STERN REVIEW ON THE ECONOMICS OF CLIMATE CHANGE.

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THE COST OF DOING NOTHING

The British climate is beyond price, it is the foundation of our way of life and the wealth created over the centuries. Although other countries at the same latitude have a harsh climate, we are fortuitous in being close to a warm current, the thermohaline circulation, or Gulf Stream, which brings the equivalent of the heat from a million power stations past our shores. At the same time disastrous hurricanes, rainstorms and severe drought are rare. Global warming will cause extreme weather events, rising sea levels and by the latter part of this century the Thames Barrier will not keep the water out of London and several other major world cities will be threatened.[1] Scientists fear that disruption to the thermohaline circulation could result in a several degree drop in temperatures in Northern Europe and they were surprised to find that recent measurements showed that it has slowed by 30%.[2]

Rising global temperatures will lead to worse problems for the majority of the world's populations. The Inuit people and the inhabitants of islands and low lying countries are already suffering the consequences of melting ice and rising sea levels. By the latter part of the century, Bangladesh will no longer exist and food production in Africa will fall by about 20% up to 50% in the south.[1] The increase in global temperatures is predicted to destabilise gas hydrates at the bottom of the ocean, which would lead to further warming and the sudden release of these gases could initiate a continental slope failure leading to tsunami up to 15 metres high.[3] All we can do is to limit the damage: we cannot stop the deterioration which we have already set in motion.

We are putting the future prosperity of the world at risk if we fail to look after the myriads of life forms which are the supporting structures for more complex life. Ecologists tell us that they are already struggling to adapt to the rapid rise in global temperatures and we are likely to lose 35% of all plant and animal species by the middle of this century if the temperature rises by over $2^{o}C$.[4] In the past, the normal fluctuations in average global temperature were only $5^{o}C$ between the ice ages and the warm inter glacial periods, but according to the report in 2001 by the Inter-Governmental Panel on Climate Change (IPCC), in a relatively short period we have increased the average global temperature by $0.6\ ^{o}C$ and this is projected to rise by $2^{o}C$ up to $5^{o}C$ this century. [5]

Scientists have observed the warming effect of carbon dioxide ($C0_2$) and other 'greenhouse gases' for over a hundred years.[6] They form an insulating layer in the atmosphere which traps part of the heat from the sun. If a planet has too much $C0_2$, like Venus, then it is too hot to sustain life as we know it, or if it has no greenhouse gases it is icy cold like Mars. We are now reaching the point where the increase in global warming gases is outside the normal range. For at least 800,000 years the $C0_2$

in the atmosphere has ranged between 180 and 280 parts per million (ppm) but since the industrial revolution this has shot up to 380 ppm and is continuing to rise exponentially.[1] The University of Oxford is undertaking the largest climate study and finds that it is possible that the global average temperature could rise by 10°C by the end of this century.[7]

Rate of warming increasing

The IPCC's report in 2001 assumed that much of the $C0_2$ caused by human activities would be stored in 'carbon sinks' in the oceans, the soil or growing plants. Until now, about half our $C0_2$ emissions have been absorbed by the world's oceans but this has caused them to become acidic and less able to absorb $C0_2$.[8] Permafrosts, which store frozen greenhouse gases, are beginning to melt and return them to the atmosphere. Measurements taken at the UK National Soil Inventory indicate that the annual net releases of $C0_2$ from the soil caused by warmer temperatures may already be offsetting our target reductions under the Kyoto Protocol.[9] It appears that growing plants may also change from being carbon sinks to sources of $C0_2$ as temperatures rise. During the hot and dry summer of 2003 there were net $C0_2$ emissions from European plants and an increase in future drought events could turn temperate ecosystems into carbon sources, contributing to positive carbon-climate feedbacks, which are already anticipated in the tropics and at high latitudes.[10]

During the past thirty years the uncontrolled use of cheap oil and gas has led to the growth of wasteful energy infrastructures. It has been cheaper to buy fuel to heat the home than to erect sound, well insulated buildings. Centralized services are cheaper to operate because the costs of distribution are borne by the users of the facility, who have access to cheap and easy mobility. There has been so much cheap gas available that electricity is generated at central power stations and the heat thrown away because it is not economic to transport it. Households then purchase a second lot of gas to heat their homes. New energy technologies have been unable to compete due to the rock bottom prices for fossil fuels, which are not covering their external costs.

COST EFFECTIVE CHOICES

In order to select the most cost effective ways to deal with climate change, we need first to assess the full costs, including externalities, of differing technologies covering:

energy security : air pollution:
climate change damage to the UK economy and environment:
possible insurance claims from other countries damaged by climate change.

More progress could be made if the Government were to fulfil its first election promise and change the remit of energy suppliers from selling energy to being energy service companies. Under the principle 'The Polluter Pays' the user of energy should pay the full costs and it is up to the Government to provide special help for vulnerable people. There could be Government help to cover the additional cost of buying houses which are energy self sufficient and will give security against future price rises. It is equitable that some of the wealth we have obtained from our North Sea oil and gas should be given to those who will in future bear the deferred costs of our profligate use of these irreplaceable resources.

Stop wasting heat

Centralized power generation causes the loss of sufficient thermal energy to heat every building in the country because it is not economic to transport heat. As explained above, two lots of gas are purchased to provide electricity and heat for the average building. The efficiency of electricity from the grid is only 35% due to heat and transmission losses, but if the electricity is generated on site with a combined heat and power (CHP) unit, total efficiency is generally above 80%. Although the Government has introduced new building regulations, much higher standards are needed to resolve the problem of heat loss.

According to the energy suppliers, E.ON UK plc, half the homes in the UK could economically change to using micro combined heat and power (CHP) and this could replace our entire nuclear generating capacity. It would also provide back up for 22 gigawatts of electricity from wind farms and would be more valuable than nuclear energy because it would be available when required at times of peak demand.[11] In the Energy White Paper it is estimated that one million domestic boilers are replaced every year. The London Climate Change Agency is planning to make London independent of the grid, so that electricity and heat are generated locally and are both utilised efficiently. [12] Fuel cell systems will provide both electricity and heat and hydrogen can be used to store intermittent supplies of renewable energy.

Small renewables

We also need to make proper assessments of the largely neglected potential input of small renewables. Old windmills are considered picturesque, but attempts to develop efficient units on this or smaller scales are deprived of funding. Even if developers of innovative energy systems can complete their R & D, it is hard for them to break into markets where established industries have mass produced products, are often not paying their external costs and may be getting substantial support from the taxpayer. Government funding is generally limited to the first prototype but many prototypes are needed before technologies can be brought to market. About £800,000 over a five year period would cover the R & D costs and patenting for a small company producing a range of wind turbines from 200 watts to 3 kilowatts, designed to operate effectively at low levels with varying wind speed and direction. The retail price in volume production for the smaller units would be about £750, including a storage battery. This would provide basic electricity for low energy lighting, computers and emergency back up in case of blackouts. The larger units would cost about £3,000 and could provide all of a household's electricity. Energy could be stored as hydrogen and the British developed alkaline fuel cell, which will be available within the next year or two, could provide a cost effective alternative to conventional power generation. Payback would be between five to ten years, reducing as larger volume production is achieved. The UK market for micro wind turbines is estimated at 10 million, with the potential for vast sales in developing countries.

It is suggested that a percentage of revenues from North Sea oil and gas resources could be used to finance the development of the energy efficient and renewable technologies which will replace them. This should be matched by contributions from the users, on the basis that the polluter should pay. Independent research carried out for the Office of the Deputy Prime Minister showed that very small renewable systems, such as a 900 watt peak photovoltaic system or a 4 m^2 solar hot water system could reduce carbon emissions by at least 20% in average homes built to the latest

(PART L) regulations. Even at today's prices, in a tiny UK renewables market with no economies of scale, this would add only 1% -2% to the sale cost of the average newly built house in England.

The Government should give the signal now that the next Part L review in 2009/2010 will make it a requirement for new buildings to incorporate renewable energy systems, leaving specific technology choice to the developer. The precedent for this approach already exists with the Government's decision to prescribe gas condensing boilers from 2005. The Borough of Merton requires developers to use onsite renewable energy systems to reduce their buildings' carbon emissions by at least 10%. Merton Council suggest that if 250 Councils took this action it would create an annual market of over £750 million for solar thermal, solar photovoltaic and micro-wind technologies. The Renewable Energy Association has stated that considerably more Government support for the commercialisation of small renewables is needed to help the current niche buildings and renewable energy sector to enter mainstream markets. There is above all else a need for consistency and continuity of policy approach from central Government. [13]

There is sufficient power if wind farms were built in the shallow waters around the UK to meet all our energy needs [14] and marine energy could make further substantial contributions. A US study finds that converting as little as 20% of potential wind energy to electricity could satisfy the entirety of the world's energy demands. [15] Engineers are also considering the possibility of empty hydrogen tankers going out to sea and returning laden with energy, or else refuelling ships at sea. The German Government is providing a subsidy of up to €55 cents per kilowatt hour (unit of electricity) for solar panels in order to encourage the commercialisation of this technology for home and export markets.

The Liverpool based Grünhaus project has a database covering a wide range of small renewable technologies which could make substantial contributions to cost effective local generation of heat and power for the UK and overseas markets.[16] If we are to reduce future greenhouse gas emissions it is imperative that developing countries build their economies upon the sustainable base of efficient, renewable energy technologies.

Transport

An E.U. survey finds that nearly half the women in the UK would be prepared to walk or cycle rather than use the car if it would be necessary to help the environment. $C0_2$ emissions could also be saved if public transport were powered by renewable energy, either biofuels or hydrogen and fuel cells. It is estimated that 15% of the average town's transport could be powered by energy from its waste. It is important to ensure that agrochemicals are not used to produce energy crops, as they also emit carbon dioxide.

If UK households start to transfer their energy requirements from fossil fuel systems to energy efficiency and renewable technologies this would contribute to new energy infrastructures. For instance, Bristol Electric Railbus has developed a light tram which is extremely efficient and is more popular than buses with people wishing to leave their cars at home. Bus operators suffer from the disadvantage that expensive capital equipment and highly paid operatives spend a large part of their time

unproductively in traffic jams, but ultra light rail systems are energy efficient, cost effective and ensure higher speed travel. [17]

It has been suggested that air passengers should cover the cost of planting trees which would absorb the equivalent of the $C0_2$ emitted on their journey. [1] Such payments would have to be obligatory to be effective and funding could also be invested in high speed ground transport powered by renewable energy.

CHANGING TO ENERGY EFFICIENCY AND RENEWABLES

Innovative engineering companies striving to enter the market have been deprived of R & D funding. This is borne out by two reports commissioned by the DTI, one from Harvard Business School [18] and the Lambert Review. [19] For the past thirty years high exchange rates combined with Government efforts to make UK industry 'leaner and fitter' hit hard at British industry's R & D spending. New so called 'disruptive' technologies could have had a healthy impact on established industries, spearheading the development of new efficient and clean technologies, but they have been largely ignored. Many politicians like huge grandiose projects and their decisions appear to be based on lobbying power and financial muscle, rather than scientific facts or the future potential for British engineering companies. Government centralization also led to the abolition of the Metropolitan authorities which were major supporters of innovative industries.

An effort is needed to encourage new energy technologies through the use of the Government's vast procurement budget. The Government has made funding available for university departments, but as pointed out by the Chairman of New Energy Finance "We have moved away from universities providing information for businesses to universities using it themselves, but they do not have the right skills for commercialization". He added "developing technologies for several years is alien to the venture capital community." [20]

The British people must be fully involved if we are to make a real effort to reduce the risk of irreversible damage from climate change. It will not be politically popular if we have to cut back on our use of energy but the leaders of all three main parties should make a concerted effort to inform the public and take a lead in the national effort to stop emitting global warming gases. If they are aware of the facts, most people will act responsibly rather than leave potentially disastrous consequences for their children to deal with.

An International Energy Agency report says that $17,000,000,000,000 investment will be needed over the next 25 years to meet world demands for energy. The UK Government is tinkering with the problem but we should be changing investment from fossil fuels to energy efficiency and renewable technologies if the British economy is to prosper.

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