increasing by about 2% per year), conventional oil production globally would peak at about 2010, and global gas production in about 2020 (fig 1). After the peak, the rate of production is predicted to decline. The higher the rate of extraction the shorter the time to major depletion of the reserves. Even exploitation of more difficult sources at higher production costs is unlikely to postpone the production peak by much more than 10 years. There are large amounts of “heavy oil” (mainly in Canada and Venezuela) and oil can be produced from oil shale. However, extraction of this oil has very adverse environmental consequences, can itself consume significant energy (overall CO2 emissions are about twice that from conventional oil per unit of useable energy) and would be more expensive than conventional oil production.

The Middle East has by far the greatest oil reserves, Saudi Arabia and Iraq having the largest. Africa, Central and South East Asia and South America also have significant oil reserves. For gas, Russia and the former Soviet Republics of Central Asia have the largest reserves, and North Africa also is a major producer. Many of these regions are potentially politically unstable.

Nuclear energy provides about 17% of the worlds electricity, and 22% of that in the UK. The only significant new nuclear plant construction is taking place in East Asia. The White Paper acknowledges the Royal Commission on Environmental Protection (RCEP) view that unresolved issues of nuclear waste rule out further nuclear plant build in the UK at present. There are potential problems of fissile material diversion and proliferation, particularly with reprocessing or any plutonium fuel cycle (nb it has been recently announced that the UK’s oxide fuel reprocessing plant at Sellafield will be closed when existing contracts are completed). At the moment, it seems likely that poorly secured stocks in the former Soviet Union are a more likely source of diversion of illicit fissile material. In the present situation the protection of nuclear plant from attack is a critical issue. The economics of nuclear electricity in the present context of low gas prices and surplus generating capacity in the UK are not attractive.

Large and medium scale hydro-power provides 20% of the world’s electricity, but only a small amount in the UK. Large projects can have adverse environmental and social effects. The Three Gorges project in China and the Narmada river schemes in India are criticised on these grounds. Large projects can also lead to conflicts between countries over control of vital water supplies. The Ilisu dam in Turkey threatened the water security of countries downstream, and India’s grandiose proposals for redirection much of its water flow is feared by

Bangladesh for the same reason.

Climate Change Constraints

It is now generally accepted that man-made climate change is occurring, and will continue even if significant efforts are made to reduce greenhouse gas emissions. Fossil fuel use releases CO2, the principal greenhouse gas, and the general consensus is that to avoid very damaging climate change, global greenhouse gas emissions should be reduced by ~ 60% by about 2050. The Royal Commission on Environmental Pollution has proposed that the UK should achieve a similar reduction on this timescale. However, very recent assessments (ref 4), taking account of carbon cycle feedbacks, indicate greater warming effects than the IPCC's latest (3rd) Scientific Assessment Report. Thus even greater reductions in greenhouse gas emissions may be needed to avoid potentially catastrophic effects.

Because CO2 has a long lifetime in the atmosphere (~ 100 years), the total released over a long period is more important than the emissions at a particular time. The Global Commons Institute (ref 5) has pointed out that the reduction in emissions from oil and gas as reserves run down would produce an acceptable profile of CO2 reduction (Fig 1) if they were not replaced by emissions from increased use of coal (or from heavy oils or oil shale).

The fossil fuel industries are vigorously promoting carbon sequestration by means of CO2 capture and storage (C&S) as a means of combating climate change. For example, CO2 could be removed from power station flue gases, compressed, transported and stored in geological formations or deep under the sea. The use of coal in this way would reduce the pressures on diminishing supplies of oil and gas for power generation. However, there are unresolved issues about the long-term stability of storage in some of the proposed media, possible environmental problems with under-sea storage, and C&S increases primary energy consumption.

The challenge is to limit energy demand while giving people in all countries a good quality of life, by major improvements in energy efficiency and the development of renewable energy and other means of reducing greenhouse gas emissions. If climate change is not constrained, loss of fresh water and productive land is likely to exacerbate conflicts in many areas, such as the Middle East and South Asia, and could devastate the basis of life in many countries.

Security and economic implications of present energy policies

Given the large changes in the price of oil that result from relatively small changes in the balance between supply and demand (as shown by the oil crises of the mid 1970s and early 1980s) it seems inevitable that, as oil output falls short of demand in the relatively near future, oil prices will rise sharply. Conflicts over

diminishing resources seem probable, and interacting crises of energy supply, security and the effects of climate change will occur (fig 2) unless a major change in present ways of energy production and use takes place. The nature of the response to the forecast shortfall in oil supply (and subsequently, gas supply) is crucial in whether it helps to manage the transition to alternative energy sources relatively smoothly and to minimise climate change, or whether it makes the situation worse.

The response of the present US administration is to emphasise the uncertainties in climate science to justify delaying action to reduce greenhouse gas emissions (although some individual states aim to introduce measures to reduce emissions), and to seek to control oil resources by military influence. Further, exploitation of oil from places which have hitherto been protected to conserve fragile environments such as Alaska, extending fossil fuel use for transport, e.g. by conversion of gas into motor vehicle fuels, and, to some extent the exploitation of carbon intensive resources like oil shale, are in progress or being proposed. These policies would not help limit climate change, and are unlikely to lead to security, even in the most militarily powerful nation. The USA's Space Command's mission of developing the ability to project overwhelming force anywhere in the world, includes maintaining the present very unequal distribution of resources between the haves and have nots. Clearly oil is one of the most vital of these resources. Missile Defence is just the first stage in the development of a massive offensive capability in space. However, such systems cannot prevent terrorism that could be exacerbated by greater inequalities.

Oil and gas revenues often support repressive and undemocratic regimes, and can lead to huge concentrations of wealth, which does not benefit the majority of the population of the countries from which it is extracted. In most cases in developing countries, oil wealth has inhibited balanced economic development. (ref 6). In many of Africa's civil wars, oil revenues have been used to buy arms, while most of the population remains impoverished. Control of the areas with oil reserves is a major factor in the civil war in Sudan. Oil revenues have also financed massive arms deals in the Middle East, such as the UK's largest ever commercial contract to supply Saudi Arabia with weapons systems and the arms used by Iraq and Iran in their costly war.

The cost of the US military protection of its oil interests has been put at the equivalent of $15 to $25 per barrel of oil (ref 7), before the military build up in 2002/2003 in the Gulf took place. If paid by the consumer, at the higher end of the range this would double the present cost of crude oil. The large US military presence in Saudi Arabia was a major factor in formenting the al Qaeda movement, but the USA's reluctance to upset some of the Saudi royal family has been said to have inhibited intelligence operations which might have reduced the risk if the terrorist attacks on the USA in 2001. Well before these attacks, very senior members of the present US administration proposed a major increase of its military presence in the Middle East, stating "while the unresolved conflict with

Iraq provides the immediate justification, the need for a substantial American presence in the Gulf transcends the issue of the regime of Saddam Hussein" (ref 8). This implies a readiness to use military force to obtain other military bases and to maintain strategic control over this region which includes Iraq and Saudi Arabia, the two countries having the world's largest oil reserves. It would seem oil was a major factor in US policy leading to the 2003 Iraq war.

Given the increasing tensions between the "West" and Arab and Muslim populations in many of the major oil and gas producing areas, the security of supplies to industrialised countries must be in doubt. Although there have been mixed messages from Saudi Arabia, in April 2002, Crown Prince Abdulla said that the Saudi Royal family "could no longer rule out using oil as a weapon...".

In the Caspian region, oil and gas exploiting companies have over-ridden local concerns for the environment, and demands for military protection of pipelines outside any democratic control in countries such as Turkey are likely to increase the risks to the security of these projects. The security of oil and gas supplies from regions like the Middle East, North Africa and former Soviet republics in Central Asia, which are potentially politically unstable, will be difficult and costly to maintain, both in financial and strategic terms.

The huge reliance of western countries on imported oil and gas is a major factor in security policies. Conflicts over remaining gas and oil supplies are likely to increase.

The economic effects of a major price increase in oil or gas as supplies fall short of potential demand may be severe. The effect on the balance of payments of importing countries would be damaging. The possible effects on the UK economy seem to have been down-played in the White Paper. In the oil shocks of the mid 70s and early 80s, much of revenue of the major oil producing countries was recycled by investments in western countries and deposits in western banks. If there are political tensions between oil and gas producing countries and their customers in a future crisis, this cosy arrangement may not be repeated, leading to major economic damage to oil importing countries.

Routes to sustainability and security.

Impending oil shortages should be an incentive to make radical improvements in energy efficiency and to develop renewable energy sources more rapidly than generally currently envisaged. In this way, the decline in greenhouse gas emissions would reduce the risk of catastrophic climate change, and the likelihood of conflicts over diminishing oil and gas resources would be minimised.

There are a number of ways to reduce dependence on limited fuel resources and to reduce greenhouse gas emissions, and a combination of approaches will be needed to address the problems. Reducing energy use by changes in the way we

live, energy efficiency, alternative energy sources, and, for greenhouse gas reduction, carbon sequestration are possible methods. The White Paper says that the UK could reduce its greenhouse gas emissions by 60% by 2050 with negligible reduction in economic growth. In fact, relative to a scenario where we continue to rely heavily on fossil fuels, and if oil and gas prices rise steeply, the economy could benefit. A progressive switch to less energy intensive systems and renewable energy sources must be considered as sound economic planning compared with delaying action until the oil or gas crisis arrives

The amount and mode of travel, type of vehicles used, the demand for goods from distant places and for goods with high embodied energy all contribute to an energy consumption in wealthy countries which is enormously greater than that in developing countries. These factors are considered as part of a country's standard of living (generally measured as Gross Domestic Product per head). GDP is a very dubious measure of well-being or quality of life. A number of studies have indicated that a good quality of life could be achieved for countries at different stages of development within reasonable environmental and resource constraints. However, achieving sustainability is not compatible with indefinite increase in energy profligacy. A society that gives people a sense of fulfillment and being valued might lead to less emphasis on more and more goods and to less frenetic travel, particularly by road and air.

Policies to reduce the number and distance of car journeys are important, including traffic management, land use planning to reduce travel needs, better facilities for cycling and walking, high quality public transport and encouragement of tele-working and tele-conferencing. For freight transport, upgrading the capacity of the rail system to be able to carry more freight would give energy savings, particularly for heavy mineral loads. Encouragement of more local production of goods, to reduce long distance road and air transport (particularly of perishable foodstuffs) would reduce energy use. However, pressures from the WTO which make it compulsory to open markets to multi-national businesses and IMF pressures on indebted developing countries to export act against local sustainability.

Energy Efficiency

Major improvements in energy efficiency in buildings and in industry are possible. Ref 9 suggests that 30% improvement could be made by measures which are cost effective at current moderate energy prices. For new buildings, high levels of insulation, good control of ventilation (with heat recovery where appropriate) and use of passive solar gains can give near zero heating loads. Air conditioning is widely specified for non-domestic buildings; often good design could eliminate this need. Major improvements in the efficiency of appliances and lighting are possible. The Climate Change Levy in the UK is beginning to produce improvements in energy efficiency in energy intensive industries, by encouraging technologies like variable speed electric drives, heat recovery and process

integration. Such improvements are vital to reduce electricity and gas consumption, both of which will be highly dependent on imported gas, on present trends.

Given the likelihood of a crisis in oil supply relatively soon, radical improvements to road vehicle efficiency are needed quickly. Over the last decade, very economical direct injection diesels have made significant inroads in the European market. Recently introduced are direct injection petrol engines, which can burn very lean mixtures at part load, and give fuel economy approaching that in diesel engines. Hybrid drive trains, in which an internal combustion engine charges a battery which then powers an electric motor drive, and which can be integrated with other energy saving technologies like energy recovery from braking, give significant improvements in fuel consumption.

Small cars already being sold using conventional technology achieve 3 litres/100km (94mpg) on the European test cycle. The PIU Energy Review suggested that a fuel consumption of 2.5litres/100km should, in the medium term, be possible for European mid-sized cars. Using known technologies such as outlined above, with lightweight materials and better aerodynamics, General Motors have shown an American full size saloon concept that achieves 3litres/100km on the US combined test cycle. The American programme that was achieving considerable success in development of very much more economical vehicles has been halted, in favour of more research into fuel cells and hydrogen fuel, which, as noted below, is likely to take several decades before impacting significantly on oil consumption and greenhouse gas emissions. In the meantime, the US average new private vehicle fuel consumption is now the highest for 22 years, largely due to more than 50% of vehicles sold being so called “light trucks”, ie 4x4s and large pick-ups.

Currently, the EU has voluntary agreements with motor manufacturers for improving fleet average CO2 emissions by 25% to be achieved by 2008 (to 140g/km CO2 emissions) and a further reduction to 120g/km by 2012. There needs to be an ongoing pressure to make much greater improvements, together with signals that fuel prices will increase in relation to reductions in fuel consumption, to prevent improvements in efficiency being taken up in increased vehicle use.

Fuel Cells

A major increase in the drive train efficiency is possible with fuel cells, but these generally require hydrogen to feed the cell to produce electricity (although a cell which will run directly on methanol is being developed) The improved efficiency would be partially offset by increased weight and size of tanks for very high pressure hydrogen or other storage system (eg as a metal hydride), and assessments must take account of the complete route from energy source to vehicle wheel, including for example, compression of the hydrogen. The overall effect on CO2 emissions depends upon the sourcing of the hydrogen. There are

proposals to produce hydrogen from natural gas or coal. While there would be advantages in eliminating local pollution and in easing pressures on oil supplies (although use of gas would increase the demand on limited gas supplies), this may not give major overall benefits on CO2 emissions relative to the best more conventional drive systems unless CO2 Capture and Storage (C&S) is used in the conversion process. However, C&S itself requires energy input and there are uncertainties in the long term retention of CO2 in some of the storage media proposed.

If the hydrogen is produced by electrolysis using electricity from renewable sources this would save CO2 emissions. However, using electricity from renewables for this purpose is unlikely to be the optimum overall strategy at least until a significant fraction of electricity (say over 20%) is produced from renewable electricity. Given the huge changes to fuelling infrastructure needed, the length of time for a major proportion of vehicles on the road to be powered by fuel cells and the timescale for a surplus of off-peak renewable electricity, it could be 30 years before hydrogen provides a major non-fossil transport fuel medium (See for example ref 10).

Renewable Energy Sources

There are a large number of possible renewable energy sources at different stages of development and having applicability in different circumstances. The government White Paper sets specific targets for renewable electricity, but none, other than a reference to EU targets, for transport fuels.

Early pressure for alternatives to fossil fuels is likely to come (probably in the second decade of the century) in relation to transport fuels, as oil supplies diminish. Given the long time frame for wide-scale introduction of fuel cell road vehicles and the massive change to infrastructure required for a hydrogen economy, a major global scale effort is needed to expand the use of liquid bio-fuels. Many crops producing oils, starches or sugars can be used to produce liquid fuels, such as bio-diesel and bio-ethanol, which can be used in road transport fuels. However, in some cases, the energy ratio (that is the ratio of energy output to that needed to produce the fuel) is not very favourable, for example if large inputs of artificial fertilizer are used. Brazil had a large scale programme for bio-ethanol from sugar cane, but this was dropped when petroleum based fuel prices fell substantially. The USA and some continental European countries have modest bio-fuel programmes, and there are plans to somewhat increase these. Bio-ethanol and bio-diesel can be introduced progressively into motor fuels without the need for a complete change to the fuel infrastructure and vehicle type, as would be the case for a hydrogen powered transport system. Recent developments in which woody matter can be converted to liquid fuels could increase overall biomass potential by a factor of about three. (Shell have recently announced the construction of a pilot plant for this process in the UK). Ref 11 claims that globally, more than 1/3 of petroleum consumption

(1998 figure) could be produced from biomass, and it can be inferred that, under favourable conditions, the cost of some bio-fuels could be competitive with petroleum based fuels from crude oil at ~ $30/barrel (a price that has been exceeded several times recently) While oil has a global price, the cost of producing bio-fuel will depend strongly on local labour costs and the availability of land. Thus it could be competitive with petroleum fuels in countries like China.

In combination with major improvements possible in vehicle fuel economy, even with an increase in the number of people using cars, major bio-fuel production globally would significantly reduce the pressure on oil supplies and give time for further alternative energy sources to be introduced eg by wide scale introduction of hydrogen as an energy carrier. Given an oil production reduction profile similar to that indicated in fig 1, this could allow perhaps a further 20 years for adapting to reduced oil supplies. (fig 3 is indicative of the potential. The 3rd column is hypothetical, just to illustrate the much greater effect of efficiency and renewables together, compared with their individual effects).

The European Commission has proposed that 5.75% of road transport fuel should be from renewables by 2010. This target should be greatly increased. If a significant proportion of this increase was bio-fuels, this could help solve the problem of large agricultural surpluses which will become more acute after the accession of countries in Central and Eastern Europe.

Although liquid bio-fuels could be transported long distances, use relatively near the point of production would be preferable in energy economy. In terms of climate change, and also of taking the pressure off limited global oil and gas supplies, it does not matter where fossil fuel savings are made. The Kyoto Treaty allows emissions trading between countries. This could help offset differences between demand and renewable energy potential in different countries, and allow production and use of bio-fuels in those places where it is most economical.

Although the potential for renewable energy is large, both globally and in the UK, currently many systems (eg photo-voltaics for electricity production) are expensive, but further development and large scale production is likely to bring costs down. A problem with many renewables for electricity production is that their output is intermittent. Incorporation of such renewables up to about 20% of the capacity on a well developed grid system is said not to give significant problems, but above this, ways of coping with this intermittency are required. Generation of hydrogen by electrolysis at times of surplus capacity is one possibility, and this could complement the use of fuel cells for transport or stationary uses. Systems for the direct storage of electricity (eg the Regenesys system that acts like a reversible fuel cell) may prove viable. However, developing systems for electricity use that can accept intermittent supply would also be valuable. An example of this is the use of heat pumps for building heating (and cooling), which, if combined with heating/cooling pipes embedded in concrete or similar material with high thermal inertia allows energy input at times of surplus

capacity on the electricity system, and can givea very high coefficient of performance, offsetting the greater costs and primary energy input of electricity compared with fossil fuels.

Aviation.

The rapid growth in aviation makes increasing demands on petroleum based fuel supplies. While some improvement in the efficiency of aircraft is possible (the IPCC suggested an increase by a factor of two by 2050), any gain is likely to be swamped by increased aviation on present trends. At cruising altitudes, aircraft produce about 2.7 times the greenhouse gas effects as burning the same amount of fuel at ground level – at these heights, water vapour, condensation trails and NOx emissions affecting ozone concentration add to global warming . It can be inferred from ref 12 on a mid-growth scenario, aviation could take up one third of the atmosphere's carrying capacity for greenhouse gases by 2050. Design changes, both evolutionary and radical, and optimisation of operating regimes could significantly reduce greenhouse gas emissions. Among the more long term design possibilities are boundary layer control to maintain laminar flow over surfaces, unducted fan engines, and for large aircraft, blended wing-body design, where a wide passenger cabin forms part of the lift-producing surface. Operational factors might include flying at a slightly lower cruise altitude to reduce the effects of water emissions (although an optimisation between this effect and increased drag is needed), and avoiding very long flight stages, where the heavy fuel load increases the fuel consumption per passenger-km. Generally, the aviation industry appears reluctant to make radical changes, preferring evolution. It seems likely that aviation is less able to contribute to greenhouse gas reductions than some other energy sectors.

Given the long time frame for major changes to aircraft fleets, a framework to ensure that aviation does not use too much of the worlds limited oil resources or of the atmosphere's carrying capacity for greenhouse gases needs to be established soon. International aviation emissions are not included in the Kyoto treaty. They should be included in future climate change negotiations, so that aviation pays for the costs it imposes on the environment. This could involve buying emissions permits (see Emissions Trading, below), but if aviation were to use a high proportion of the atmosphere's carrying capacity and this squeezed out other essential energy uses, this would be unacceptable. In the shorter term, a Europe wide emissions charge or tax on fuel (at present untaxed) on all flight movements within and into and out of Europe should be imposed. Alternatives to flying should be encouraged, such as high speed rail links for journeys of medium length, and tele-conferencing for a proportion of long-distance business meetings. Valuing places nearer home could reduce people's urge to fly frequently to distant places. Currently, UK government policies, encouraging major expansion of airport capacity on a "predict and provide" basis, appear to pay little regard to environmental constraints.

Institutional and fiscal framework.

A Royal Society report (ref 13) suggests that economic instruments such as a carbon tax or tradable emissions permits would be much more effective in achieving greenhouse gas emissions reductions than detailed regulation. However, in the case of road transport, mandatory fuel economy standards seem necessary to make the needed improvements quickly enough. If fuel prices were to increase substantially, it would be essential to compensate people on low incomes, for example, in meeting travel costs in rural areas with inadequate public transport, by increases in benefits or by other means.

To achieve major reductions in fossil fuel use any increased fuel taxes should be recycled to support further energy efficiency measures and the introduction of renewable energy sources. This should include increasing the tax advantage of bio-diesel and bio-ethanol relative to petroleum based motor fuels. Such recycling would be much more effective in reducing CO2 emissions than that due to the restraint on energy use from higher prices alone.

These measure should of course be in conjunction with international negotiations on greenhouse gas emissions to achieve an effective and equable framework involving all countries. The principle of “Contraction and Convergence” combined with Emissions Trading, developed by the Global Commons Institute (ref 4) provides a good basis for negotiations. In this, the global total of emissions is set, reducing on a trajectory which limits the risks of catastrophic climate change. Within this total, the emissions quotas of all countries would converge over a period of several decades to an equal per capita level. Emissions Trading would allow countries whose overall emissions exceed their “quota” to buy permits from countries which do not use their full quota. The latter may be countries which are favourably placed because they have not developed in ways which are fossil fuel profligate (eg not having land use patterns dependent on extensive use of cars), and where renewables may be the most economic form of energy. This proposal could (at least in the early stages) transfer considerable sums of money to developing countries. C&C has been favourably endorsed by the Royal Commission on Environmental Pollution and has support within the European Parliament and by a number of countries.

WTO treaties like the General Agreement on Trade in Services (GATS) must not be framed so as to allow free trade to over-ride environmental and social considerations in energy services. The policies of the IMF which force indebted developing countries to produce products for export, often into a saturated market, rather than become more self-sufficient, not only distort the development process, but in the case of perishable foods, create more energy profligate air transport.

Conclusions.

The two main issues relating to current energy use are resource depletion and climate change due to greenhouse gas emissions. The UK Energy White Paper accepts the need for major reductions in greenhouse gas emissions and sets quite demanding targets, but greatly underplays the risks in energy security. The use of oil for transport is the fastest growing energy sector, and oil production is expected to fall short of potential demand within the next decade, with gas production declining somewhat later. This could lead to conflicts over the remaining oil and gas.

Climate change is likely to lead to loss of productive land and to water shortages, which will exacerbate conflicts in many parts of the world. Most industrialised countries have committed themselves to the (limited) reductions in greenhouse gas emissions in the Kyoto Treaty, but the USA has withdrawn from the treaty. Pressure should be applied on non-compliant countries by example, and if necessary, by economic means (noting the huge US overseas debt and weakness of the dollar) to accept responsibly the need to reduce excessive demands on the environment and on resources.

Developing fuels which can substitute soon for a significant proportion of petroleum products for transport and very much more fuel efficient vehicles must be a near term priority. Countries or regional groupings which take such actions are likely to survive the impending oil crisis better than those which do not. If a global effort is made, the time gained for further substitution of oil by longer term renewables could avert a crisis. Developing an energy economy less dependent on gas is also important, but the timeframe for achieving this could be somewhat longer.

There are a large number of technologies to enhance energy efficiency and to produce energy from renewable sources. However, as well as developing these, a less energy profligate life style in rich countries will be necessary to allow poorer countries and future generations to meet their needs.

* Urgent action to improve the energy efficiency of road vehicles should be taken, by a combination of legislation on higher vehicle economy standards and consistent price signals, together with encouragement of near term renewable fuels for transport, eg bio-fuels, by greater tax incentives.
* Continued action to improve energy efficiency in all sectors and to develop a range of renewable energy sources is needed
* Pressure should be applied in negotiations within the UN Framework Convention on Climate Change for a post Kyoto regime for effective and equable greenhouse gas reductions, preferably on the basis of “Contraction and Convergence”
* International aviation should be brought within the UNFCCC framework. Aviation should pay for emissions permits for any increase in its emissions, and there should be a realistic tax on aviation fuel.
* The financial, organisational and institutional measures to ensure the

objectives set out in the UK Energy White paper are achieved must be put into effect.

Major expenditure on sustainable development, particularly in energy related fields, is more likely to lead to long term security than ever greater reliance on more and more costly weapons systems to maintain control of scarce resources. Countries that attempt to maintain security by military dominance cannot eliminate the risks from terrorism which could be increased if much of the world's population is impoverished by climate change or disempowered by countries that seek to control diminishing energy resources.

The world is reaching a turning point. The technical, social, economic and political challenges are huge, but people can thrive when working on challenges to achieve a common goal of environmental sustainability, justice and reducing the causes of conflict. The skills of architects, engineers and planners should be harnessed to achieve these goals.

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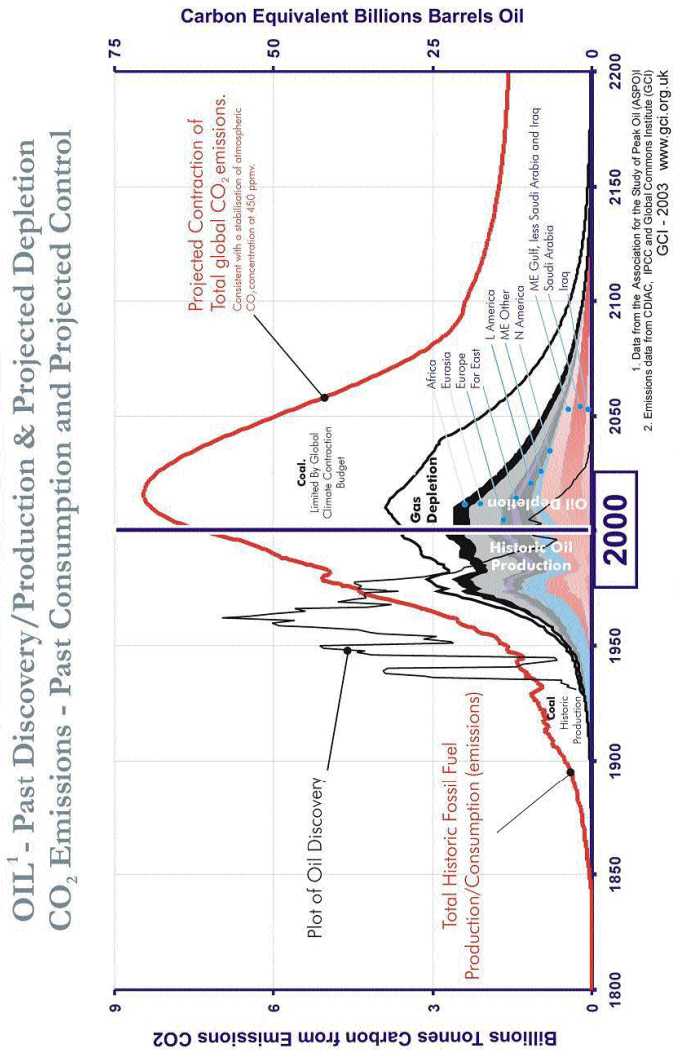

OIL[1] - Past Discovery/Production & Projected Depletion
CO_2 Emissions - Past Consumption and Projected Control
Billions Tonnes Carbon from Emissions CO2
Carbon Equivalent Billions Barrels Oil
Plot of Oil Discovery
Total Historic Fossil Fuel Production/Consumption (emissions)
Coal Historic Production
Historic Oil Production
2000
Projected Contraction of Total global CO_2 emissions.
Consistent with a stabilisation of atmospheric CO_2 concentration at 450 ppmv.
Coal. Limited By Global Climate Contraction Budget
Gas Depletion
Oil Depletion
Africa
Eurasia
Europe
Far East
L America
ME Other
N America
ME Gulf, less Saudi Arabia and Iraq
Saudi Arabia
Iraq
1. Data from the Association for the Study of Peak Oil (ASPO)
2. Emissions data from CDIAC, IPCC and Global Commons Institute (GCI)
GCI - 2003 www.gci.org.uk

figure 1

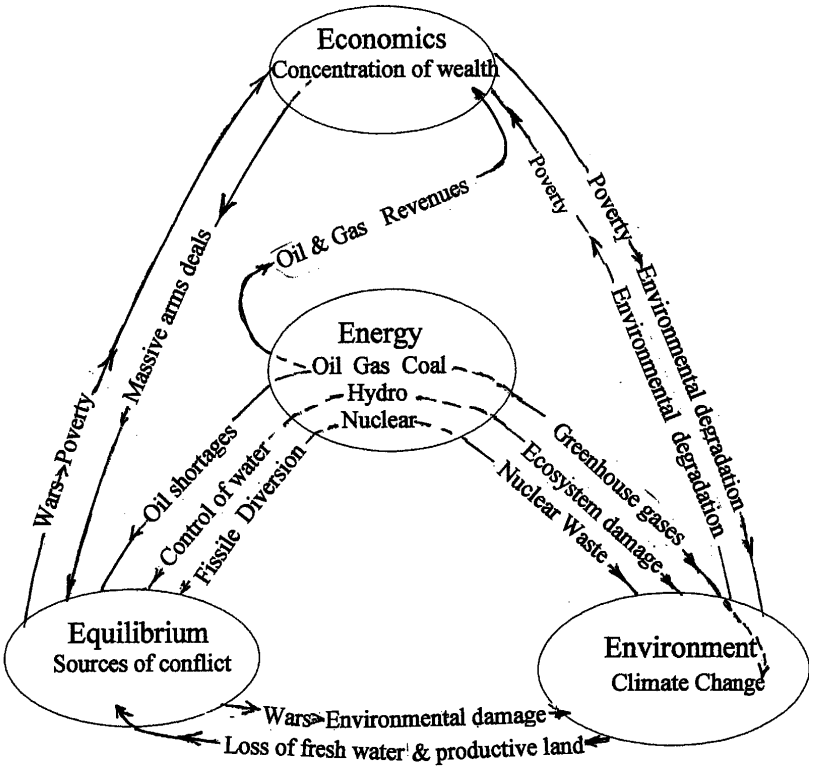
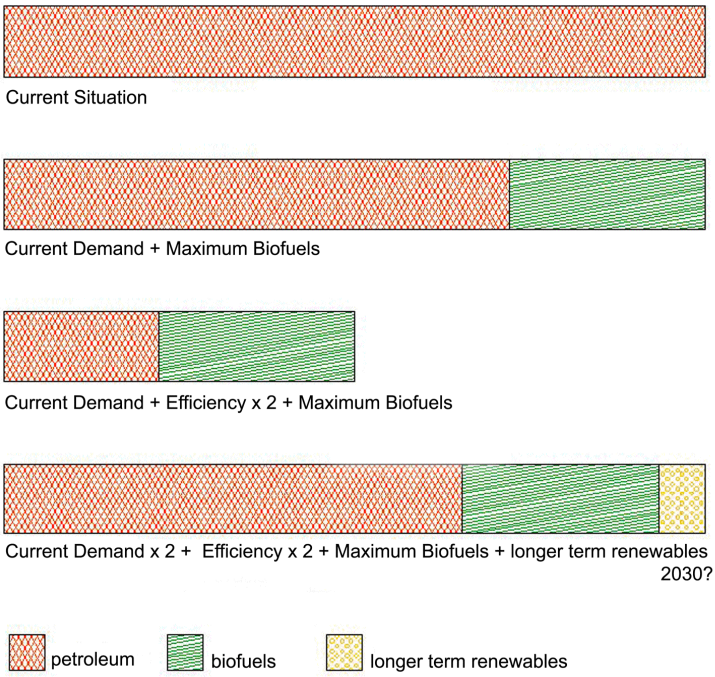

Economics
Concentration of wealth
Oil & Gas Revenues
Poverty
Poverty → Environmental degradation
Environmental degradation
Massive arms deals
Wars → Poverty
Energy
Oil Gas Coal
Hydro
Nuclear
Oil shortages
Control of water
Fissile Diversion
Greenhouse gases
Ecosystem damage
Nuclear Waste
Equilibrium
Sources of conflict
Environment
Climate Change
Wars → Environmental damage
Loss of fresh water & productive land

fig. 2



Transport Fuels: Efficiency Plus Renewables
indicative only - see page 9

fig. 3

Briefing Paper

energy

September 2003

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