WWF-UK Background Paper: Potential for a Low Carbon Energy System in the UK

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Introduction

Climate change is one of the most serious environmental challenges ever to face our planet. Energy production and use is by far the biggest contributor to the problem, mainly through carbon dioxide (CO_2) emissions from fossil fuel combustion. Emissions reductions from the energy sector thus have to be a key priority in climate change strategies. WWF's climate change programme promotes sustainable solutions for the energy sector, in particular energy efficiency and renewable energy.

Energy is used in three main ways: as electricity, as heat and in transport. WWF-UK's focus is on the production and use of electricity where we believe there is the most scope for adopting lower carbon technologies. In the heat market, the predominant fuel is natural gas and there are very few, if any, viable alternatives to switch to other fuels. There are measures that can be taken to reduce the amount of heating (and therefore gas) that is used, and these are explored in the section on energy efficiency below[1].

This policy backgrounder accompanies WWF-UK's energy position statement and sets out our views on options available in the UK to reduce greenhouse gas emissions from the energy sector.

UK Greenhouse Gas Emissions & Energy Use

UK EMISSIONS

Current (2000) UK emissions of CO_2 are around 155 MtC (Million tonnes of Carbon). Under a business as usual scenario, these are expected to be around 110 MtC in 2050[2]. It has been suggested, specifically by the Royal Commission on Environmental Pollution (RCEP)[3], that the UK should be aiming to cut emissions of CO_2 by 60 per cent by 2050. This would mean that by 2050 the UK's emissions of CO_2 should be no higher than 60 MtC[4]. This means that the UK is going to have to take action to reduce emissions of CO_2 by some 50 MtC (and probably by more) in addition to those already expected to occur. To put this in context, the current UK Climate Change Programme is projected to result in CO_2 reductions of around 30 MtC by 2010.

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[1] It should be noted that the emissions per unit of energy are much lower for gas than they are for electricity – emissions of CO_2 from gas are approximately 0.2 kg/kWh compared to around 0.6 kg/kWh for electricity (based on the current mix of predominantly fossil fuel based generation technologies).

[2] This figure includes the effect of the current Climate Change Programme, closure of most of the current nuclear capacity and historic fuel switching in the electricity supply industry.

[3] Royal Commission on Environmental Pollution (RCEP), *Twenty-second Report: Energy the Changing Climate,* The Stationery Office, June 2000.

[4] The exact figure depends on the baseline selected. The RCEP implied a baseline year of 1997 (155 MtC), but 1990 is most usually used as a baseline (168 MtC). A limit of 60 MtC is used here as a useful indication of the target required.

Table 1 gives a sectoral breakdown of the UK's emissions of carbon dioxide in 1990 and 2000 and out to 2020. It shows that power stations are a major source of CO_2 emissions, indicating that action must be taken in the power sector (electricity generation) if serious emission reductions are to be made.

Table 1 UK Carbon Dioxide Emissions by source

Source	Carbon Dioxide Emissions MtC			
	1990	2000	2010	2020
Power Stations	54.1	40.2	35.6	37.4
Refineries	5.1	5.1	6.3	6.5
Residential	21.5	22.2	22.6	23.7
Services	8.4	9.6	9.7	10.1
Industry	35.2	33.8	32.2	31.9
All Transport	35	36.4	41.7	46.7
Land use change	8.7	7.0	5.7	4.4
Total without land use change	**159.3**	**147.3**	**148.1**	**156.3**
Total with land use change	**168.0**	**154.3**	**153.8**	**160.7**

Source: Adapted from DETR, *Climate Change The UK Programme*, November 2000

ENERGY DEMAND AND PRODUCTION IN THE UK

Energy Demand

Table 2 shows aggregated energy demand by fuel out to 2020 from three sectors – domestic, service and industrial (demand for each sector is shown in Appendix 1).

Table 2 clearly shows that energy demand, particularly for electricity, is expected to continue to grow even with existing measures in place and that reductions in energy demand will have to be an essential part of future actions to reduce emissions.

Table 2 Aggregated UK Energy Demand by Fuel

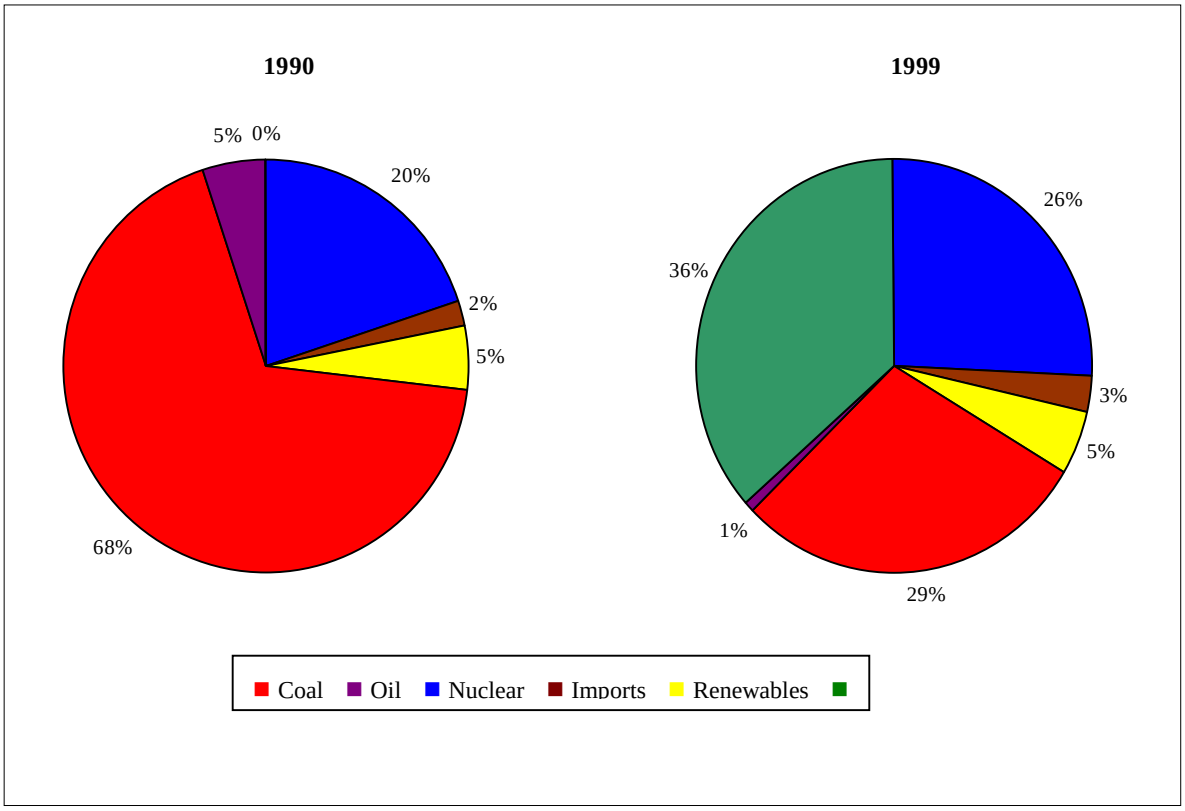
Energy Source	Energy demand (Mtoe)				Percentage change 1990 - 2020
	1995	2000	2010	2020	
Electricity	24.5	28.5	31	33	35 %
Gas	51	59.5	62	63	23.5 %
Oil	12	11.5	12	12.5	4 %
Solid Fuel	9	8	7	8	-11 %
Total Energy Demand	**98**	**108**	**114**	**120**	**22 %**

Source: Adapted from Performance and Innovation Unit, *The Energy Review*, February 2002

Electricity generation

Figure 1 below shows the mix of fuels used to generate electricity in 1990 and 1999. These graphs raise two particularly important issues for the future of electricity generation in the UK.

Figure 1 UK Electricity generation mix by fuel



Source: DTI, *Energy Projections for the UK, Energy Paper 68*, November 2000

Firstly, they show the rapid reduction in the use of coal from 68 per cent in 1990 to 29 per cent in 1999 coupled with a huge rise in the amount of gas used from zero in 1990 to 37 per cent in

1999. This ‘dash-for-gas’ as it became known is the main reason for the reduction in CO_2 emissions shown in Table 1 and is largely responsible for the UK being on track to meet its Kyoto emission reduction commitments. This dash for gas was a one-off and will not be able to be repeated in the future, which means that if the UK is to make the emission reductions outlined above, other lower carbon technologies will have to be introduced.

Secondly, they highlight the major role played by nuclear power in the generation of electricity. This is important as many of the UK’s nuclear power stations are coming to the end of their lives and it is expected that by 2023 all bar one of them will be closed. This has implications for the UK’s capacity to meet its electricity generation needs and the ability to meet its emission reduction targets. It is estimated that if the electricity generated by nuclear power stations in 2000/1 had been generated by the current mix of fossil fuels, then the UK’s emissions of CO_2 would have increased by 50 million tonnes of CO_2 (about 13.5 MtC).

Decisions need to be made soon as to how this generation capacity will be replaced. WWF believes that this ‘capacity’ gap can be met through a programme of energy efficiency and the development of Combined Heat and Power (CHP) and renewable energy technologies without the need to develop new (or refurbish existing) nuclear power plants. The options for doing this are discussed further below.

Low Carbon Technologies

As has been shown above if the UK is to make dramatic reductions in CO_2 emissions in the future, action must be taken in the energy sector to reduce demand and move to lower or zero carbon electricity generation technologies. In the UK, there are a number of options available to achieve these goals – increased uptake of energy efficiency technologies, increased penetration of renewable generation technologies, increased use of CHP, refurbishment and expansion of existing nuclear capacity and use of carbon capture and sequestration. Table 3 gives an indication of how cost effective each technology is at reducing carbon and the following sections look at the potential for each of these technologies in more detail.

Energy Efficiency

Table 4 shows the economic potential for energy efficiency across the economy. It shows quite clearly the massive potential for improving energy efficiency by as much as 30 per cent, with much of this potential in the domestic sector. Other studies have identified a potential to reduce energy demand by up to 50 per cent. There are varying views as to exactly how much of the identified potentials are cost effective but there is consensus that much of it is.

It is difficult to say precisely the quantity of emission reduction that will be delivered by energy efficiency but recent analysis has indicated that implementing the 30 per cent efficiency improvement could deliver some 20 MtC above what will currently be delivered through existing programmes.

Table 3 Costs and Carbon Reduction Potential of Low Carbon Technologies

Technology	Carbon abatement cost £/tC 2020		Carbon reduction potential MtC		Unit cost (p/kWh)
	Minimum	Maximum	2020	2050	
Domestic energy efficiency	-300	50	15	30	Low
Service sector energy efficiency	-260	50	4	10	Low
Industrial energy efficiency	-80	30	9	25	Low
Large CHP	-190	110	3	5	< 2
Micro CHP	-630	-110	1	5	2.5 - 3.5
Onshore wind	-80	50	1	5	1.5-2.5
Offshore wind	-30	150	8	>20	2.0 - 3.0
Other marine (wave & tidal)	70	450	Small	>20	3.0 - 6.0
Energy crops	70	200	3	10	2.5 - 4.0
Solar photovoltaics	520	1250	<1	>20	10 – 16
Nuclear	70	200	7	>20	3.0 - 4.0
Carbon sequestration	80	280	Small	>20	3.0 - 4.5

Source: Adapted from Performance and Innovation Unit, *The Energy Review*, February 2002

Table 4 Energy Saving Potential

Sector	Potential energy saving (Mtoe)	Per cent	Financial (£m)
Domestic	17.4	37.2 %	5,000
Service	3.8	21.0 %	1,190
Industry	8.6	23.8 %	1,380
Transport	19.3	35.0 %	4,700
Total	**49.1**	**31.4 %**	**12,300**

Source: Adapted from Performance and Innovation Unit, *The Energy Review*, February 2002

WWF Position

Action on energy efficiency should focus on the domestic sector. This is the sector with most potential to save energy and where there are few existing measures, except those aimed predominantly at the fuel poor. It is a sector that to date been the most difficult to address. Energy prices are only a small proportion - about 3 per cent – of average household expenditure,

giving very little incentive for consumers to focus on reducing their energy use. Whilst some kind of taxation on domestic energy would help to incentivise the uptake of energy efficiency measures, it would have to be levied at a very high level to make any real difference to energy consumption. Rising prices on their own will not be enough to harness the energy efficiency potential in the domestic sector other policies and measures will also be required. WWF believes the following measures should be introduced:

- Better information to consumers on the life cycle energy costs of electrical appliances at the point of sale
- Tighter building regulations. Energy efficiency standards in the current building regulations are still less stringent those of a number of other European countries and technologies exist now to build houses that have near zero requirements for space heating and are zero emission.
- Fiscal incentives should be introduced to favour the most efficient appliances and houses (through the reduction of VAT, reduction of stamp duty and preferential mortgages)
- The current '28 day' regulations that are a barrier to the establishment of energy services should be removed.

Whilst the focus of energy efficiency measures should be on the domestic sector action, there will need to be continued action in other sectors of the economy. WWF believes these should include:

- Annual increase in the Climate Change Levy.
- Re-negotiation of the Climate Change Levy agreements at the 2003 review to ensure they deliver truly additional efficiency measures in return for the 80 per cent discounts.
- Targeted information to SMEs to allow them to respond to increased energy prices as a result of the climate change levy.

Renewable Energy

Numerous studies have looked at the potential for renewable energy to be used in electricity generation and the results of these studies show that the UK could generate a large proportion of its electricity from renewable energy. The most recent analysis was undertaken as part of the PIU Energy Review, the results of which are shown in Table 5. To put the figures into context, it is expected that by 2010 around 390 TWh of electricity will be supplied.

These figures show that renewable energy could, by 2025, provide anything up to 70 per cent of the UK's electricity, although this would incur a cost of around 7p/kWh compared to a current electricity price of around 2.5 p/kWh. However the figures do show that even at lower prices, a substantial quantity of electricity could be produced from renewables. This highlights the unambitious nature of current government targets

The government currently has a target that by 2010 10 per cent of electricity supplied be generated by renewable technologies. The cost of meeting this target will be passed on to consumers and to ensure that the costs to consumers are not excessive the price at which this target can be met has been capped at around 5.5 p/kWh[5] (this is expected to increase prices to

[5] The 'cap' is 3p/kWh above the base price of electricity which is currently around 2.5 p/kWh

consumers by about 4.5 per cent). If it is achieved, the 10 per cent target will result in around 39 TWh of renewable electricity being supplied.

Table 5 Costs and potential of different renewable energy technologies

Technology	Electricity generated (TWh/yr)			
	2.5 p/kWh	3 p/kWh	5 p/kWh	7 p/kWh
Agriculture and Forestry residues	1	3	19	19
Energy crops	0	5	33	33
Landfill gas	2	7	7	7
Municipal solid waste	3	4	6	7
PV	0	0	0	0.5
Tidal	< 1	1	1.4	2
Wave	0	0	33	33
Onshore Wind	10	45	57	57
Offshore Wind	35	98	100	100
Total Renewable Potential	**51**	**163**	**257**	**258**

Source: Adapted from Performance and Innovation Unit, *The Energy Review*, February 2002

The PIU Energy Review recommended that the renewables target is extended beyond 2010 by an additional 39 TWh to 2020, estimated to be equivalent to a further 10 per cent increase. This means that renewables would provide some 78 TWh (around 20 per cent) of electricity by 2020. The Energy Review expects that achieving such a target would raise prices to consumers by around 5-6 per cent.

Which Renewable Technologies?

There is much discussion and confusion as to which technologies should be classified as renewable and gain the benefit of Government support. In the UK there are currently four different classifications of renewable technologies – the Climate Change Levy classification which includes energy from waste but excludes large Hydro; the classification under the Renewables Obligation which includes energy from waste under certain conditions (only the organic fraction and only using advanced technologies) and includes new or refurbished large hydro; the classification under the EST's Future Energy scheme which includes energy from waste with no conditions attached and refurbished large Hydro; and the EU definition which includes Energy from Waste under different criteria again (waste incineration must not undermine policies to reduce waste and increase recycling). It is clear that these definitions must be harmonised to remove any confusion as to what qualifies as a renewable technology and to ensure that support only goes to the truly renewable technologies.

WWF classifies the following technologies as renewable: onshore wind, offshore wind, biomass (including energy crops, forestry and agriculture residues, wood waste), solar (photovoltaics and

thermal), hydro, wave and tidal (excluding barrages), landfill and sewage gas (based on anaerobic digestion).

WWF does not consider energy from the incineration of municipal waste to be a renewable technology.

WWF Position

The above analysis shows that the current UK government targets for renewable energy are well below the identified cost-effective potential. Long-term targets must be set that reflect this identified potential. WWF believes that the aim should be for at least 200 TWh of the UK's electricity to come from renewables by 2050. What proportion of total electricity supplied this will be is uncertain and depends largely on the success of an energy efficiency programme but could be as much as 70 per cent. As with energy efficiency, quantifying the carbon reduction of achieving such a target is difficult but it has been indicated that a contribution of 40 per cent renewables to the current electricity generation mix would deliver about 13 MtC in CO_2 reductions.

Achieving this target is clearly feasible but will also require additional action to remove the current barriers to the development of renewable energy. These include:

- Relieving the problems caused by the New Electricity Trading Arrangements (NETA
- Relieving some of the planning constraints. WWF does not believe that the planning system itself is wrong but that there are actions can be taken to smooth the passage of renewables through the system. These include setting regional renewable energy targets, as well as greater public understanding of the issues surrounding energy choices and the links between energy and climate change.
- Improving the network access conditions particularly for small scale generation

Combined Heat and Power (CHP)

Combined Heat and Power generation, where heat and electricity are produced together, dramatically increases the efficiency of electricity and heat production and therefore has a role to play in reducing emissions from electricity generation. Table 3 shows that CHP could contribute reductions in the region of 10 MtC by 2050. Other modelling has suggested that CHP could reach that level by 2020 if development is accelerated through specific policy support. CHP has the potential to be used both at a large scale on industrial sites that have a large demand for heat, and at a domestic scale where it can replace the standard household boiler. It is in the domestic application that most potential is seen.

WWF Position

WWF supports the development of CHP as a means of reducing emissions in energy generation (specifically electricity). However, CHP is currently suffering major problems in the market due to a number of factors, including the current high gas price and low electricity price, and the impact of NETA which is resulting in many proposed projects being put on hold or suspended altogether. Unlike renewables, which has a renewable obligation to support it – thus ensuring that suppliers will find a way of solving many of the problems with its development, CHP has no such support mechanism and unless the government gives additional support to CHP, the market will collapse. WWF supports the recent announcement that all electricity exports from

qualifying CHP plants will be exempt from the Climate Change Levy. This measure, on its own, will not be enough on its own to adequately support the development of CHP and in addition the following mechanisms should be introduced:

- Power station consents process that promotes CHP as standard
- Building regulations that require the use of CHP boilers
- Introduction of a CHP Obligation

CHP will also benefit from changes to NETA and improved access to the electricity grid already discussed.

Nuclear Energy

The figures above indicate that nuclear energy does not provide any economic benefits over those of other technologies. Its costs both in terms of per unit of electricity supplied and per tonne of carbon reduced are no lower, and in many cases are much higher, than those of renewables, energy efficiency and CHP.

WWF Position

WWF believes that nuclear power cannot be viewed as a sustainable technology due to the high risks to the environment and human health associated with its operation. The electricity gap created by the closure of the UK's nuclear capacity can be more than covered by energy efficiency, renewables and CHP. WWF believes the government should rule out the future development of nuclear energy as an electricity generation technology and focus on the development of truly sustainable technologies [6].

Carbon Removal and Disposal

This technology involves removing the CO_2 from fossil fuels before it is released into the atmosphere and 'locking it up' in deep repositories. One method of sequestration is to use the CO_2 to aid oil recovery by pumping it into oil wells thus releasing more oil and storing the CO_2. It is being seen as a method of allowing the continued use of fossil fuelled generation, particularly coal, whilst still reducing emissions. The costs of the technology are high and there are huge uncertainties surrounding its feasibility, particularly the permanence of the stored carbon

WWF Position

WWF is concerned about the high risks, costs and uncertainties associated with carbon removal and disposal. In WWF's view, other options for emission reductions, in particular energy efficiency and renewables need to be prioritised.

[6] Full details of WWF-UK's policy on Nuclear Energy can be found in WWF-UK, *WWF-UK Policy on Nuclear Energy,* July 2002.

Conclusion

WWF's analysis shows that UK can move to low carbon technologies at low cost and make dramatic reductions in CO_2 emissions without the need to rely on nuclear or ‘cleaned up’ fossil fuel technologies. If these potentials are to be realised, government needs to put its support behind these sustainable technologies.

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