Free Range Bulletin 03/02:

Hijacking Green Energy

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We need to change how we use and produce energy in order to slow the impacts of climate change. 'Renewable energy' – energy sources that can be sourced from the environment perpetually – was the buzz word after the oil crisis of the early 1970s. In the 1990s, we went 'green', and green energy was promoted as the alternative for the environmentally conscious consumer. But now 'green' means something different – money. Have the mainstream environment groups lost the plot on energy? Are they compromised by their promotion of green energy into following the lead of the industry rather than promoting energy conservation ahead of production? And is green energy in the UK now dominated by the profits to be made from market subsidies?

It has been said that the Blair government is fixated by targets. This distorts the priorities given to the best long-term strategy over the short-term need to meet targets – meaning that the overall outcome for society is worse. Energy policy suffers the same problems. Driven by targets, the responses to the challenge of sustainable energy use are being restricted to 'industry friendly' options. More importantly, the subsidies introduced to support a 'green' energy policy favour energy production over conservation.

Perhaps the greatest problem has been the response of the mainstream environmental organisations. Like other aspects of 'green consumerism', they have promoted green energy as another element of conspicuous consumption. But this means only people able buy this green energy can have it. If you're poor, no matter what your conscience, you have to buy the environmentally damaging energy sources.

The problem is that by abdicating responsibility for sustainable energy policy to market forces the government, and the leading environmental campaign groups, have allowed the debate of low-carbon energy to be skewed in favour of token measures. It also traps them into acquiescing in the face of, or even supporting, badly designed 'renewable' projects – such as poorly located wind turbines and incinerators. What other solution ave they to offer?

Rather than fiddle at the edges we must tackle the energy issue as a whole. That means ignoring any talk about production until there is a plan in place for energy conservation. Ultimately this is what decides whether energy production is sustainable. The current situation, where renewables are barely meeting the growth in energy demand, leaving the old damaging sources still going strong, is not a sustainable policy.

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How much energy are we talking about

Before thinking of solutions it's better to think on the scale of the problem. Exactly how much energy is used in the UK? In 2002, the we used an amount of energy equivalent to 237.7 million tonnes of oil[1] – enough energy to keep a 100-Watt bulb lit for 3.15 billion years. That's not just electricity, but all forms of fuel that are used to power the UK.

Whether it is wind turbines, waste incinerators, or nuclear power stations, energy is usually presented to the public as 'electricity'. In fact, electricity forms only a minor share of energy usage. Large quantities of coal and gas are transformed into electricity – but this is still not as much as the gas, coal and oil that are used directly by industry, in homes, and especially within the transport sector. It is this mix of fuels that affects how we replace fossil fuels with more sustainable alternatives.

Renewable energy has increased significantly as an energy source. Of the 237.7Mtoe (million tonnes oil equivalent) of energy used by the UK in 2002, 3.2Mtoe[2] (1.3% of the total) was classified as 'renewable'. Most of that consisted of 'biofuels' such as waste wood, heat recovery, waste incineration or landfill gas. Wind and wave energy formed only 0.108Mtoe, or 3.4%, of the whole figure for renewables (0.05% of total energy consumption). Compared to wind, hydro power produced four times more, waste incineration (although incineration cannot objectively be classed as 'green') seven times more, and burning landfill gas nearly nine times more.

The problem is: all that new renewable energy projects do is to meet a fraction of the projected increase in energy

UK Energy Facts – 2002[1]

- Primary consumption of energy in the UK was 237.7 million tonnes oil equivalent (Mtoe – see glossary) sourced from: gas, 41%; petroleum, 32%; coal, 17%; electricity, 9%; and renewables/wastes, 1%.
- By sector, energy consumption was: domestic, 31%; transport, 26%; industry, 25%; and services, 18%.
- Domestic energy consumption has risen 32% since 1970, and 19% since 1990.
- Space heating and hot water accounted for 82% of domestic use, and 64% of commercial uses.
- The energy use in households has increased 9% since 1990, partly because of more appliances per household, but also because of the higher household numbers.
- Energy use in the industrial sector fell 55% between 1970 and 2001, primarily as a result of the shift away from energy intensive manufacturing industries.
- Energy consumption in the transport sector has almost doubled since 1970, and tripled in the air transport sector.
- Between 1990 and 2001, energy use in the air transport sector increased 56%, rail transport sector 8%, road transport 7%.
- Since 1990, energy use in road freight has increased by 17%, whilst passenger transport only increased 1%.
- Between 1970 and 2001, energy consumption in the service sector overall rose 25% – but whilst in the public sector energy consumption fell 7%, in the private sector consumption rose 59%.

demand. They are not replacing energy from fossil fuel sources at all. This means that the UK's fossil fuel emissions are set to grow incrementally over the next two decades.

The Department of Trade and Industry's (DTI) energy projections predict energy trends until 2020[3]. Primary energy consumption is forecast to grow around 1% per year. These figures indicate (averaging the increase from the 'high' and 'low' projections) that over 20 years energy demand will increase 1.3Mtoe per year. The increase in renewables over the same period will be only 0.41Mtoe per year. This is, in part, due to the sceptical view taken of the role of renewables – which in turn makes some investors reluctant to put money into renewables in the UK. But it is also due to the scales of the growth in energy demand, and the fact that most of this new demand will be taken up by burning gas.

National Energy Policy – *the White Paper*

In February 2003, the government issued a new policy document, or 'White Paper', on energy – *Our Energy Future, Creating a Low Carbon Economy*[4]. This document outlines the future policy on energy in the UK until 2010, and leading on until 2020. The main purpose of the document is to outline how the UK will meet its commitment to implement the requirements of the Kyoto Protocol, and the government's further commitment to implement a cut in carbon dioxide (CO_2) emissions of 60% below the emissions level in 1990 (which is well beyond the Kyoto targets).

The UK's Kyoto 1990 baseline is roughly 160MtC/yr (million tonnes of carbon per year). The White Paper's target is a cut of 60% by 2050 – to around 65MtC/yr. The target for 2020 is a cut of 5MtC/yr to 25MtC/yr. This is made up of:

- energy efficiency in households, 4 to 6MtC/yr (25%);
- energy efficiency in industry, commerce and public sector, 4 to 6MtC/yr (25%);
- transport (continuing voluntary fuel efficiency agreements and a switch to biofuels), 2 to 4MtC/yr (15%);
- increasing renewable generation, 3 to 5MtC/yr (20%);
- the EU carbon trading scheme, 2 to 4MtC/yr (15%).

The White Paper sets no particular target for the mix of energy sources in order to meet the CO_2 target. Instead, the energy industry will be encouraged to introduce measures, within the operation of the energy market, to meet the target. It sets a target for renewable energy of 10% *of electricity supply* by 2010 – note electricity supply, not energy demand. This has a very subtle meaning in terms of the overall energy system. In 2001, about 93Mtoe of the primary energy demand of 249Mtoe (37%) was used to supply electricity[5]. Of this figure, about 55Mtoe (59%) was wasted as 'conversion losses', and 38Mtoe (41%) was supplied as electrical power. 10% of 38Mtoe is 3.8Mtoe, *just 1.5% of total energy demand*. Converting to electrical energy, that's around 44TWh (tera-Watt-hours) of renewable energy.

The White Paper sets a target for renewable energy of 10% of electricity supply... that's 2,233 [of the largest] *wind turbines*

How this figure is met has important consequences. For example, if 40% of renewable energy (17.6TWh) was produced by wind turbines, 6.7GW (giga-Watts) of wind turbine capacity would need to be created (turbines produce about 30% of their rated capacity as continuous energy). Even assuming that the wind turbines were rated at 3MW (mega-Watts) each, some of the biggest around, that's a equivalent to 2,233 wind turbines. Want to get 30% of *all* the UK's electrical energy from wind? Even at today's level of supply, that's 133TWh, equating to 454GW of turbine capacity – 151,333 100 metre tall, 3 megawatt wind turbines!

Those who support wind turbines... have to realise that, as an engineering problem, it's just not do-able without creating other environmental consequences

Those who support wind turbines (and seemingly promote them as the UK's most promising means of obtaining sustainable energy supplies) have to realise that, as an engineering problem, it's just not do-able without creating other environmental consequences. Air, which powers the turbine, just isn't heavy enough to reap energy efficiently without huge amounts of equipment. We have to look to a wider range of solutions. We have to look further into the problem and realise that the production chain cannot sustainably provide the projected quantity of power. As the priority, we have to look at the demand side to minimise the amounts of energy that we must provide.

It's important to appreciate the way energy connects to so many other environmental issues. Transport, land impacts, climate change, water pollution, air pollution and social justice are inextricably linked with energy. A good example of this is air transport. Air freight operations based in the UK has risen 83% (measured as tonne-kilometres) since 1979[1]. Currently the UK's emissions from aviation are around 9MtC/yr. This is projected rise to between 14 and 16MtC/yr by 2020 – the mid-point of the target that the government has for cutting carbon emissions by 2010.

Currently the UK is running 9% *below* the Kyoto 1990 baseline for carbon emissions. This is because of the switch to gas for electricity generation which is more efficient than coal. This advantage will be lost around 2005 as fossil fuel consumption, led by increases in air transport, road transport and the use of more gas for power generation, increases carbon emissions[3]. On current estimates, the UK will once again pass the 1990 Kyoto baseline between 2015 and 2025, depending upon levels of economic growth and fuel prices between now and then.

Under the White Paper it is proposed to provide financial support to renewable power projects, reaching a level of £1 billion per year by 2010. At the same time the UK will be buying carbon credits via the EU scheme. Buying 2 to 4MtC/yr on the open market, perhaps in auctions against the USA, Japan, and other major industrial nations, may cost tens of millions to hundreds of millions of pounds. So in adopting this policy, without any meaningful debate on the wider impacts, the government is committing the UK to significant increases in expenditure. If that money were diverted to other technologies it could significantly reduce carbon emissions. But that's not the issue. The issue is that the government's energy policy is devised to meet the terms for reform specified by global corporate interests.

Commodifying everything

Inspired by the market leaders in energy trading in the mid-1990s, like Enron, the form of the global market for energy production and carbon trading was agreed well before the government consulted on its policy. Commerce likes to reduce everything to simple commodities – that way something can be owned, traded, and a profit extracted. In turn, the market can define the terms upon which the commodity is created or used, usually to favour the largest producers. Energy services were one of the first public utilities to be privatised in the late 1980s – setting a model that would be followed in states across the globe. This is

Glossary

Energy – the physical potential of heat, movement, electricity, light and other forms of radiation.

Primary supply – how much raw energy is produced in the UK, including energy, like oil, that is exported.

Primary demand – how much energy is used in the UK.

Transformation – the conversion of one type of energy to another – e.g., gas to electricity (transformation always results in a loss, dependent upon efficiency).

Efficiency – the ratio of power input to power output (expressed as power output divided by power input times 100%).

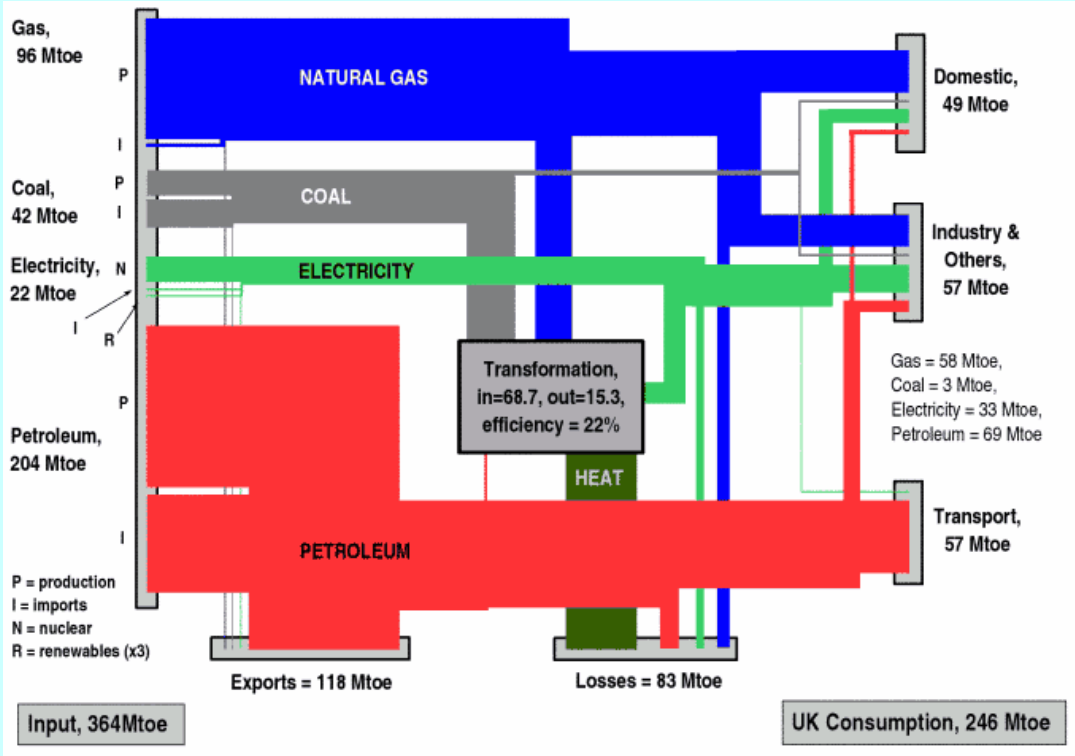
'tonne oil equivalent' (toe) – in order to express energy in similar units, energy values are converted to represent tonnes of oil. Hence 1toe equals 11,360kWh of electricity, or 1.6 tonnes of power station coal, or just over 1 cubic metre of natural gas. Usually presented in multiples of thousands (ttoe) or millions (Mtoe).

Watt (W) – the international unit of power, equal to one unit of energy, a Joule, supplied every second. Usually used in multiples of one thousand (kilo-Watt, kW), one million (mega-Watt, MW), or one billion (giga-Watt, GW)

Watt-hours (Wh) – a Watt supplied every second for one hour. Usually used in multiples of one thousand (kilo-Watt-hour, kWh), one million (mega-Watt-hour, MWh), one billion (giga-Watt-hour, GWh) or one-thousand-billion (tera-Watt-hour, Twh).

Kyoto Protocol – agreed under the auspices of the United Nations in 1997, the purpose of the Kyoto Protocol is to reduce global carbon emissions to less damaging levels.

Carbon – carbon comes in many forms, and so is usually expressed as 'tonnes carbon content' (tC, or millions, MtC). But the actual mass of material released will be higher – e.g., carbon dioxide, by weight, contains 27% carbon, whilst methane contains 75%.



Energy Flowchart[5]

This diagram is adapted from a similar DTI study. It shows the flow of energy through the UK. Energy inputs are on the left, outputs are on the right, and losses from the system are at the bottom.

What is significant is the general flow rather than the individual totals. In particular, the dominance of gas and petroleum in the system as a whole. Also, the major loss of energy created through 'transform-ation' (mainly electri-city generation).

Commerce likes to reduce everything to simple commodities... the mainstream environment groups have been complicit in this process

also one explanation as to why reform of the energy sector has been so difficult to achieve.

In the field of energy, the mainstream environment groups have been complicit in this process. They have promoted the development of renewable energy as another form of consumerism. Willingly encouraging the public to pay a premium for renewable energy which, in terms of the UK's carbon balance sheet, has made no significant difference in carbon emissions – nor or will it if DTI forecasts come to pass. Carbon emissions in the UK have dropped for two reasons. Firstly, the declining role of manufacturing industry in the UK economy. But mainly because we burn more gas today, instead of coal, at greater levels of combustion efficiency.

Today there are many power projects that receive a subsidy for the power they produce. Most of them are not wind turbines – they are landfill gas engines, waste incineration plants, and existing hydro-power projects. The table, right, outlines the DTI's statistics on the growth of different types of 'renewable' energy projects since 1990, covering both heat production as well as electricity.

The general characteristic of renewable power projects is that they are small. Ideally they would supply local needs. But to get subsidy for the power they generate these projects must be of a scale where they can connect to the regional electricity grid. This creates a number of problems. In fact, the legacy of the centralisation of the electricity generating grid from the 1960s onward has been that all power projects must be very large in order to be economically viable. Power stations, apart from a few oil- and gas-fired stations that generate to meet very short

UK Renewable Energy Sources – 1990 to 2002[2]

	thousand tonnes oil equivalent			
Source	**1990**	**2000**	**2001**	**2002**
Solar heating/photovoltaics	6.4	12	14.2	17.1
Wind and wave	0.8	81.3	83	108.4
Hydro (small and large-scale)	447.7	437.3	348.7	411.7
Landfill gas	79.8	731.2	835.8	892.1
Sewage gas	138.2	168.7	168.4	183.7
Wood (domestic/industrial)	174.1	502.8	468.8	469.8
Waste combustion	119.1	610.1	665.8	726.1
Other biofuels	64.7	287.4	388.9	392.6
Total	**1,031**	**2,831**	**2,974**	**3,201**

peaks in demand, do not generate to meet local need.

The problems of the structure of the power industry, the national and regional electricity grids, and the development of renewable energy, has been identified by the Parliamentary Office for Science and Technology. In their October 2001 report, they state: "*seeking to develop embedded and renewable generation technologies... must go hand in hand with changes to electricity networks themselves*".

The White Paper contains no clear proposals for how the national grid can be 'de-nationalised'. Again this is left to the privatised bodies who now administrate the national grid and regional power distribution.

Like past models of economic imperialism, carbon trading requires that... countries dis-appropriate their citizens...

The Enron scandal, and its political connections in the UK as well as the USA, is an example of the power that the energy industry has over national governments. We have to question whether, in making the White Paper, the Blair government gave more concern to the need to change modern energy culture, or to the potential political costs of alienating the energy corporations. Given the nature of climate change the risks outweigh the potential savings, and so we should adopt a precautionary approach. However, the energy industry's infiltration of the political arena means that the required clean break with the past 300 years of fossil-carbon-based energy will not be easily broken.

So instead, like the mainstream environment organisations, the measures suggested by government enhance the powers of the energy trading organisations. Key amongst these are the proposal for 'carbon trading'. Like other forms of pollution trading, carbon trading seeks to transfer the per-capita carbon allowance from poor countries to rich countries in return for money. This has two effects. Firstly, it enshrines the reduction in carbon emissions to the spreadsheets of energy accountants. It is not necessary for those countries who have become rich by burning fossil carbon to change their ways. Secondly, it removes the individual rights of people in developing countries to 'their carbon'.

But it's not just carbon emissions trading that is being peddled. There is a market emerging in 'carbon sinks'. This involves planting large areas of land with trees that are supposed to 'soak up' carbon. States or corporations, and even individuals, are encouraged to buy the 'carbon credits' that pay for these schemes. Problem is, the concept is futile – the whole notion behind such schemes was condemned in 1999 by the global organisation that studies climate change, the Intergovernmental Panel on Climate Change. As the Earth warms, the fixated carbon will be liberated with the first forest fire. Worse still, groups in the USA are proposing to 'seed' the ocean with nutrients to increase plankton growth, and hence carbon fixation. But, like nutrient pollution in freshwater habitats, this in turn could have damaging consequences to the rest of the ocean ecosystem. Like carbon credits, ocean seeding would be funded by corporations 'buying' carbon through the scheme.

Like past models of economic imperialism, carbon trading requires that developing countries dis-appropriate their citizens of their carbon allowance in order to take part in the scheme. These deals are also likely to be seen by organisations such as the World Bank and International Monetary Fund as an easy source of foreign exchange. Therefore it's likely that any increases in income that poorer countries see may be swallowed up by losses in other aid funding. These payments will in effect be instantly returned to the developing countries as part of debt-relief or 'structural adjustment' programmes.

The EU Carbon Trading Scheme

The purpose of the EU Carbon Trading Scheme is to centrally purchase emissions permits sufficient for the needs of all EU states. These will have to be bought through an auction-like process against the other leading industrial nations.

The first stages of the scheme will be implemented in the EU during 2005. By 2008, all member states should be trading through the scheme. Large carbon emitters, like power stations, iron furnaces or cement works, will have to obtain emissions permits via the scheme. In the UK, this is roughly about 5,000 industrial plants. It is also likely that the government will have to buy permits on behalf of small businesses that fall below the threshold for individual permits. This will be co-ordinated through a 'UK National Allocation Plan', currently being put together by the economic consultancy group NERA (under contract from the government), which will be submitted to the EU in March 2004.

The initial cost of carbon permits will be in the range of £10 to £28 per tonne of carbon – most likely the lower end because the largest carbon emitters have already been reserved a large bank of permits. However, each year the available amount of carbon will be decreased. Initially then, energy prices might rise by 10% to 15%. But if EU states rely more and more on carbon credits to meet reduction targets, energy prices could rise by up to 4%, year on year, after 2010.

For the UK, then, with the stated policy of buying 2 to 4 million tonnes of carbon permit per year, that's a cost of £20 million to £112 million per year. That could rise to beyond £150 million per year after 2015.

The '2030 Crunch'

There are various factors that intersect the globe's energy, environment and political problems – and all come to a head in around 25 years time. These have been called the 2030 'crunch' or 'spike'. There are various groups now writing on this subject in an attempt to make the governments of the industrialised world address the issue. Some United Nations organisations have written detailed analyses of the problem[6]. Some politicians[7] in the industrialised nations are also writing at length on the threat of these issues to our future safety and security. In response some politicians advocate either more security, military strength, or a rapprochement over old rivalries for the sake of the globe – but mostly no real change in current energy and trade policy.

The critical problems identified are:

- Crude oil production has just peaked, and new finds of oil are not keeping pace with increasing demand – crude oil production will be 'compromised' by 2030.
- Climate change is starting to have effects on the tropical zones, with drought and desertification spreading over larger areas – by 2030 it is predicted that we could see migrations of people as 'environmental refugees'.
- Global freshwater resources are under stress, in the northern states (due to excessive consumption) as well as in developing countries (due to drought).
- Agricultural land resources are being depleted so yields cannot be maintained without large inputs of energy – meaning current levels of food production are threatened.
- World population, outside of most industrialised nations, is still growing significantly, putting further stress on resources – but the demands of the industrialised nations for resources is in turn putting greater pressure on developing countries.

Every one of these factors has a link with energy use. It would be possible to write at length on each one of these aspects, but let's just take one – climate change.

Climate change is happening. There is sufficient evidence for this that even the US Environmental Protection Agency has confirmed that it is happening and humans are the cause of it. We have to act to address the problem now. We could cease all carbon production tomorrow, but climate change would still occur because of the buffering of carbon in the environment – it could take a century or more for levels to reduce significantly.

Of greatest concern today are the role of climatic feedback mechanisms, and their unpredictability, that could make climate change far worse. These have been revealed from the research into the fossil record, deep ocean sediments, and the gases trapped in Arctic ice. Of these, methane emissions from seabed methane hydrate deposits are the most worrying. Methane hydrate is a solid form of methane, formed at low temperature and high pressure on the continental shelves as organic matter in sediment decays. If the temperature of the sea rises, as is happening today, the hydrate can 'flash' to gas, and bubble out of the ocean to the atmosphere. What makes things worse is that methane is 60 times more potent a greenhouse gas than carbon dioxide.

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Evidence from the Permian/Triassic global extinction, around 200 million years ago, indicates that a mild episode of global warming was caused by a large amount of volcanic activity. This caused temperatures to rise by around 5ºC. But this in turn triggered the release of methane hydrate, causing more warming, causing more releases, causing more warming... etc. At the end of this runaway process global temperatures rose by 12ºC – causing desertification across the globe.

Perhaps more worryingly, some in the energy industry want to try and tap methane hydrate as a source of natural gas – creating yet more carbon emissions. The principle barrier to this is that the attempt to tap it could cause the whole deposit to break down, releasing it's entire methane load.

OK, so what's the answer?

The solution is simple – stop using so much energy!

On the positive side, we solve other problems at the same time as energy intersects so many other issues:

- Air transport is the fastest-growing carbon source within the fastest growing energy sector, transport – but air transport is objected to because of it's impacts on the countryside and the areas around airports.
- The road transport sector in general will dominate both our future energy consumption and our carbon emissions – but road congestion is one of the UK's major problems.
- The domestic sector has seen very little improvement in energy efficiency over the past thirty years – but the housing stock in the UK is extremely energy inefficient, and household numbers are growing.
- The UK farming sector has been in depression for a long period of time – and yet the development of more local forms of food production to reduce transport emissions, and farm waste digestion to produce gas and electricity, could improve farm incomes.
- The UK is running out of places to put its waste, and under government pressure, many local authorities are

considering waste incineration to solve the problem – but an economy that recycles materials instead of burning them produces more jobs, and reduces energy and resource consumption.

The prime reason that reform of the energy industry cannot be integrated into the solution to wider environmental problems is the reason why the energy industry itself can't change – the role of deregulatory pressure. This is a part of the 'globalisation project' that certain states have been enacting since the 1980s. Trying to change energy policy means battling the foreign policies of states like the USA.

For example, transport emissions cannot be addressed until pressure to change transport patterns reduces the use of cars and lorries. But reductions in cars and lorry use can't be achieved whilst pressure is maintained to improve the road infrastructure for cars and lorries over more efficient modes of transport. And the pressure for better roads is in turn promoted by the free trade agenda requiring more transport.

This is why the abdication of the mainstream environment organisations from the energy issue, in favour of a consumer-based approach advocating 'green energy', is so abhorrent. Energy is the common thread that runs through all of the key environmental issues in the UK and Europe today. You cannot divorce one from the other. But those problems will not be solved with wind turbines – the greatest priority is minimising energy use.

Of course, waiting in the wings are the nuclear lobby. They promote 'carbon free' energy from nuclear power. But this is a fallacy. Firstly because electricity is not a wonder-fuel – we need equal quantities of chemical-based fuels that can be used in vehicles, and creating gases, or charging batteries, has other impacts. Secondly, developing of nuclear plants, and treating radioactive waste, does create carbon dioxide – because of all the concrete and steel that's required. But the main reason to reject the nuclear option is that it creates highly toxic wastes that we can't safely dispose of. Having more of these plants/this waste around also increases the chances of nuclear weapons proliferation, terrorism, and consequently creates global instability – Iraq being a recent example, perhaps Iran and North Korea the next.

There have been promising developments related to energy conservation in the past, but they have gone nowhere. This is because they require industry to act pro-actively. For example, the former Office of Electricity Regulation (OFFER) commissioned a report in 1992 on 'demand-side measures' (DSM)[8]. This looked at the experience in the US and Europe on reducing energy consumption by getting energy users to increase the efficiency of use. Such programmes have been highly effective at reducing consumption. Mostly DSM schemes are aimed at space and water heating. This is

The Practicality (or not) of Biofuels

Many are promoting 'biofuel' as the answer to fuel use in the transport sector. But, like wind turbines, this concept works in ignorance of the scale of production that would be required to support current transport energy demand.

One of the prime fuel crops, in northern Europe at least, is rapeseed (or canola). Other options for hotter climates are sunflower and maize (or corn). Rapeseed and other oil-rich plants can be converted into a fuel similar to diesel. For example, to produce 1 tonne (te) of bio-diesel from rapeseed requires 2.8te of raw rapeseed†. This produces a fuel with a calorific value of 37.3GJ/te. The calorific value of fossil diesel is around 42.3GJ/te, therefore you have to burn 1.13 times the amount of bio-diesel for the same power output.

Currently rapeseed is grown with a yield of around 3.1 tonnes per hectare of land. Taking the rapeseed produced per hectare, and the calorific value of bio-diesel this produces, a hectare of land produces bio-diesel equivalent to 40.8GJ of energy. Converting to the standard 'toe', one hectare produces 0.83toe of energy.

If we assume the average diesel car does 45 miles per gallon, in energy terms that's around 0.0036GJ per mile. So a hectare of land provides enough bio-diesel to send a vehicle 11,333 miles (4,586 miles per acre). Assuming that an average vehicle does around 9,000 miles per year, each vehicle needs $^4/_5$ths of a hectare, or 2 acres, of rapeseed to run it for a year.

In 2001, road transport consumed 42,000,000toe of energy. Switching to rapeseed as the main source, this would require 50,602,409 hectares of land. In 2002, the UK grew 357,000 hectares of rapeseed‡. In other words, we grew enough rapeseed in 2002 to meet 0.7% of the theoretical demand for bio-diesel. To produce sufficient bio-diesel would require nearly twelve times the amount of land currently in cultivation (4,238,000 hectares in 2002).

So, this is where the practicality of bio-diesel runs into the brick wall of reality. We would have to turn-over so much land to bio-diesel production that we would no longer be able to produce sufficient food. It should also be noted that rapeseed and other oilseeds require large energy inputs for production – in particular large amounts of nitrate fertiliser which are heavily reliant on crude oil for their production. Therefore it isn't a practical option for providing all our fuel oil. We could of course source our oilseed from the large areas of cultivated land in developing countries. But as these crops require the best land, it would deny the citizens of these countries access to their best land for food production – just at the time that climate change will put existing crop production under extreme stress.

Sources:

† Evaluation *of the Comparative Energy, Global Warming, Socio-Economic Costs and Benefits of Bio-diesel*, School of Environment and Development, Sheffield Hallam University (under contract from the Department of Environment, Food and Rural Affairs), January 2003.

‡ *Agriculture in the United Kingdom 2002*, Department of Food, and Rural Affairs, 2003.

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because three quarters of all domestic/commercial energy is used for space and water heating. Improvements in the use of energy in appliances also has a role to play – but the results are not as significant. But this is the current policy – concentrating on appliances which form only a minor part of domestic energy use. Whilst 'energy rating' schemes have been developed for appliances, there has been little support for schemes that address space and water heating.

The OFFER report, and the ideas behind it, were squashed by the industry. The reason is simple – privatisation. DSM can only be implemented by the energy provider, so the costs would be borne by the regional electricity companies. But the benefits would primarily go to a different set of companies, the energy generators. Hence, no progress. But unless we implement radical energy conservation measures based around DSM, the level of energy that we have to provide to meet society's demands is unsustainable.

We need more smaller, local sources of power. The pre-requisite for this is the reorganisation of the electricity grid so that small quantities of power can be supplied to the local grid more easily. Small sources could be things such as a solar roof on a large building, or street lights that incorporate solar cells, or local farms/industry. One of the promising sources in urban areas could be the digestion of waste and sewage sludge to produce gas. In rural areas too, the digestion of waste from farms, especially cow and pig farms, could produce large amounts of energy, and more income for farmers. Digestion will also produce gas for bottling, as well as providing a constant supply of electricity.

Wind power will be significant – but not under the current model of development. The best location for wind power is where it is needed. Putting wind farms in remote upland areas means that a proportion of the energy, perhaps 20%, is lost during transmission. We need more wind power, but in the places that it is used. Off-shore capacity too, whilst creating transmission losses, has the advantage that it provides power without encroaching on other land uses. Perhaps our greatest asset, and to date the poor relation in terms of funding, is tidal and wave power. Potentially it could supply larger amounts of energy than wind power.

The greatest reform we can implement is through the tax system. Abolish VAT on all purchases, as well as fuel duty, and instead levy a 'carbon tax'. This would be based upon the carbon content of the material bought, valued according to the energy required for its manufacture and use. In this way we solve many problems in one go. We encourage the best forms of generation by making them comparatively cheaper, rather than subsidising them. We encourage the use of recycled goods, because virgin materials would be more expensive. We also encourage the sale of goods that last longer because they have a lesser impact than goods that have a short service life or that are disposable.

Energy conservation does not mean switching off – it means doing what we do better. But this reduces the turn-over of the energy industry, and so their profits – which makes them a legal and political block to reform. So, it is incumbent upon all of us to work at the personal level for a sustainable energy policy. This begins by making those that claim to represent us – the environment groups – promote policies based upon fact, and not 'tilt at windmills'. But ultimately we have to make life as difficult as possible for the politicians and global corporations in order to get the political reforms we need. And we all must realise, this is no longer about 'saving the planet', it's too late for that. It's about making the coming challenges to our lives as bearable as possible.

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