Annex 1B
Low carbon technologies

Introduction

1B.1 Energy is big business. The energy industries' output of over £30 billion per year contributes 3.2 per cent of GDP and the industries directly employ 136,000 people. An increasing part of that output comes from low carbon sources such as renewables. Minimising the environmental impact of the production, distribution and use of fuels is a big challenge. This annex considers the growth of environmentally friendly technologies and their contribution to the reduction of environmental impacts driven by the use of energy.

1B.2 Two technologies that are making a growing contribution to the reduction of carbon emissions from the UK economy are renewable energy sources and Combined Heat and Power. Between 1990 and 2005, the use of renewable sources to generate both heat and electricity has increased by a factor of four. Over the same period, CHP capacity for electricity has also more than doubled.

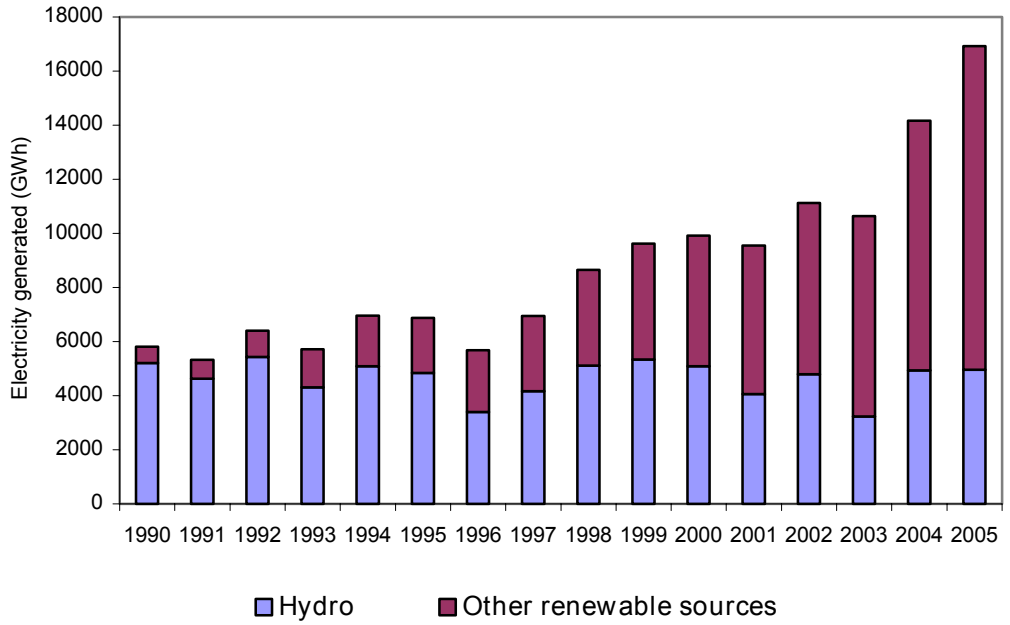
Renewables

1B.3 Renewable fuels are those that are continuously available and sustainable in our environment, such as wind and solar energy. In particular, they emit no greenhouse gases or are emissions neutral over their life cycle, for example energy crops.

1B.4 Electricity generation from renewable sources went up by 191 per cent between 1990 and 2005, and electricity generated by non-hydro renewables increased by a factor of almost 20 - see Chart 1B.1. Renewable sources were used to generate 4.2 per cent of all UK electricity produced in 2005.

1B.5 This has resulted in substantial savings in carbon and other emissions that would have resulted from more conventional forms of generation. Estimates of this saving in carbon emissions depend on assumptions about how the electricity would otherwise have been generated. The Government has a target of 10 per cent of electricity supplied coming from renewable sources by 2010 and, on this basis, annual carbon savings will then be of the order of 2.5 MtC each year if the equivalent were generated from gas.

Chart 1B.1 Electricity generated by renewable sources, 1990 to 2005



Source: DTI

1B.6 The growth in the use of renewables to generate electricity has been encouraged by Government policies. The Government's 2003 Energy White Paper 'Our energy future – creating a low carbon economy' confirmed a clear strategy for the future based on the growth of renewable fuel sources. It also indicated an aspiration by 2020 to double renewables' share of electricity from the 2010 target.

1B.7 The UK's renewables policy consists of four keys strands to support the target. Firstly, from 1 April 2002, the Renewables Obligation (RO) for England and Wales and the corresponding Obligation for Scotland place a requirement on all electricity suppliers to supply a specific and increasing proportion of their electricity from eligible renewable energy sources. The Governments target is 10 per cent for 2010. After that the Government plans to extend the level of the RO so it remains above the level of renewables actually installed, up to a 20 per cent obligation. An obligation for Northern Ireland was also introduced on 1 April 2005. Secondly, the electricity generated from renewable sources is exempt from the Climate Change Levy. Thirdly, Government has made available around £500m of spending for low carbon renewable technologies through research and development, with further funding from the Environmental Transformation Fund set up in June 2006 and, fourthly, a strategic regional approach is being taken to planning and setting targets for renewables.

Table 1B.1 Electricity generated from renewable sources, 1990 to 2005

GWh

Year	Wind [1]	Large-scale hydropower	Small-scale hydropower	Biofuels	Total amount of electricity generated
1990	9	5,080	127	595	5,812
1991	9	4,482	142	688	5,320
1992	33	5,282	149	934	6,398
1993	217	4,143	159	1,198	5,717
1994	344	4,935	159	1,519	6,956
1995	392	4,672	166	1,642	6,871
1996	488	3,275	118	1,805	5,685
1997	667	4,005	164	2,096	6,945
1998	877	4,911	206	2,626	8,648
1999	851	5,128	207	3,395	9,616
2000	947	4,871	214	3,796	9,914
2001	967	3,845	210	4,493	9,549
2002	1,256	4,584	204	5,047	11.127
2003	1,256	3,113	115	6,133	10,638
2004	1,736	4,645	282	7,302	14,171
2005	2,908	4,494	467	9,042	16,919

[1] Includes 1 GWh of solar photo voltaics in 1999 and 2000 and 2GWh of solar photo voltaics in 2001.

1B.8 Table 1B.1 shows how much electricity has been generated by each renewable source since 1990. Up until 2000, hydroelectric plants generated the largest share of electricity from renewables. Hydropower is generated by direct action of water on turbines that drive electricity generators. The rivers and reservoirs that provide the head of water needed for hydro schemes are mainly located in Scotland and Wales. The amount of electricity generated from large-scale hydro sources varies each year according to the amount of water available. On average since 1990 around 4,600 GWh per year has been generated but the amount varied substantially from year to year with the lowest output (3,113 GWh) recorded in 2003 and the highest (5,282 GWh) in 1992. Large-scale hydro schemes are defined as those belonging to companies with an aggregate hydro capacity of 5 MWe or over.

1B.9 There has been a large increase in the electricity generated by wind power from a very low level in 1990. Wind power accounted for 1.9 per cent of the UK's total generating capacity in 2005 and 0.7 per cent of total electricity output. Most of the wind power came from onshore sites – these produced 2,505 GWh out of the total of 2,908 GWh of electricity generated from wind power in 2005.

1B.10 The first onshore wind farm connected to the National Grid was completed at Delabole in Cornwall in 1991. Onshore sites are mostly located in lightly populated upland areas of the country and are concentrated in Northern Ireland, Scotland, Wales, the North of England, Cornwall and a few sites along the East Coast of England. The number of turbines varies at different sites, though more recent installations tend to have larger, more efficient turbines, which generate electricity at lower unit cost. Most have a capacity of around 1 MW, although new wind farms may have much larger turbines of 2 MW or more.

1B.11 Offshore facilities in the UK are still at an early stage of development. The first offshore site was established at Blyth in 2000, operating with two 1.9 MW turbines, whilst Britain's first major offshore site at North Hoyle, off North Wales, went online in 2003. Total offshore capacity was 214 MW at the end of 2005. There is huge potential for the further exploitation of offshore wind - the European offshore resource is very large and some of the windiest offshore areas are concentrated in the northern section of the North Sea, along the Atlantic coast of the British Isles. The UK's wind resource is estimated to be around half the European total.

1B.12 The growth of wind power in the 1990's was encouraged, like other renewables, through the implementation of a programme of assessment and financial support to renewable industries and the implementation of the Non Fossil Fuels Obligation (NFFO) in England and Wales, the NI NFFO in Northern Ireland and the Scottish Renewable Order (SRO) in Scotland. The NFFO was a competitive scheme aimed at creating an initial market, so that the most promising fuels would be able to survive in a competitive market place without long-term financial support. The Renewables Obligation (RO) has now replaced NFFO as the main instrument of financial support to the renewable industry. Electricity generated from renewables in 2005 was three times that in 2001, the last year before the RO came into place.

1B.13 One half of electricity generated from renewables in 2005 came from biofuels. This term covers two categories of renewables: biomass and biogases. Biomass materials include trees and grass crops (such as willow and miscanthus) and forestry, agricultural and urban waste that can be burnt to produce energy. Grants are available to establish energy crops. The main biogas is methane produced from landfill sites and sewage plants. Burning the methane can generate energy from waste and, at the same time, reduce the amount of methane, a powerful greenhouse gas, in the atmosphere. A significant development in 2000 was the opening of the world's largest straw fired power station in Cambridgeshire.

1B.14 Unlike other renewables, biofuel energy does release carbon dioxide into the atmosphere; in the case of plant materials, it is only returning to the atmosphere

carbon dioxide that was removed through photosynthesis during the plant's lifetime. Burning fossil fuels, by contrast, returns carbon dioxide to the atmosphere that has been locked away in the Earth's crust for millions of years.

Table 1B.2 Renewable energy sources used to generate heat, 1990 to 2005

Thousand tonnes of oil equivalent

Year	Biofuels					Other	Total
	Landfill gas	Sewage sludge digestion	Wood combus-tion – industrial	Munici-pal solid waste combus-tion [1]	Other biofuels	Solar and geother-mal	
1990	34.2	34.6	-	31.1	246.0	7.2	353.1
1991	36.3	43.5	-	33.5	246.0	7.6	366.9
1992	31.5	43.5	-	30.8	276.1	7.9	389.9
1993	15.0	34.0	236.8	28.2	276.1	8.2	598.3
1994	18.9	52.1	455.1	29.5	276.1	8.5	840.3
1995	15.1	58.5	498.1	30.5	276.2	8.9	887.3
1996	16.6	58.5	505.5	31.9	276.2	9.5	898.1
1997	15.5	58.2	506.1	9.0	276.2	9.7	874.6
1998	13.6	54.1	436.9	15.2	276.4	9.9	805.9
1999	13.6	54.2	367.7	20.2	276.4	10.2	742.3
2000	13.6	48.3	220.8	24.7	276.4	11.9	595.6
2001	13.6	49.4	195.6	26.2	276.4	14.0	575.2
2002	13.6	53.4	195.6	33.7	276.4	16.9	589.7
2003	13.6	52.5	195.6	33.7	276.4	20.6	592.5
2004	13.6	52.5	195.6	33.7	278.1	25.4	598.9
2005	13.6	48.0	80.9	33.7	278.1	30.2	484.5

[1] Biodegradable part only.

1B.16 Biofuels were promoted through the NFFO, until the Renewables Obligation superseded the NFFO on 1 April 2002. Under the RO electricity generation plant fired by a fuel supply of 90 per cent or more (by calorific value) biodegradable material is eligible for the Renewable Obligation, regardless of the energy conversion technology used.

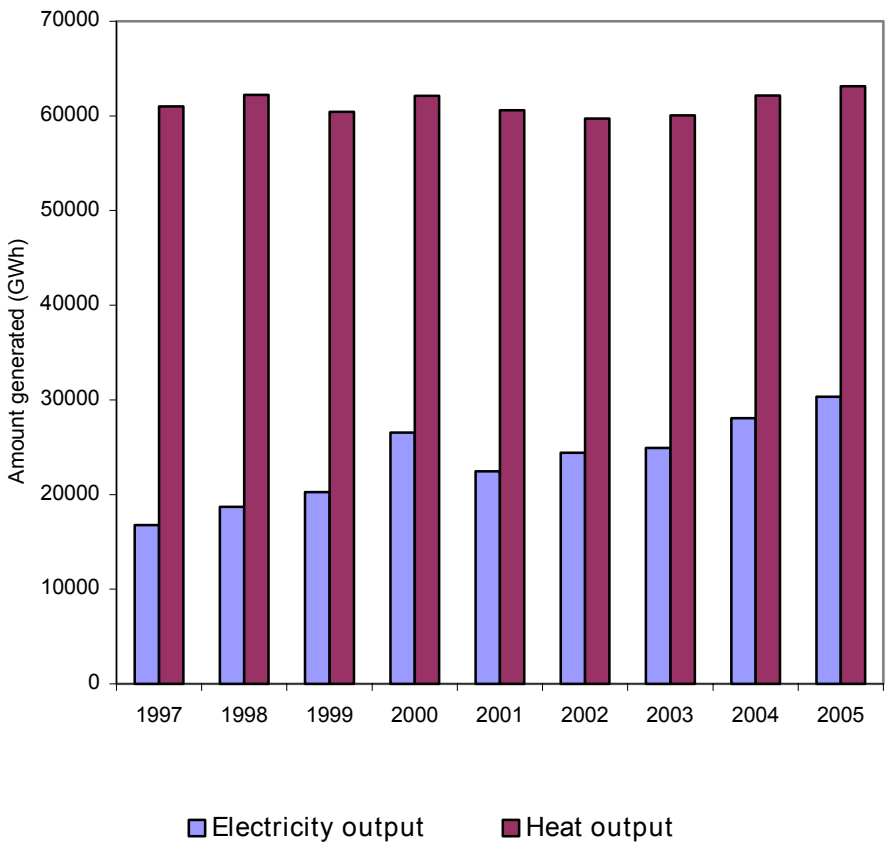
1B.15 As well as constituting more than a half of electricity generated from renewable sources, biofuels are also used to generate heat, as the table above shows. There are also small amounts of heat sourced from active solar heating and geothermal aquifers. Active solar heating can be used in the domestic sector as a water heating mechanism. It is also used to heat swimming pools and for some other applications. Passive solar energy is used in almost all buildings to save energy because windows or transparent roofs allow in natural light, which reduces use of energy for lighting. Geothermal aquifers contain hot water at depths of between 1,500 metres and 3,000 metres below the surface. If this water is pumped to the surface it can be used in community heating schemes

Combined Heat and Power

1B.17 Combined heat and power (CHP) is the simultaneous generation of usable heat and power in a single process. Whereas an electricity-only plant is typically large, and connected at very high voltage to the grid transmission system, a CHP plant is typically much smaller, sized to make use of the available heat, and connected to the lower voltage distribution system. Not only is CHP more efficient through utilisation of heat that might otherwise be wasted, it also avoids significant transmission and distribution losses.

1B.18 CHP usually displaces boiler plant and electricity-only plant using a range of technologies. CHP typically achieves a 25 to 35 per cent reduction in primary energy usage compared with electricity-only generation and heat-only boilers. This can allow the host organisation to make substantial savings in costs and emissions where there is a suitable heat load.

Chart 1B.2 Electricity and heat output of CHP schemes, 1997 to 2005

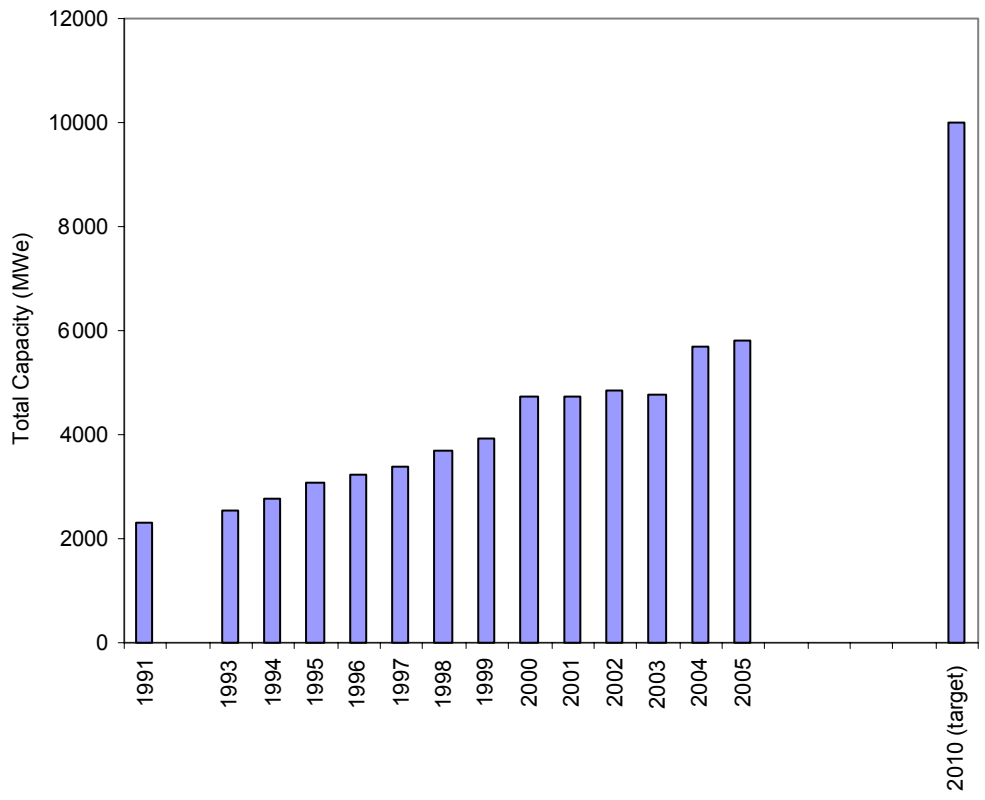


Source: DTI

1B.19 Chart 1B.2 shows the change in the electricity and heat output of CHP schemes between 1997 and 2005. Whereas the heat generated from CHP has remained approximately the same over this period, electricity output has grown significantly. The rise up to 2000 reflected the liberalisation of the electricity markets, which gave a strong incentive to design schemes to maximise electricity generation for a given heat load. However, following the introduction of the New Electricity Trading Arrangements (NETA) in March 2001, the price of electricity fell, including the price of electricity exported from CHP plant. This led to a decline in investment in new plant and, between 2000 and 2001, to a decline in electrical output from existing plants too. Since then though, electricity output has risen again and in 2005 exceeded the 2000 level by 14 per cent.

1B.20 CHP accounted for 6.9 per cent of electricity generated in 2005 which, given the fuel efficiency of CHP plants, delivered substantial savings in carbon emissions compared with what would have been emitted if electricity-only plant and boilers had been used to deliver the same amount of heat and electricity output that CHP plants produced. Estimates of these savings depend on the assumptions about the nature of electricity-only plant that has been displaced by CHP. Estimates of these savings may be found in the June 2003 issue of Energy Trends.

Chart 1B.3 Installed capacity of CHP plants



Source: DTI

1B.21 Given the environmental benefits that CHP delivers, the Government has set a UK target of at least 10,000 MWe of installed Good Quality CHP by 2010. Good Quality CHP capacity was 5,791 MWe at the end of 2005. To support CHP and help reach the target, the Government has introduced a range of policies to encourage its development. These include Climate Change Levy (CCL) exemption for Good Quality CHP fuel inputs and all CHP electricity outputs; Enhanced Capital Allowances (ECAs) to stimulate investment; reducing the VAT rate to all domestic CHP appliances; and a target for Government departments to source 15 per cent of their electricity from CHP by 2010. In its Climate Change Programme, the Government announced that it will introduce a further two measures to support CHP. These were that the treatment of CHP will be fully considered in the UK's National Allocation Plan for the second phase of the EU Emissions Trading Scheme and that the Renewable Obligation Certificates will be extended to include mixed waste plants that use Good Quality CHP. The Government's Energy Review set out further proposals on climate change, by encouraging planners and local authorities to use distributed energy generation for new developments. Chart 1B.3 shows the growth in CHP capacity since 1990.

Micro-CHP

1B.22 Micro-CHP unit acts like a normal domestic high efficiency boiler providing heat and hot water, but also simultaneously drives a generator producing electricity that displaces power drawn from the grid. Government supports the development of this new technology and the potential it offers for significant energy savings. For example, in the March 2005 Budget, the Chancellor announced a reduction in VAT for micro-CHP. The Government's CHP strategy published in April 2004 recognised that micro-CHP had the potential to contribute 300-500 MW towards the overall CHP target of 10 GW by 2010. However, deployment of Micro-CHP units so far is at a low level. The Government announced plans to encourage councils to promote microgeneration and remove planning applications for householders installing new equipment in the Energy Review.

1B.23 The Government commissioned a study from the Energy Saving Trust to predict future take-up, costs and benefits of microgeneration technologies. This study suggested that 30-40% of the UK's electricity demands could be met through microgeneration technologies with Micro-CHP leading the way.

Sources/further reading:

Digest of UK Energy Statistics 2006, DTI
http://www.dti.gov.uk/energy/statistics/publications/dukes/page29812.html

Energy White Paper 2003 – 'Our energy future – creating a low carbon economy'
http://www.dti.gov.uk/energy/policy-strategy/energy-white-paper/page21223.html

Second annual report on the implementation of the Energy White Paper – July 2005
http://www.dti.gov.uk/energy/policy-strategy/energy-white-paper/second-annual-report/page21420.html

Energy Review - July 2006
http://www.dti.gov.uk/energy/review/page31995.html

Micro generation Strategy
http://www.dti.gov.uk/energy/sources/sustainable/microgeneration/strategy/page27594.html

Renewables for power generation, IEA
http://www.iea.org/textbase/nppdf/free/2000/renewpower_2003.pdf

Ofgem Environmental action plan, annual review 2003/04
http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/7626_14704.pdf

The Government's Strategy for Combined Heat and Power to 2010, 2004, Defra
http://www.defra.gov.uk/environment/energy/chp/pdf/chp-strategy.pdf

Useful websites:

DTI: **http://www.dti.gov.uk/**

DEFRA: **http://www.defra.gov.uk**

BWEA: **http://www.bwea.com/index.html**