Chapter 7
Renewable sources of energy

Introduction

7.1 This chapter provides information on the contribution of renewable energy sources to the United Kingdom's energy requirements. It includes sources that under international definitions are not counted as renewable sources or are counted only in part. This is to ensure that this Digest covers all sources of energy available in the United Kingdom. However, within this chapter the international definition of total renewables is used and this excludes non-biodegradable wastes. The energy uses of wastes are still shown in the tables of this chapter but as "below the line" items. This chapter covers both the use of renewables to generate electricity and the burning of renewable fuels to produce heat either in boilers (or cookers) or in combined heat and power (CHP) plants. This year the coverage of liquid biofuels for transport has also been extended and data included in the Commodity balances (Tables 7.1 to 7.3) and the use of renewables table (Table 7.6).

7.2 The data summarise the results of an ongoing study undertaken by the AEA on behalf of the Department for Business, Enterprise and Regulatory Reform (BERR) to update a database containing information on all relevant renewable energy sources in the United Kingdom. This database is called RESTATS, the Renewable Energy STATisticS database.

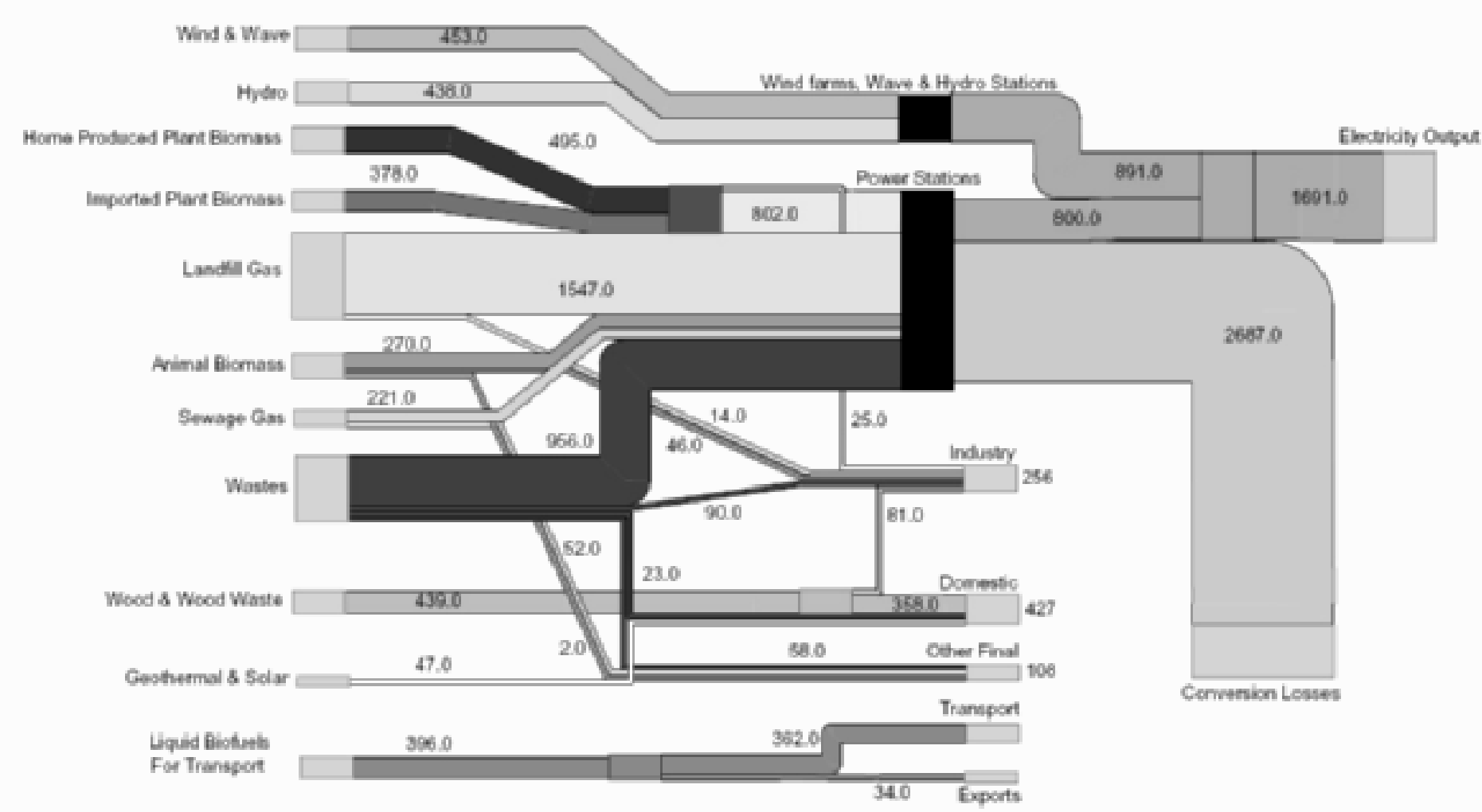
7.3 The study started in 1989, when all relevant renewable energy sources were identified and, where possible, information was collected on the amounts of energy derived from each source. The renewable energy sources identified were the following: active solar heating; photovoltaics; onshore and offshore wind power; wave power; large and small scale hydro; biomass (both plant and animal based); geothermal aquifers. The technical notes at the end of this chapter define each of these renewable energy sources. The database now contains 19 years of data from 1989 to 2007.

7.4 The information contained in the database is collected by a number of methods. For larger projects, an annual survey is carried out in which questionnaires are sent to project managers. For technologies in which there are large numbers of small projects, the values given in this chapter are estimates based on information collected from a sub-sample of the projects. Further details about the data collection methodologies used in RESTATS, including the quality and completeness of the information, are given in the technical notes at the end of this chapter.

7.5 An energy flow chart for 2007, showing the flows of renewables from fuel inputs through to consumption, is included for the first time, overleaf. This is a way of simplifying the figures that can be found in the commodity balance for renewables energy sources in Table 7.1. It illustrates the flow of primary fuels from the point at which they become available from home production or imports (on the left) to their eventual final uses (on the right) as well as the energy lost in conversion.

7.6 Commodity balances for renewable energy sources covering each of the last three years form the first three tables (Tables 7.1 to 7.3). Unlike in the commodity balance tables in other chapters of the Digest, Tables 7.1 to 7.3 have zero statistical differences. This is because the data for each category of fuel are, in the main, taken from a single source where there is less likelihood of differences due to timing or measurement. These balance tables are followed by 5-year tables showing capacity of, and electricity generation from, renewable sources (Table 7.4), and generation from sources eligible for the Renewables Obligation (RO) and sources qualifying under the Renewables Directive (RD) (Table 7.5). Table 7.6 shows renewable sources used to generate electricity and heat in each of the last five years. A long-term trends commentary and table (Table 7.1.1) covering the use of renewables to generate electricity and heat is available on BERR's energy statistics web site and accessible from the Digest of UK Energy Statistics home page: www.berr.gov.uk/energy/statistics/publications/dukes/page45537.html.
Also available on the web site is Table 7.1.2 summarising all the renewable orders made under the Non Fossil Fuels Obligation (NFFO), Northern Ireland Non Fossil Fuels Obligation, and Scottish Renewables Orders (SRO) along with descriptive text.

Renewables flow chart 2007 (thousand tonnes of oil equivalent)



Notes:
This flow chart is based on data that appear in Tables 7.1 and 7.4

Renewables Obligation and Renewables Directive

7.7 In April 2002 the Renewables Obligation (RO) (and the analogous Renewables Obligation (Scotland)) came into effect[1]. It is an obligation on all electricity suppliers to supply a specific proportion of electricity from eligible renewable sources. Eligible sources include all those covered by this chapter but with specific exclusions. These are: existing hydro plant of over 20 MW; all plant using renewable sources built before 1990 (unless re-furbished and less than 20 MW); and energy from mixed waste combustion unless the waste is first converted to fuel using advanced conversion technology. Only the biodegradable fraction of any waste is eligible (in line with the EU Directive, see paragraph 7.8, below). All stations outside the United Kingdom (the UK includes its territorial waters and the continental shelf) are also excluded. The upper part of Table 7.5 shows all the components of total electricity generation on an RO basis. Strictly speaking until 2005, the RO covers only Great Britain, but in these UK based statistics Northern Ireland renewable sources have been treated as if they were also part of the RO.

7.8 The European Union's Renewables Directive (RD) (which came into force in October 2001) uses the same "international definition" as is used elsewhere in this chapter (in that it excludes non-biodegradable wastes). In 2006 the European Commission clarified its definition and confirmed that imports of electricity generated from renewable sources cannot be included, although such imports will be part of the overall consumption of electricity in the UK which forms the denominator in the calculation of the Renewables Directive percentage (see paragraph 7.12, below). AEA has estimated the percentage of municipal solid waste (MSW) that was non-biodegradable for all the years in the RESTATS database. For 2007 the estimate is the same as in earlier years, namely that 37½ per cent of MSW was non-biodegradable as were all of waste tyres (but see paragraph 7.72) and hospital waste. The lower part of Table 7.5 shows the components of total electricity generation on an RD basis.

7.9 Prior to 2002 the main instruments for pursuing the development of renewables capacity were the NFFO Orders for England and Wales and for Northern Ireland, and the Scottish Renewable Orders. In this chapter the term "NFFO Orders" is used to refer to these instruments collectively. For projects contracted under NFFO Orders in England and Wales, the Non Fossil Purchasing Agency (NFPA) provided details of capacity and generation. The Scottish Executive and Northern Ireland Electricity provided information on the Scottish and Northern Ireland NFFO Orders, respectively. Statistics of these Orders can now be found on the BERR energy web site (see paragraph 7.6, above).

Renewables Targets

7.10 Since February 2000, the United Kingdom's renewables policy has consisted of four key strands:

- a new RO on all electricity suppliers in Great Britain to supply a specific proportion of electricity from eligible renewables, introduced in April 2002;
- exemption of electricity from renewable sources[2] from the Climate Change Levy, introduced from April 2001;
- an expanded support programme for new and renewable energy including capital grants and an expanded research and development programme; and
- development of a regional strategic approach to planning and targets for renewables.

The RO is part of the UK's programme to tackle climate change and to encourage a more sustainable approach to energy consumption. Previous policy has been successful in introducing renewables to the UK marketplace and in reducing costs. The focus of current policy is to build on these achievements through the Obligation and a system of capital grants designed to bring forward offshore wind and energy crops, thereby maximising the chances of meeting the Government's targets.

7.11 The EU Directive of October 2001 proposed that Member States adopt national targets for renewables that are consistent with reaching the overall EU target of 12 per cent of energy (22.1 per cent of electricity) from renewables by 2010. The UK "share" of this target is that renewables sources

[1] *Parliamentary approval of the Renewables Obligation Orders under The Utilities Act 2000 was given in March 2002.*

[2] *Electricity generated by hydro stations with a declared net capacity of more than 10 MW is not exempt from the Climate Change Levy.*

eligible under the RD should account for 10 per cent of UK electricity **consumption** by 2010. In March 2007 the European Council agreed to a common strategy for energy security and tackling climate change. An element of this was establishing a target of 20 per cent of EU's energy to come from renewable sources. In January 2008 the European Commission published proposals for each Member State's contribution to the EU target. The Commission's proposal was that the UK by 2020 15 per cent of final energy consumption should be accounted for by energy from renewable sources (see paragraph 7.13, below).

Table 7A: Percentages of electricity derived from renewable sources

	2005	2006	2007
Overall renewables percentage (international basis)	4.25r	4.54r	4.96
Percentage on a Renewables Obligation basis	4.01r	4.44r	4.88
Percentage on a Renewables Directive basis	4.17r	4.46r	4.90

7.12 Chart 7.3 shows the growth in all sources of renewables generation since 1990 and Table 7A gives renewables shares on three different bases for the three most recent years. They show progress towards the RO and RD targets. Generation from all renewables in the UK (on the international definition basis) accounted for 4.96 per cent of UK electricity generation in 2007. In 2007 the RO percentage rose by 0.44 percentage points to 4.88 per cent of electricity sales by licensed suppliers. On the basis used for the Renewables Directive, the percentage of UK electricity consumption accounted for by RD eligible renewable sources rose from 4.46 per cent in 2005 to 4.90 per cent in 2007. The increases in all three percentages shown in Table 7A are mainly due to growth in the numerators (ie the renewables element) but the small declines in the respective denominators have also played a part. The overall percentage of electricity generation in 2007 fell by 0.6 per cent, while for the RO percentage there was a fall of 0.4 per cent in electricity sales by licensed suppliers. For the RD basis electricity consumption fell by 1.1 per cent in 2007.

7.13 An article published in the March 2008 Energy Trends (see Annex C for further information about Energy Trends) compared current and proposed target levels of the share of renewable energy in total final energy consumption in each of the 27 EU Member States. Total final energy consumption in this article is on the basis favoured by Eurostat. It includes the use of electricity and heat (and other fuels used for heating) by final consumers, and the use of energy for transport purposes. This Eurostat definition of total final energy consumption (which is calculated on a net calorific value basis) also currently includes consumption of electricity by electricity generators, consumption of heat by heat generators, transmission and distribution losses for electricity, and transmission and distribution losses for distributed heat. In the UK, energy balances are usually published on a gross calorific value basis, but in order to facilitate comparisons with EU statistics the balances for 2004, 2005 and 2006 have been calculated on a net calorific value basis and are available at:
http://stats.berr.gov.uk/energystats/dukes1_1-1_3net.xls .

Table 7B: Percentages of energy derived from renewable sources

	2005	2006	2007
Percentage of final energy consumption (ie the basis proposed by Eurostat for the new Renewables Directive)	1.32	1.50	1.78
Percentage of primary energy demand (ie the basis previously quoted in this Digest)	1.77	1.88	2.04

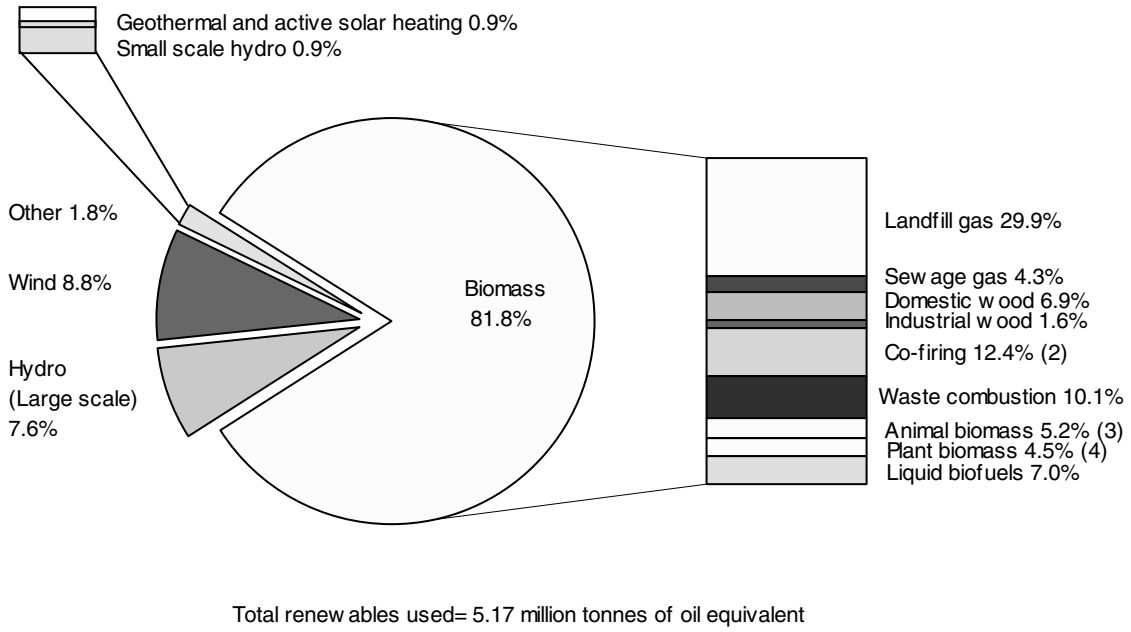
7.14 Table 7B shows that overall, renewable sources, excluding wastes and passive solar design (see paragraph 7.35), continues to increase and provided 2.0 per cent of the United Kingdom's total primary energy requirements in 2007. On the basis proposed by Eurostat, which measures renewables contribution relative to final energy consumption, the UK percentage rose by 0.28 percentage points in 2007 to 1.78 per cent. The primary energy demand basis produces higher percentages because thermal renewables are measured including the energy that is lost in transformation. The thermal renewables used in the UK are less efficient in transformation than fossil fuels and currently account for nearly half of electricity generation from renewables. As non-thermal renewables such as wind (which by convention are 100 per cent efficient in transformation) grow as a

proportion of UK renewables use, the final energy consumption percentage will overtake the primary consumption percentage.

Commodity balances for renewables in 2007 (Table 7.1), 2006 (Table 7.2) and 2005 (Table 7.3)

7.15 This year eleven different categories of renewable fuels are identified in the commodity balances. Some of these categories are themselves groups of renewables because a more detailed disaggregation could disclose data for individual companies. In the commodity balance tables the distinction between biodegradable and non-biodegradable wastes cannot be maintained for this reason. However, for this Digest the biomass category has been separated into animal based biomass, plant based biomass, and liquid biofuels for transport. To reduce confusion the term "biofuels" is now only used for liquid biofuels used for transport and "biomass" is used as the term to describe all fuels from biological sources. Liquid biofuels for transport were previously not included in these commodity balances. The largest contribution to renewables in **input** terms (82 per cent) is from biomass, with large-scale hydro electricity production and wind generation contributing the majority of the remainder as Chart 7.1 shows. For the first time in 2007 wind (with a 9 per cent share) contributed more than large scale hydro in primary input terms. Only 2 per cent of renewable energy comes from renewable sources other than biomass, wind and large-scale hydro. These include solar, small-scale hydro and geothermal aquifers.

Chart 7.1: Renewable energy utilisation 2007 (1)



(1) Excludes all passive use of solar energy and all non-biodegradable wastes. In this Chart renewables are measured in primary input terms – see paragraph 7.15.
(2) Biomass co-fired with fossil fuels in power stations; imported 7.3% of total renewables, home produced 5.1%
(3) 'Animal biomass` includes farm waste, poultry litter, and meat and bone combustion.
(4) 'Plant biomass' includes straw and energy crops.

7.16 79 per cent of the renewable energy produced in 2007 was transformed into electricity. This is a decrease from 83 per cent in 2006 and 85 per cent in 2005, because the use of biofuels for transport has grown faster than the use of renewables for electricity. While biomass appears to dominate the picture when fuel inputs are being measured, hydro electricity and wind power together provide a larger contribution when the output of electricity is being measured as Table 7.4 shows. This is because on an energy supplied basis (see Chapter 5, paragraph 5.27) hydro (and also wind, wave and solar) inputs are assumed to be equal to the electricity produced. For landfill gas, sewage sludge,

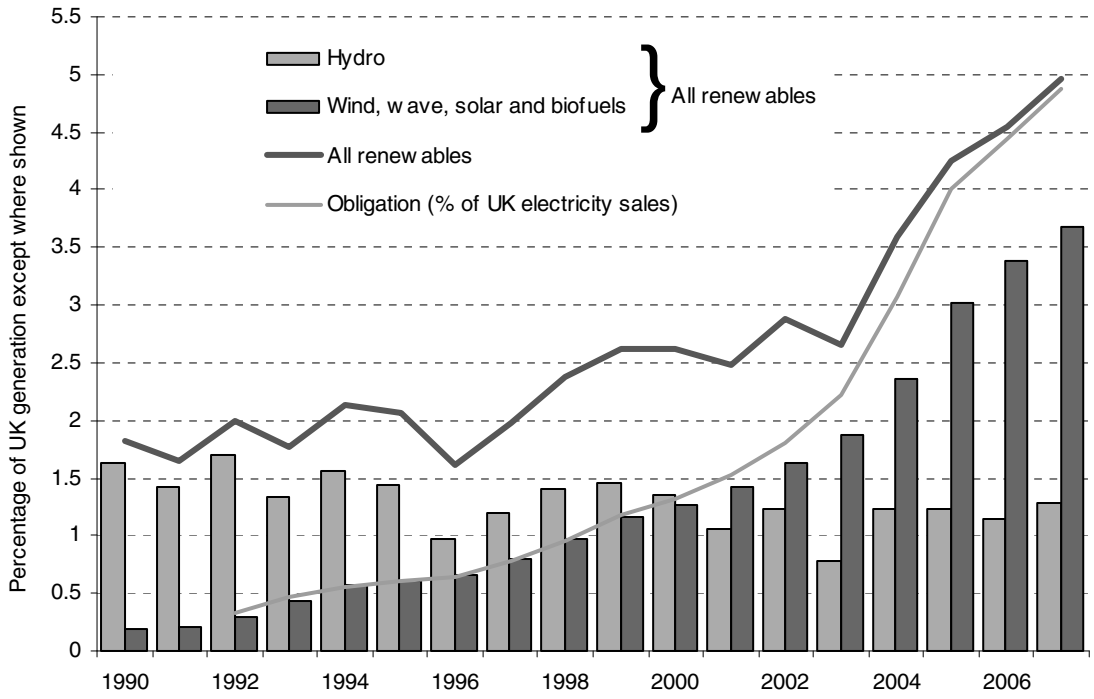
municipal solid waste and other renewables a substantial proportion of the energy content of the input is lost in the process of conversion to electricity as the flow chart (page 174, illustrates).

Capacity of, and electricity generated from, renewable sources (Table 7.4)

7.17 Table 7.4 shows the capacity of, and the amounts of electricity generated from, each renewable source. Total electricity generation from renewables in 2007 amounted to 19,664 GWh, an increase of 1,548 GWh (+8.5 per cent) on 2006. The main contributors to this substantial increase were 917 GWh from onshore wind (+26 per cent), 439 GWh from large scale hydro (+11 per cent), 253 GWh (+6 per cent) from landfill gas, 132 GWh (+20 per cent) from offshore wind, and 94 GWh (+9 per cent) from municipal solid waste combustion. There was a 572 GWh decrease in co-firing of biomass with fossil fuels (-23 per cent). The increase from large scale hydro was greater than the decrease recorded in 2006, which was attributable to drier weather and took hydro generation to a new record level. Even so, generation from wind (both onshore and offshore) overtook hydro to become the largest renewables technology in output terms, with both closely followed by landfill gas. Co-firing of biomass was the next most prominent. In 2007, 27 per cent of the electricity generated from renewables was from wind, 26 per cent was from hydro sources, 24 per cent from landfill gas, 10 per cent from co-firing, and 13 per cent from other biofuels.

7.18 As a result, all renewable sources provided 4.98 per cent of the electricity generated in the United Kingdom in 2007, 0.43 percentage points higher than in 2006. Chart 7.2 shows the growth in the proportion of electricity produced from renewable sources. It includes the progress towards the renewables targets set under the RO and RD (see paragraphs 7.10 to 7.14 above and 7.24 below).

Chart 7.2: Growth in electricity generation from renewable sources since 1990

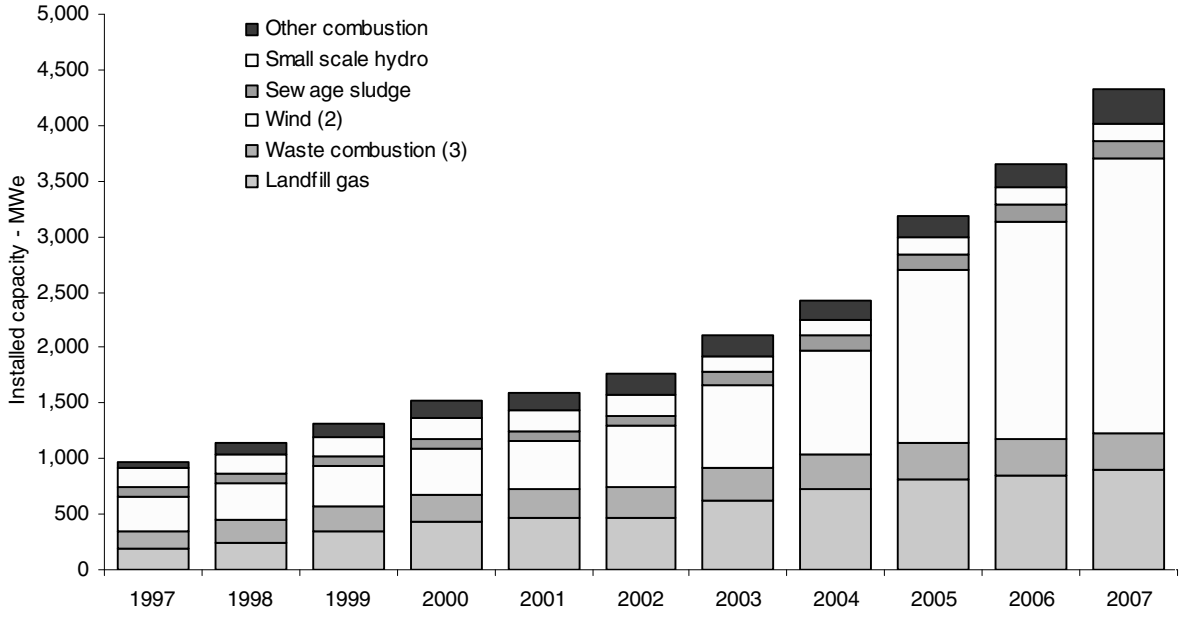


7.19 There was a 13 per cent increase (+665 MWe) in the installed generating capacity of renewable sources in 2007, mainly as a result of a 26 per cent increase (+433 MWe) in onshore wind capacity and a 30 per cent increase (+90 MWe) in offshore wind capacity. There was also a 5 per increase (+44 MWe) in the capacity fuelled by landfill gas and a 37 per cent increase (+83 MWe) in capacity fuelled by animal or plant biomass.

7.20 Chart 7.3 (which covers all renewables capacity except large scale hydro) illustrates the continuing increase in the electricity generation capacity from all significant renewable sources. This

upward trend in the capacity of renewable sources will continue as recently consented onshore and offshore windfarms and other projects come on stream.

Chart 7.3: Electrical generating capacity of renewable energy plant (excluding large-scale hydro)(1)



(1) Large scale hydro capacity was 1,359 MWe in 2007.
(2) Wind includes both onshore and offshore and also includes solar photovoltaics (14.3 MWe in 2007) and shoreline wave (0.5 MWe in 2007).
(3) All waste combustion plant is included because both biodegradable and non-biodegradable wastes are burned together in the same plant.

7.21 In 2007, (excluding large-scale hydro which largely pre-date the introduction of NFFO) 27 per cent of electricity from renewables was generated under NFFO contracts. If ex-NFFO sites (NFFO 1 and 2 in England and Wales) are included the proportion increases to 35 per cent. Table 7.4, however, includes both electricity generated outside of these contracts and electricity from large-scale hydro schemes, and thus reports on total electricity generation from renewables. All electricity generated from renewables is also reported within the tables of Chapter 5 of this Digest (eg Table 5.6).

7.22 Plant load factors in Table 7.4 have been calculated in terms of installed capacity and express the average hourly quantity of electricity generated as a percentage of the average capacity at the beginning and end of the year. In the past the overall figure has been heavily influenced by the availability of hydro capacity during the year, which in turn has been influenced by the amount of rainfall during the preceding period. Low rainfall in the winter of 2002/2003 led to 2003 having particularly low hydro load factors. The dry weather in 2006 had a lesser effect. Two factors contributed to the lower load factor for wind in 2003. Firstly 110 MWe was installed late in the year and had little opportunity to contribute to generation. Secondly, the long hot summer of 2003 was not as windy as previous years. The load factors for biomass in 2006 and 2007 were lower than in 2005 because of a combination of factors. Firstly, some sites did not generate, although their capacity is still available, and secondly, one large new site did not begin to operate until late in 2006 and another until late in 2007. As a result the overall load factor for renewables and wastes was again below the record level seen on 2004. Plant load factors for all generating plant in the UK are shown in Chapter 5, Table 5.10.

7.23 To overcome the biasing of load factors for wind caused by new turbines coming on stream either early or late in a calendar year, Table 7.4 also contains a second statistic to describe the load factor of wind turbines. This statistic is calculated in the same way as the other load factors but

includes only those wind farms that have operated throughout the calendar year with an unchanged configuration. See paragraphs 7.76 and 7.77 for the full definitions. In 2007, this "unchanged configuration" load factor for onshore wind farms is slightly lower than the all-onshore wind factor because of more new turbines coming on stream early in the calendar year compared with the latter half of the year. For offshore wind farms the reverse is true with the "unchanged configuration" load factor; higher than the all-offshore load factor. This is because one new offshore wind farm came on stream in the latter half of the year, and also because in some months some other new turbines had generation lower than their potential.

Electricity generated from renewable sources: Renewables Obligation and Renewables Directive bases (Table 7.5)

7.24 Electricity generated in the UK from renewable sources eligible under the RO in 2007 was 9.3 per cent greater than in 2006. This compares with growth of 10.5 per cent in 2006, 33 per cent in 2005 and 38 per cent in 2004. Electricity generated in the UK from renewable sources eligible under the Renewables Directive in 2007 was 8.5 per cent greater than in 2006. This compares with growth of 6.9 per cent in 2006, 20 per cent in 2005 and 33 per cent in 2004. Chart 7.3 shows the growth in the proportion of electricity produced from renewable sources under the Renewables Obligation and international definitions.

Renewable sources used to generate electricity and heat (Table 7.6)

7.25 Between 2006 and 2007 there was an increase of 3.7 per cent in the **input** of renewable sources into electricity generation. Wind grew by 25 per cent, hydro by 11 per cent, but biomass by only 0.4 per cent.

7.26 Compared to 2001, total inputs to electricity generation have doubled, aided by a doubling of the use of biomass and a more than quadrupling of the use of wind.

7.27 Table 7.6 also shows the contribution from renewables to heat generation. Renewables used to generate heat are now shown to have declined to a low point in 2000 but since picked up to be less than 20 per cent lower in 2007 than the level 10 years earlier. The decline was mainly due to tighter emissions controls discouraging on-site burning of biomass, especially wood waste by industry. Domestic use of wood provides the main contribution to renewables used for heat, but the use of animal and plant biomass has shown strong growth in recent years. In addition, the use of active solar heating has almost tripled in the last five years.

7.28 This year a re-assessment of the use of wood by households has taken place, resulting in the estimates being increased compared with earlier years. Further details are given at paragraph 7.51.

Biofuels for transport

7.29 AEA has researched the UK production and consumption of biofuels for transport in 2007 and combined this with the information they had previously obtained for 2006. Their findings are as follows:

7.30 Around 485 million litres of biodiesel were produced in the UK in 2007 (up from 291 million litres in 2006). Biodiesel consumption figures can be obtained from figures published by HM Revenue and Customs (HMRC) derived from road fuel taxation statistics. The most usual way for biodiesel to be sold is for it to be blended with ultra-low sulphur diesel fuel and thus it is reported as part of the road transport use of diesel in Chapter 3. The duty payable on biodiesel is just over half the duty payable on road diesel and in blended fuels the duty payable is proportionate to the duty payable on the constituent fuels. These HMRC figures show that 347 million litres of biodiesel were consumed in 2007, up from 169 million litres in 2006 and 33 million litres in 2005. This implies that around 138 million litres of biodiesel were exported in 2007. The total annual capacity for biodiesel production in the UK could reach 1,600 million litres per year in 2010 if all the planned plant become operational and the existing plant operate at full capacity. This production level would be equivalent to just around 6 per cent of the UK's diesel consumption in 2007. This reduced capacity, compared to that reported as planned in last year's Digest, is due to a number of plants having closed or are planning to close citing that it is currently uneconomic to produce biodiesel in the UK because of subsidised US imports, the price of biodiesel being too low, a shortage of feedstock, and high feedstock prices.

7.31 HMRC data show that 153 million litres of bioethanol was consumed in the UK in 2007, up from 95 million litres in 2006, and 85 million litres in 2005. Only one UK plant was in production in 2007, and so the majority of the bioethanol was imported. If all planned plants became operational on current planned timescales, their combined capacity would be around 600 million litres by 2011, equivalent to 2.4 per cent of the UK's petrol consumption in 2007. Some of the capacity reported as planned in last year's Digest will not now go ahead due to the uncertain future market.

7.32 The HMRC data have been converted from litres to tonnes of oil equivalent and the data are now shown as additional rows in Table 7.6. In 2007, 7 per cent of the renewable sources used in the UK in primary input terms were liquid biofuels for transport, up from 4 per cent in 2006 and less than half a per cent in 2003.

Technical notes and definitions

7.33 Energy derived from renewable sources is included in the aggregate energy tables in Chapter 1 of this Digest. The main commodity balance tables (Tables 7.1 to 7.3) present figures in the common unit of energy, the tonne of oil equivalent, which is defined in Chapter 1 paragraph 1.26. The gross calorific values and conversion factors used to convert the data from original units are given on page 211 of Annex A and inside the back cover flap. The statistical methodologies and conversion factors are in line with those used by the International Energy Agency and the Statistical Office of the European Communities (Eurostat). Primary electricity contributions from hydro and wind are expressed in terms of an electricity supplied model (see Chapter 5, paragraph 5.27). Electrical capacities in this chapter are quoted as Installed capacities. However, in Chapter 5, Declared Net Capacity (DNC) or Transmission Entry Capacity of renewables are used when calculating the overall UK generating capacity. These measures take into account the intermittent nature of the power output from some renewable sources (see paragraph 7.74, below).

7.34 The various renewable energy sources are described in the following paragraphs. This section also provides details of the quality of information provided within each renewables area, and the progress made to improve the quality of this information. While the data in the printed and bound copy of this Digest cover only the most recent five years, these notes also cover data for earlier years that are available on the BERR web site.

Use of existing solar energy

7.35 Nearly all buildings make use of some passive solar energy because they have windows or roof lights, which allow in natural light and provide a view of the surroundings. This existing use of passive solar energy is making a substantial contribution to the energy demand in the UK building stock. Passive solar design (PSD), in which buildings are designed to enhance solar energy use, results in additional savings in energy. The installed capacity of PSD in the UK and other countries can only be estimated and is dependent on how the resource is defined. The unplanned benefit of solar energy for heating and lighting in UK buildings is estimated to be 145 TWh/year. The figure is very approximate and, as in previous years, has therefore not been included in the tables in this chapter. Only a few thousand buildings have been deliberately designed to exploit solar energy – a very small proportion of the total UK building stock. It has been estimated that the benefit of deploying PSD in these buildings is equivalent to a saving of about 10 GWh/year.

Active solar heating

7.36 Active solar heating employs solar collectors to heat water mainly for domestic hot water systems but also for swimming pools and other applications. Updated figures have been obtained by AEA (on behalf of BERR). For 2007, an estimated 95 GWh for domestic hot water generation replaces gas heating; for swimming pools, an estimated 294 GWh generation replaces gas (45 per cent), oil (45 per cent) or electricity (10 per cent).

Photovoltaics

7.37 Photovoltaics (PV) is the direct conversion of solar radiation into direct current electricity by the interaction of light with the electrons in a semiconductor device or cell. There have been significant increases in capacity and generation of PV in recent years due to increased support from the Government. The Major Photovoltaic Demonstration Programme that offered grants for small, medium and large-scale installations encouraged a significant number of new projects. This has been replaced by the BERR Low Carbon Buildings Programme (LCBP), which was launched on 1st April 2006 and is intended to run for three years. The installed capacity increased from 8.2 MW in 2004 to 10.9 MW in 2005 and 14.3 MW in 2006. Data for 2007 are not yet available and the 2006 figure has been used as an estimate for 2007. Any revision to this figure will be published later in the year in Energy Trends.

Onshore wind power

7.38 A wind turbine extracts energy from the wind by means of a rotor fitted with aerodynamic-section blades using the lifting forces on the blades to turn the rotor primary shaft. This mechanical power is used to drive an electrical generator. The figures included for generation from wind turbines are based on actual metered exports from the turbines and, where these data are unavailable, are

based on estimates using regional load factors (see paragraphs 7.76 and 7.77 regarding load factors) and the wind farm installed capacity.

7.39 There are 423 wind farms or separately registered wind projects in the RESTATS database. Of these projects, 73 are under a current NFFO contract totalling 500 MW. There are an additional 28 ex-NFFO schemes accounting for a further 156 MW, of which 25 (154 MW) are now claiming ROCs. NFFO and ex-NFFO schemes account for 32 per cent of the UK installed capacity. A further 1,418 MW of wind power (181 schemes) claim ROCs with the remainder not receiving any form of subsidy. Wind power installations in the UK continue at pace with 433 MW of onshore turbines coming onstream in 2007.

Offshore wind power

7.40 The UK's offshore wind resource is vast, with the potential to provide more than the UK's current demand for electricity. Offshore wind speeds are higher than those onshore (typically up to 0.5m/s higher 10 km offshore) and also less turbulent. However, elevated inland sites can have higher wind speeds.

7.41 Due to the higher costs of installing each turbine offshore the machines tend to be larger than their onshore counterparts (2 MW and above). This is driven by economics, with larger machine more cost effective per unit of electricity generated. The larger turbines also experience higher wind speeds, because taller towers put the rotors into the stronger winds. In addition, onshore constraints such as planning, noise effects and visual impact are likely to be reduced offshore. As of December 2007 there were seven operational offshore wind farms totalling 394 MW. These were Blyth (WTG1 and WTG 2), North Hoyle, Scroby Sands, Kentish Flats, Barrow and Burtbo. In addition Beatrice (10 MW) provided electricity to the neighbouring offshore oil platform and its capacity and generation are not included in the UK figures.

Wave and Tidal Stream Power

7.42 Waves in the oceans are created by the interaction of winds with the surface of the sea. Because of the direction of the prevailing winds and the size of the Atlantic Ocean, the United Kingdom has wave power levels amongst the highest in the world. Under BERR's R&D programme a 75 kW experimental prototype an oscillating water column device came on line in late 1991 on the Hebridean island of Islay and was decommissioned in 1999. This was followed by another concrete shoreline Oscillating Water Column (OWC) device, the Limpet, also on Islay. Limpet has a nameplate capacity of 500 kW and was expected to produce an annual average output of approximately 200 kW. In fact it has only produced approximately one tenth of this because the seabed profile in front of the machine was shallower than expected. Since 2000, BERR's Technology Programme has supported the development of a number of concepts most notably the Pelamis - an articulated tube with sections linked by hinged joints - being developed since 1998 by Edinburgh-based Ocean Power Delivery Ltd. A full-scale prototype has undergone a number of sea trials including 200 hours of grid-connected operation in 2004 and 2007. A 2.25 MW Pelamis farm consisting of three 750 kW machines is currently in the process of being commissioned in Portugal. Several wave energy generation projects are being planned for the near future, including:

- Scottish Power's proposed Pelamis farm at the European Marine Energy Centre (EMEC) on Orkney
- Npower Renewables' and Wavegen's OWC breakwater at Siadar Bay on the isle of Lewis
- the South West Regional Development Agency's proposed Wave Hub site off the north coast of Cornwall that will host four independent farms developed by E.On (Pelamis), Ocean Power technologies, Fred Olsen and Oceanlinx.

7.43 Tidal currents are created by the movement of the tides, often magnified by local topographical features such as headlands, inlets to inland lakes, and straits. Tidal current energy is the extraction of energy from this flow, analogous to the way a wind turbine operates in air. A recent study estimated that the available UK resource is up to 22 TWh per year. Since 2000 BERR's Technology Programme has supported the development of a number of device concepts. To date, two device concepts have had full-scale prototypes deployed at sea. The first is the Seaflow machine installed by Bristol-based Marine Current Turbines Ltd (MCT) near Lynmouth in June 2003. This is in the process of being decommissioned but was not grid-connected and only operates during specific tests. The other device was the Stingray, which uses an oscillating hydrofoil instead of a rotating turbine, developed by Northumberland-based The Engineering Business Ltd (EB). The 180 tonne

device was installed in Yell Sound, Shetland, in September 2002 and again in 2003. After analysing the results of these tests and the costs of building the machine, EB decided to put its development on indefinite hold. In March 2008 MCT installed its Seagen machine, a 1.2 MW nameplate capacity grid-connected twin rotor pile mounted turbine that is a successor to the same company's Seaflow machine, in Strangford Narrows in Northern Ireland. When fully commissioned, the device will deliver electricity to the grid on a commercial basis. MCT has announced plans for a joint venture with Npower Renewables to develop a 10.5 MW farm at the Anglesey Skerries.

7.44 In February 2006, BERR launched the Marine Renewables Deployment Fund with total funding of £42 million to provide a 25 per cent capital grant and £100 per MWh additional revenue support for multi-device farms. In October 2006, the Scottish Executive announced the Scottish Ministers' Wave and Tidal Energy Support Scheme (WATES), closely modelled on the BERR scheme but with a 40 per cent capital grant, different eligibility criteria and a budget of £8 million. In January 2008 an Energy Bill began its progress through Parliament and is expected to become law in mid 2008. This introduces a banding structure into the Renewables Obligation that will enable wave and tidal to claim two ROCs per MWh instead of one as currently. In April 2008, the Scottish Executive issued a consultation proposing to discontinue its Marine Support Obligation, with effect from April 2009, and replace it with a banded/multiple ROC mechanism, but that wave and tidal should receive support at a higher level than that proposed by the UK Government.

7.45 The only commercial facilities operating by 2010 are likely to be those constructed under BERR's Marine Renewables Deployment Fund and the Scottish Executive's WATES scheme. These are not expected to amount to more than around 25 MW of capacity in total, the majority of which will come on stream after 2010.

Large scale hydro

7.46 In hydro schemes the turbines that drive the electricity generators are powered by the direct action of water either from a reservoir or from the run of the river. Large-scale hydro covers plants with a capacity of 5 MW and over. Most of the plants are located in Scotland and Wales and mainly draw their water from high-level reservoirs with their own natural catchment areas. Major Power Producers (MPPs) report their output to BERR in regular electricity surveys. Prior to 2004 these data were submitted in aggregate form and not split down by size of scheme. This meant that some small-scale schemes were hidden within the generation data for the large-scale schemes. Since 2004 MPPs have provided a more detailed breakdown of their data and some smaller sites previously included under "large scale" are now under "small scale". There is some 1,359 MW of installed capacity for large-scale hydroelectric schemes in the UK. The coverage of these large-scale hydro figures is the same as that used in the tables in the Chapter 5 of this Digest. The data in this Chapter exclude pumped storage stations (see paragraph 5.52).

Small scale hydro

7.47 Electricity generation schemes with a hydro capacity below 5 MW are classified as small scale. These are schemes being used for either domestic/farm purposes or for local sale to electricity supply companies. Currently there is 166 MW of installed small-scale hydro schemes. Of this, 59 per cent is owned by small-scale energy producers with the remainder owned by major power producers. Of the 307 schemes in existence, over 77 per cent of schemes claim ROCs, with 43 schemes having current NFFO contracts. Compared to previous years, the total number of schemes has increased by 45 with a corresponding increase in installed capacity of 13 MW.

Geothermal aquifers

7.48 Aquifers containing water at elevated temperatures occur in some parts of the United Kingdom at between 1,500 and 3,000 metres below the surface. This water can be pumped to the surface and used, for example, in community heating schemes. There is currently only one scheme operating in the UK at Southampton.

Biomass

(a) Landfill gas

7.49 Landfill gas is a methane-rich biogas formed from the decomposition of organic material in landfill. The gas can be used to fuel reciprocating engines or turbines to generate electricity or used directly in kilns and boilers. In other countries, the gas is cleaned to pipeline quality or used as a vehicle fuel. Landfill gas exploitation has benefited considerably from NFFO and this can be seen

from the large rise in the amount of electricity generated since 1992. Further commissioning of landfill gas projects under NFFO will continue to increase the amount of electricity generated from this technology. Ofgem's ROCs database also provides details of landfill gas sites claiming ROCs. Information on landfill gas was supplemented by a RESTATS survey carried out by AEA in 2008 on behalf of BERR, and covered the period up to the end of 2007. In 2007 the number of operating landfill gas sites increased by 22, with a corresponding increase in installed capacity of 44 MW.

(b) Sewage sludge digestion

7.50 In all sewage sludge digestion projects, some of the gas produced is used to maintain the optimum temperature for digestion. In addition, many use combined heat and power (CHP) systems. The electricity generated is either used on site or sold under the NFFO. Information from these projects was provided from the CHAPSTATS Database, which is compiled and maintained by AEA on behalf of BERR (see Chapter 6). Within the CHAPSTATS database the majority of the data are gathered through the CHP Quality Assurance (CHPQA) Programme and BERR's Electricity Generated Inquiry (EGI). However, many sewage treatment works are not part of the CHPQA Programme and data provided to the EGI is often in a consolidated form where data on multiple sites are amalgamated. To improve the quality of this data set, from 2005 onwards data on sewage treatment plant are based upon electricity generation figures provided to Ofgem via the NFFO and ROC registers. Where such data are not available, estimates are made from average load factors for such technologies. Ongoing data cleansing activities have continued this year with corrections being applied to historic RESTATS data going back four years to 2003. In this year's statistics, data for 24 per cent of the schemes (48 per cent by electrical capacity) were from CHPQA, data for 73 per cent of schemes (46 per cent by capacity) were from RESTATS (ie ROCs registers) and data for 3 per cent (6 per cent by capacity) were carried forward historically from the EGI.

(c) Domestic wood combustion

7.51 Domestic wood use includes the use of logs in open fires, "AGA"-type cooker boilers and other wood burning stoves. Up to 2002 the figure given for each year is an approximate estimate based on a survey carried out in 1989. The Forestry Commission carried out a survey of domestic wood fuel use in 1997 but the results from this were inconclusive. As an upper limit, about 600,000 oven-dried tonnes (ODTs) were estimated to be available for domestic heating. In 2001, AEA undertook a study of UK domestic wood use on behalf of BERR. A methodology was devised for surveying the three major sectors involved in wood use – the stove or boiler supplier, the wood supplier and the end user. Questionnaires were devised for all these parties and then attempts were made to contact representative samples in the various regions of the UK. From the evidence obtained via the questionnaires and telephone interviews, we believe that the domestic wood burning market is growing, but not in the area of wood as the primary heat source. This still remains a relatively small market and a small percentage of the wood burnt. Unfortunately, the survey was unable to provide statistically sound evidence as to the amount of wood used in the domestic sector and although it was felt that there has been a small increase in the domestic use of wood as a fuel, on the basis of the results of the approach, at the time AEA could not justify modifying the current estimate for the UK. In view of the importance attached to finding out about domestic wood use, the Forestry Commission decided to undertake another study guided by the lessons learnt from the previous work. In particular they would approach the newly emerging wood cooperatives, as they are likely to be a good source if information now that they should be more well established, the National House-Building Council (NHBC) to examine new build and treating equipment suppliers, fuel suppliers and users under separate surveys. This work is on-going. In 2005, as part of an omnibus survey, a pilot study was undertaken in Scotland by the Forestry Commission to assist in developing the correct methodology prior to a national survey, but unfortunately the response rate was poor. A review of a different approach to calculating domestic wood use has suggested that we have been underestimating the use of this resource in recent years. Although this approach is still undergoing peer review, we are nevertheless confident enough at this stage to make some historic changes to these data, the first time since the survey began in 1989.

(d) Industrial wood combustion

7.52 In 1997, the industrial wood figure (which includes sawmill residues, furniture manufacturing waste etc.) was included as a separate category for the first time. This was due to the availability of better data as a result of a survey carried out in 1996 on wood fired combustion plants above 400 kW thermal input. A follow-up survey was subsequently carried out for 2000. This survey highlighted that there were fewer sites (174) operating than in 1996 due to the imposition of more stringent emissions

control. A survey of industrial wood use carried out in 2006, for schemes above 400 kW thermal input, concluded that in-house use of wood waste continued to be in decline. There is, however, increased interest in off-site use of untreated wood for space heating in schools, hospitals, nursing homes, government buildings, etc. Untreated wood will increasingly form a major fuel input to schemes involving energy crops; this is further discussed in the next section.

(e) Energy crops and forestry residues

7.53 Short rotation willow coppice plantations (SRC) have become well established but the rate of uptake of the technology has been very slow. Interest has also been shown in Miscanthus. Over 500 hectares of SRC have been have been planted in the south of Scotland and northern England to supply the Steven's Croft, Lockerbie 44 MWe project. Further plantings are planned to increase the supply in the coming years both for Lockerbie and Sembcorp (see below). Some SRC from the plantings made for the ARBRE project (see below), have been used for co-firing in coal-fired power stations. In December 2007 a new support scheme for energy crops was introduced by the Department for Environment Food and Rural Affairs (Defra), administered by Natural England, as part of the Rural Development Programme for England (RDPE) 2007-2013.

7.54 In England, Project ARBRE in South Yorkshire was contracted under NFFO 3 to generate 10 MW of electricity of which 8 MW were to be exported to the local grid. This project ran into difficulties and was sold to new owners who are still evaluating their options on taking the project forward. However, SembCorp Utilities UK has completed a 32 MW wood-burning power station, burning 55,000 tonnes a year of SRC, with the balance recovered wood, forestry residues and sawmill co-product at the Wilton facility on Teesside. It entered commercial operation in summer 2007. The 44 MW plant at Steven's Croft near Lockerbie has also entered commercial service, fuelled mainly by forestry, sawmill co-product, and recovered wood. There is an intention to replace 25 per cent of this fuel by SRC . A 2.6 MW plant in Eccleshall, burning wood and Miscanthus, built by Eccleshall Biomass Ltd started commercial operation in summer 2007. The Port Talbot Bioenergy Plant, a 14 MW electric scheme firing mostly forestry residues and saw mill co-product will enter service in June 2008.

(f) Straw combustion

7.55 Straw can be burnt in high temperature boilers, designed for the efficient and controlled combustion of solid fuels and biomass to supply heat, hot water and hot air systems. There are large numbers of these small-scale batch-fed whole bale boilers. The figures given are estimates based partly on 1990 information and partly on a survey of straw-fired boilers carried out in 1993-94. A 37 MW straw fired power station near Ely, Cambridgeshire is currently the only electricity generation scheme in operation.

(g) Waste combustion

7.56 Domestic, industrial and commercial wastes represent a significant resource for materials and energy recovery. Wastes may be combusted, as received, in purpose built incinerators or processed into a range of refuse derived fuels for both on-site and off-site utilisation. Only the non-biodegradable portion of waste is counted in renewables statistics although non-biodegradable wastes are included in this chapter as "below the line" items. The paragraphs below describe various categories of waste combustion in greater detail.

7.57 In 2007, 22 waste-to-energy plants were in operation, burning municipal solid waste (MSW), refuse derived fuel (RDF) and general industrial waste (GIW).

7.58 **Municipal solid waste combustion:** Information was provided from the refuse incinerator operators in the United Kingdom that practice energy recovery using the RESTATS questionnaire. This included both direct combustion of unprocessed MSW and the combustion of RDF. In the latter, process waste can be partially processed to produce coarse RDF that can then be burnt in a variety of ways. By further processing the refuse, including separating off the fuel fraction, compacting, drying and densifying, it is possible to produce an RDF pellet. This pellet has around 60 per cent of the gross calorific value of British coal. The generation from MSW has been split between biodegradable sources and non-biodegradable sources using information outlined in paragraph 7.59 below. Approximately 62.5 per cent of generation from MSW was estimated to be from biodegradable sources. Non-biodegradable municipal solid waste is not included in the overall renewables percentage under the international definition of renewables (see paragraph 7.1). However, such wastes are still shown in the tables accompanying this chapter as 'below the line' items.

7.59 There has been an ongoing programme of waste analysis in the UK for many years; such analyses may be carried out to an accuracy of ± 1 per cent. Such studies are guided by the use of ACORN (which stands for A Classification Of Residential Neighbourhoods) socio-economic profiles which are used to select sample areas for the analysis of household collected waste and is based on the premise that households of similar socio-economic characteristics are likely to have similar behavioural, purchasing and lifestyle characteristics; this will be reflected in the quantity and composition of waste that those households produce. The large scale study in Wales showed that the only category in domestic waste to show a statistically significant seasonal variation was garden waste; as garden waste is a small percentage (certainly when compared to food and kitchen waste), the effect on the operation of biomass-to-energy plants should be almost unnoticed. As there is now virtually no regional variation to be seen within the UK; these data will probably become the UK standard. UK domestic waste has a biodegradable content of 67.5 per cent ± 1 per cent and this accounts for about 62.5 per cent of the energy generated from its combustion. MSW comprises domestic waste plus other feedstocks, such as, general industrial waste, building demolition waste and tree clippings from civil amenities. This has the net effect of reducing the percentage composition of the biodegradable content to 61 per cent ± 1 per cent. Because the combustion properties of some of the other biodegradable materials added is similar to that of domestic waste, this has virtually no effect on the percentage of the energy generated from the biodegradables component, which remains at about 62.5 per cent.

7.60 **General industrial waste combustion:** Certain wastes produced by industry and commerce can be used as a source of energy for industrial processes or space heating. These wastes include general waste from factories such as paper, cardboard, wood and plastics.

7.61 A survey conducted in 2001 noted that GIW is now burnt in MSW waste-to-energy facilities. As no sites are solely burning GIW for heat or electricity generation, this feedstock is being handled under the MSW category.

7.62 **Specialised waste combustion:** Specialised wastes arise as a result of a particular activity or process. Materials in this category include scrap tyres, hospital wastes, poultry litter, meal and bone and farm waste digestion. Although the large tyre incineration plant with energy recovery has not generated since 2000 the cement industry has burned some waste tyres in its cement and lime kilns. Although part of waste tyre combustion is of biodegradable waste, because there is no agreed method of calculating the small biodegradable content, all of the generation from waste tyres has been included under non-biodegradable wastes in this chapter (see paragraph 7.59, above).

7.63 Information on hospital waste incineration was based on a RESTATS survey, carried out by AEA in 2007 on behalf of BERR. In light of the significant changes that have taken place within the sector over the previous three years, this survey aimed to establish if there were any changes and developments in the market. This survey revealed an ongoing process of centralisation and consolidation, as the industry responds to changes in pollution emissions and clinical waste regulations. It also documented the closure of many smaller incineration facilities with energy recovery, for whom the costs of compliance with regulations were no longer viable. Despite this, the survey established that energy recovery in this field does have a future, with three new sites for power generation being developed.

7.64 One poultry litter combustion project started generating electricity in 1992; a second began in 1993. Both of these are NFFO projects. In addition, a small-scale CHP scheme began generating towards the end of 1990. However, this has now closed due to new emissions regulations. A further NFFO scheme started generating in 1998, and during 2000 an SRO scheme began to generate. A further poultry litter scheme became fully operational in 2001. Over the most recent five years one of the earlier poultry litter projects was fuelled mainly by meat and bone. Two additional schemes fuelled primarily by meat and bone have also been built.

7.65 Information on farm waste digestion in the United Kingdom is based on a survey carried out during 1991-1992 with follow-up studies in 1996 and 2005. There was a farm digestion project generating electricity under the NFFO; its output was included in the commodity balances but ceased to operate in 1998. In 2003, however, a large centralised anaerobic digestion scheme (Holsworthy) generating electricity under NFFO 5 came on-line. With the exception of this scheme, data collected

from the surveys were used to derive estimates for 1997 through to 2004. The 2005 survey showed that number of sites using farm waste digestion fell significantly since 1996, which was mainly attributed to tightening waste regulations and lack of maintenance. However, this has not prevented new digesters being built and commissioned in since 2006.

(h) Co-firing of biomass with fossil fuels

7.66 Co-firing of biomass fuel in fossil fuel power stations is not a new idea. Technically it has been proven in power stations worldwide, although, until 2002, it was not practised in the UK. The biomass fuel is usually fed by means of the existing stoking mechanism as a partial substitute for the fossil fuel. The combustion system may cope with up to a 25 per cent substitution without any major changes to the boiler design and airflows, but fuel preparation and transport systems may be the limiting feature at percentages much lower than this.

7.67 Since 2002, co-firing of biomass with fossil fuels has been eligible under the RO, the first time that any renewable energy initiative has included co-firing. Compared with other renewables, co-firing is relatively low cost and quick to implement. As such, the following limits were placed on co-firing to prevent a high volume of co-firing reducing the value in the RO for other renewables whilst enabling markets and supply chains for biomass to develop:

- Only electricity generated before 1 April 2011 would be eligible;
- From 1 April 2006 at least 25 per cent of the biomass used must consist of energy crops.

7.68 The scheme has since been extended further to allow longer for an energy crop market to develop and to recognise the need to reduce CO_2 emissions from coal-fired generation as the role that coal will play in the UK's generation has increased. The current position is that there are no caps on co-firing with energy crops. However, to reduce the risk of flooding the ROC market with co-fired ROCs, thereby affecting ROC prices and investor confidence adversely, there is a limit on the number of co-fired ROCs using non-energy crop biomass a supplier can present to Ofgem when demonstrating that it has met its obligation. This is 10 per cent from 1 April 2006 until 31 March 2011 and 5 per cent from 1 April 2011 until 31 March 2016.

7.69 In May 2007 the Government published the Energy White Paper, "Meeting the Energy Challenge". This proposed banding the RO, where different levels of support are given to different renewable technologies. If these proposals are implemented the caps on co-firing would be removed completely but to off-set this, co-firing with non-energy crops would be moved into a band receiving less than 1 ROC per 1MWh. This will allow more co-firing to come forward but at an appropriate support level, minimising the risk of co-firing impacting negatively on other renewables.

(i) Biodiesel and bioethanol

7.70 In the UK biodiesel is defined for taxation purposes as diesel quality liquid fuel produced from biomass or waste cooking oil, the ester content of which is not less than 96.5 per cent by weight and the sulphur content of which does not exceed 0.005 per cent by weight or is nil. Diesel fuel currently sold at a number of outlets is a blend with 5 per cent biodiesel. Bioethanol is defined for taxation purposes as a petrol quality liquid fuel consisting of ethanol produced from biomass ie from vegetable and animal substances consisting of the biodegradable fraction of products, wastes and residues from agriculture, forestry and related activities, or industrial and municipal waste. For further information see www.hmrc.gov.uk and search for 'Biodiesel' and 'Bioethanol' and www.uktradeinfo.co.uk/index.cfm?task=bulloil .

7.71 The Renewable Transport Fuel Obligation (RTFO), introduced in April 2008, places a legal requirement on transport fuel suppliers (ie those who supply more than 450,000 litres of fossil fuel per annum to the UK market) to ensure that 5 per cent (by volume) of their overall fuel sales is from a renewable source by 2010/11, with staged required levels of 2.5 per cent (by volume) for 2008/9 and 3.75 per cent (by volume) in 2009/10. Once the 5 per cent level is reached it is estimated that it will save around a million tonnes of carbon per annum.

Combined Heat and Power

7.72 A CHP plant is an installation where there is a simultaneous generation of usable heat and power (usually electricity) in a single process. Some CHP installations are fuelled either wholly or partially by renewable sources of energy. The main renewable sources that are used for CHP are biomass particularly sewage gas.

7.73 Chapter 6 of this Digest summarises information on the contribution made by CHP to the United Kingdom's energy requirements in 2003 to 2007 using the results of annual studies undertaken to identify all CHP schemes. Included in Tables 6.1 to 6.9 of that chapter is information on the contribution of renewable sources to CHP generation in each year from 2003 to 2007. Corresponding data for 1996 to 2002 are available on the BERR energy web site. The information contained in those tables is therefore a subset of the data contained within the tables presented in this chapter.

Generating capacity and load factor

7.74 The electrical capacities are given in Table 7.4 as installed capacities ie the maximum continuous rating of the generating sets in the stations. In Chapter 5 Declared Net Capacity (DNC) is used, ie the maximum continuous rating of the generating sets in the stations, less the power consumed by the plant itself, and reduced by a specified factor to take into account the intermittent nature of the energy source e.g. 0.43 for wind, 0.365 for small hydro and 0.33 for shoreline wave. DNC represents the nominal maximum capability of a generating set to supply electricity to consumers. For electrical capacities of generation using renewables in DNC terms see Table 7.1.1 on the BERR energy web site.

7.75 Plant load factors in this chapter have been calculated in terms of installed capacity (ie the maximum continuous rating of the generating sets in the stations) and express the average hourly quantity of electricity generated as a percentage of the average of the capacities at the beginning and end of the year.

7.76 In the 2006 Digest a new term was introduced to describe the amount of electricity generated from wind farms compared with the amount that such turbines would have generated had they been available for the whole of the calendar year and running continually and at maximum output throughout the calendar year. This term is "load factor on an unchanged configuration basis". A full account of the exercise to derive these factors can be found in *Energy Trends*, March 2006 pages 28 to 32. *Energy Trends* is available on the BERR energy web site at www.berr.gov.uk/energy/statistics/publications/trends/index.html, although here the term "capacity factor" was used.

7.77 To compare the two calculations, the **load factor** for a calendar year (as historically reported in this Digest) is:

$$\frac{\text{Electricity generated during the year (kWh)}}{\text{(Installed capacity at the beginning of the year + Installed capacity at the end of the year (kW))} \times 0.5 \times 8760 \text{ hours}}$$

whilst the **load factor on an unchanged configuration basis** for a calendar year is:

$$\frac{\text{Electricity generated during the year (kWh)}}{\text{(Installed capacity of wind farms operating throughout the year with an unchanged configuration (kW))} \times 8760 \text{ hours}}$$

In addition, because load factors on an unchanged configuration basis are mainly of interest for commercial scale wind power rather than small/micro generation, turbines under 100 kW are excluded and any single turbine of 100 kW or above is considered to be a wind farm.

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7.1 Commodity balances 2007

Renewables and waste

Thousand tonnes of oil equivalent

	Wood waste	Wood	Poultry litter, meat and bone, and farm waste	Straw, SRC, and other plant-based biomass (3)	Sewage gas	Landfill gas
Supply						
Production	81	358	270	495	221	1,547
Other sources	-	-	-	-	-	-
Imports	-	-	-	378	-	-
Exports	-	-	-	-	-	-
Marine bunkers	-	-	-	-	-	-
Stock change *(1)*	-	-	-	-	-	-
Transfers	-	-	-	-	-	-
Total supply	**81**	**358**	**270**	**873**	**221**	**1,547**
Statistical difference *(2)*	-	-	-	-	-	-
Total demand	**81**	**358**	**270**	**873**	**221**	**1,547**
Transformation	**-**	**-**	**223**	**775**	**170**	**1,534**
Electricity generation	-	-	223	775	170	1,534
Major power producers	-	-	203	422	-	-
Autogenerators	-	-	19	354	170	1,534
Heat generation	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	-
Coke manufacture	-	-	-	-	-	-
Blast furnaces	-	-	-	-	-	-
Patent fuel manufacture	-	-	-	-	-	-
Other	-	-	-	-	-	-
Energy industry use	**-**	**-**	**-**	**-**	**-**	**-**
Electricity generation	-	-	-	-	-	-
Oil and gas extraction	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	-
Coal extraction	-	-	-	-	-	-
Coke manufacture	-	-	-	-	-	-
Blast furnaces	-	-	-	-	-	-
Patent fuel manufacture	-	-	-	-	-	-
Pumped storage	-	-	-	-	-	-
Other	-	-	-	-	-	-
Losses	**-**	**-**	**-**	**-**	**-**	**-**
Final consumption	**81**	**358**	**48**	**97**	**52**	**14**
Industry	**81**	**-**	**46**	**25**	**-**	**14**
Unclassified	81	-	46	25	-	14
Iron and steel	-	-	-	-	-	-
Non-ferrous metals	-	-	-	-	-	-
Mineral products	-	-		-	-	-
Chemicals	-	-	-	-	-	-
Mechanical engineering, etc	-	-	-	-	-	-
Electrical engineering, etc	-	-	-	-	-	-
Vehicles	-	-	-	-	-	-
Food, beverages, etc	-	-	-	-	-	-
Textiles, leather, etc	-	-	-	-	-	-
Paper, printing, etc	-	-	-	-	-	-
Other industries	-	-	-	-	-	-
Construction	-	-	-	-	-	-
Transport	**-**	**-**	**-**	**-**	**-**	**-**
Air	-	-	-	-	-	-
Rail	-	-	-	-	-	-
Road	-	-	-	-	-	-
National navigation	-	-	-	-	-	-
Pipelines	-	-	-	-	-	-
Other	**-**	**358**	**2**	**72**	**52**	**-**
Domestic	-	358	-	-	-	-
Public administration	-	-	-	-	52	-
Commercial	-	-	-	-	-	-
Agriculture	-	-	2	72	-	-
Miscellaneous	-	-	-	-	-	-
Non energy use	**-**	**-**	**-**	**-**	**-**	**-**

(1) Stock fall (+), stock rise (-).

(2) Total supply minus total demand.

(3) SRC is short rotation coppice.

(4) Municipal solid waste, general industrial waste and hospital waste.

(5) The amount of shoreline wave included is less than 0.05 ktoe.

7.1 Commodity balances 2007 (continued)

Renewables and waste

Thousand tonnes of oil equivalent

Waste *(4)* and tyres	Geothermal and active solar heat	Hydro	Wind and wave *(5)*	Liquid biofuels for transport	Total renewables	
						Supply
956	47	438	453	396	5,262	Production
-	-	-	-	-	-	Other sources
-	-	-	-	-	378	Imports
-	-	-	-	-34	-34	Exports
-	-	-	-	-	-	Marine bunkers
-	-	-	-	-	-	Stock change *(1)*
-	-	-	-	-	-	Transfers
956	**47**	**438**	**453**	**362**	**5,606**	**Total supply**
-	-	-	-	-	-	**Statistical difference** *(2)*
956	**47**	**438**	**453**	**362**	**5,606**	**Total demand**
785	**1**	**438**	**453**	**-**	**4,378**	**Transformation**
785	1	438	453	-	4,378	Electricity generation
58	-	356	-	-	1,039	Major power producers
727	1	81	453	-	3,339	Autogenerators
-	-	-	-	-	-	Heat generation
-	-	-	-	-	-	Petroleum refineries
-	-	-	-	-	-	Coke manufacture
-	-	-	-	-	-	Blast furnaces
-	-	-	-	-	-	Patent fuel manufacture
-	-	-	-	-	-	Other
-	-	-	-	-	-	**Energy industry use**
-	-	-	-	-	-	Electricity generation
-	-	-	-	-	-	Oil and gas extraction
-	-	-	-	-	-	Petroleum refineries
-	-	-	-	-	-	Coal extraction
-	-	-	-	-	-	Coke manufacture
-	-	-	-	-	-	Blast furnaces
-	-	-	-	-	-	Patent fuel manufacture
-	-	-	-	-	-	Pumped storage
-	-	-	-	-	-	Other
-	-	-	-	-	-	**Losses**
171	**46**	**-**	**-**	**362**	**1,228**	**Final consumption**
90	**-**	**-**	**-**	**-**	**256**	**Industry**
90	-	-	-	-	256	Unclassified
-	-	-	-	-	-	Iron and steel
-	-	-	-	-	-	Non-ferrous metals
-	-	-	-	-	-	Mineral products
-	-	-	-	-	-	Chemicals
-	-	-	-	-	-	Mechanical engineering, etc
-	-	-	-	-	-	Electrical engineering, etc
-	-	-	-	-	-	Vehicles
-	-	-	-	-	-	Food, beverages, etc
-	-	-	-	-	-	Textiles, leather, etc
-	-	-	-	-	-	Paper, printing, etc
-	-	-	-	-	-	Other industries
-	-	-	-	-	-	Construction
-	-	-	-	**362**	**362**	**Transport**
-	-	-	-	-	-	Air
-	-	-	-	-	-	Rail
-	-	-	-	362	362	Road
-	-	-	-	-	-	National navigation
-	-	-	-	-	-	Pipelines
81	**46**	**-**	**-**	**-**	**610**	**Other**
23	46	-	-	-	427	Domestic
39	-	-	-	-	90	Public administration
10	-	-	-	-	10	Commercial
-	-	-	-	-	74	Agriculture
9	-	-	-	-	9	Miscellaneous
-	**-**	**-**	**-**	**-**	**-**	**Non energy use**

7.2 Commodity balances 2006

Renewables and waste

Thousand tonnes of oil equivalent

	Wood waste	Wood	Poultry litter, meat and bone, and farm waste	Straw, SRC, and other plant-based biomass (3)	Sewage gas	Landfill gas
Supply						
Production	81	322r	174	538	195r	1,465
Other sources	-	-	-	-	-	-
Imports	-	-	-	497	-	-
Exports	-	-	-	-	-	-
Marine bunkers	-	-	-	-	-	-
Stock change *(1)*	-	-	-	-	-	-
Transfers	-	-	-	-	-	-
Total supply	**81**	**322r**	**174**	**1,035**	**195r**	**1,465**
Statistical difference *(2)*	-	-	-	-	-	-
Total demand	**81**	**322r**	**174**	**1,035**	**195r**	**1,465**
Transformation	**-**	**-**	**149**	**948**	**149r**	**1,451**
Electricity generation	-	-	149	948	149r	1,451
Major power producers	-	-	129	543	-	-
Autogenerators	-	-	19	405	149r	1,451
Heat generation	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	-
Coke manufacture	-	-	-	-	-	-
Blast furnaces	-	-	-	-	-	-
Patent fuel manufacture	-	-	-	-	-	-
Other	-	-	-	-	-	-
Energy industry use	**-**	**-**	**-**	**-**	**-**	**-**
Electricity generation	-	-	-	-	-	-
Oil and gas extraction	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	-
Coal extraction	-	-	-	-	-	-
Coke manufacture	-	-	-	-	-	-
Blast furnaces	-	-	-	-	-	-
Patent fuel manufacture	-	-	-	-	-	-
Pumped storage	-	-	-	-	-	-
Other	-	-	-	-	-	-
Losses	**-**	**-**	**-**	**-**	**-**	**-**
Final consumption	**81**	**322r**	**25**	**87**	**46r**	**14**
Industry	**81**	**-**	**23**	**16**	**-**	**14**
Unclassified	81	-	23	16	-	14
Iron and steel	-	-	-	-	-	-
Non-ferrous metals	-	-	-	-	-	-
Mineral products	-	-	-	-	-	-
Chemicals	-	-	-	-	-	-
Mechanical engineering, etc	-	-	-	-	-	-
Electrical engineering, etc	-	-	-	-	-	-
Vehicles	-	-	-	-	-	-
Food, beverages, etc	-	-	-	-	-	-
Textiles, leather, etc	-	-	-	-	-	-
Paper, printing, etc	-	-	-	-	-	-
Other industries	-	-	-	-	-	-
Construction	-	-	-	-	-	-
Transport	**-**	**-**	**-**	**-**	**-**	**-**
Air	-	-	-	-	-	-
Rail	-	-	-	-	-	-
Road	-	-	-	-	-	-
National navigation	-	-	-	-	-	-
Pipelines	-	-	-	-	-	-
Other	**-**	**322r**	**2**	**72**	**46r**	**-**
Domestic	-	322r	-	-	-	-
Public administration	-	-	-	-	46r	-
Commercial	-	-	-	-	-	-
Agriculture	-	-	2	72	-	-
Miscellaneous	-	-	-	-	-	-
Non energy use	**-**	**-**	**-**	**-**	**-**	**-**

(1) Stock fall (+), stock rise (-).
(2) Total supply minus total demand.
(3) SRC is short rotation coppice.
(4) Municipal solid waste, general industrial waste and hospital waste.
(5) The amount of shoreline wave included is less than 0.05 ktoe.

7.2 Commodity balances 2006 (continued)

Renewables and waste

Thousand tonnes of oil equivalent

Waste *(4)* and tyres	Geothermal and active solar heat	Hydro	Wind and wave *(5)*	Liquid biofuels for transport	Total renewables	
						Supply
918r	38	395	363	232	4,721r	Production
-	-	-	-	-	-	Other sources
-	-	-	-	-	497r	Imports
-	-	-	-	-44	-44r	Exports
-	-	-	-	-	-	Marine bunkers
-	-	-	-	-	-	Stock change *(1)*
-	-	-	-	-	-	Transfers
918r	**38**	**395**	**363**	**188**	**5,174r**	**Total supply**
-	-	-	-	-	-	**Statistical difference** *(2)*
918r	**38**	**395**	**363**	**188**	**5,174r**	**Total demand**
773r	**1**	**395**	**363**	**-**	4,229r	**Transformation**
773r	1	395	363	-	4,229r	Electricity generation
59	-	318	-	-	1,049r	Major power producers
714r	1	77	363	-	3,180r	Autogenerators
-	-	-	-	-	-	Heat generation
-	-	-	-	-	-	Petroleum refineries
-	-	-	-	-	-	Coke manufacture
-	-	-	-	-	-	Blast furnaces
-	-	-	-	-	-	Patent fuel manufacture
-	-	-	-	-	-	Other
-	-	-	-	-	-	**Energy industry use**
-	-	-	-	-	-	Electricity generation
-	-	-	-	-	-	Oil and gas extraction
-	-	-	-	-	-	Petroleum refineries
-	-	-	-	-	-	Coal extraction
-	-	-	-	-	-	Coke manufacture
-	-	-	-	-	-	Blast furnaces
-	-	-	-	-	-	Patent fuel manufacture
-	-	-	-	-	-	Pumped storage
-	-	-	-	-	-	Other
-	-	-	-	-	-	**Losses**
145r	**37**	**-**	**-**	**188**	**945r**	**Final consumption**
65	**-**	**-**	**-**	**-**	**198r**	**Industry**
65	-	-	-	-	198r	Unclassified
-	-	-	-	-	-	Iron and steel
-	-	-	-	-	-	Non-ferrous metals
-	-	-	-	-	-	Mineral products
-	-	-	-	-	-	Chemicals
-	-	-	-	-	-	Mechanical engineering, etc
-	-	-	-	-	-	Electrical engineering, etc
-	-	-	-	-	-	Vehicles
-	-	-	-	-	-	Food, beverages, etc
-	-	-	-	-	-	Textiles, leather, etc
-	-	-	-	-	-	Paper, printing, etc
-	-	-	-	-	-	Other industries
-	-	-	-	-	-	Construction
-	-	-	-	**188**	**188r**	**Transport**
-	-	-	-	-	-	Air
-	-	-	-	-	-	Rail
-	-	-	-	188	188r	Road
-	-	-	-	-	-	National navigation
-	-	-	-	-	-	Pipelines
81	**37**	**-**	**-**	**-**	**560r**	**Other**
23	37	-	-	-	382r	Domestic
39	-	-	-	-	84r	Public administration
10	-	-	-	-	10	Commercial
-r	-	-	-	-	74	Agriculture
9	-	-	-	-	9	Miscellaneous
-	-	-	-	-	-	**Non energy use**

7.3 Commodity balances 2005

Renewables and waste

Thousand tonnes of oil equivalent

	Wood waste	Wood	Poultry litter, meat and bone, and farm waste	Straw, SRC, and other plant-based biomass (3)	Sewage gas	Landfill gas
Supply						
Production	81	287r	176	621	208r	1,421
Other sources	-	-	-	-	-	-
Imports	-	-	-	421	-	-
Exports	-	-	-	-	-	-
Marine bunkers	-	-	-	-	-	-
Stock change *(1)*	-	-	-	-	-	-
Transfers	-	-	-	-	-	-
Total supply	**81**	**287r**	**176**	**1,042**	**208r**	**1,421**
Statistical difference *(2)*	-	-	-	-	-	-
Total demand	**81**	**287r**	**176**	**1,042**	**208r**	**1,421**
Transformation	**-**	**-**	**161**	**956**	**154r**	**1,407**
Electricity generation	-	-	161	956	154r	1,407
Major power producers	-	-	159	582	-	-
Autogenerators	-	-	2	373	154r	1,407
Heat generation	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	-
Coke manufacture	-	-	-	-	-	-
Blast furnaces	-	-	-	-	-	-
Patent fuel manufacture	-	-	-	-	-	-
Other	-	-	-	-	-	-
Energy industry use	**-**	**-**	**-**	**-**	**-**	**-**
Electricity generation	-	-	-	-	-	-
Oil and gas extraction	-	-	-	-	-	-
Petroleum refineries	-	-	-	-	-	-
Coal extraction	-	-	-	-	-	-
Coke manufacture	-	-	-	-	-	-
Blast furnaces	-	-	-	-	-	-
Patent fuel manufacture	-	-	-	-	-	-
Pumped storage	-	-	-	-	-	-
Other	-	-	-	-	-	-
Losses	**-**	**-**	**-**	**-**	**-**	**-**
Final consumption	**81**	**287r**	**15**	**86**	**54r**	**14**
Industry	**81**	**-**	**12**	**14**	**-**	**14**
Unclassified	81	-	12	14	-	14
Iron and steel	-	-	-	-	-	-
Non-ferrous metals	-	-	-	-	-	-
Mineral products	-	-	-	-	-	-
Chemicals	-	-	-	-	-	-
Mechanical engineering, etc	-	-	-	-	-	-
Electrical engineering, etc	-	-	-	-	-	-
Vehicles	-	-	-	-	-	-
Food, beverages, etc	-	-	-	-	-	-
Textiles, leather, etc	-	-	-	-	-	-
Paper, printing, etc	-	-	-	-	-	-
Other industries	-	-	-	-	-	-
Construction	-	-	-	-	-	-
Transport	**-**	**-**	**-**	**-**	**-**	**-**
Air	-	-	-	-	-	-
Rail	-	-	-	-	-	-
Road	-	-	-	-	-	-
National navigation	-	-	-	-	-	-
Pipelines	-	-	-	-	-	-
Other	**-**	**287r**	**2**	**72**	**54r**	**-**
Domestic	-	287r	-	-	-	-
Public administration	-	-	-	-	54r	-
Commercial	-	-	-	-	-	-
Agriculture	-	-	2	72	-	-
Miscellaneous	-	-	-	-	-	-
Non energy use	**-**	**-**	**-**	**-**	**-**	**-**

(1) Stock fall (+), stock rise (-).

(2) Total supply minus total demand.

(3) SRC is short rotation coppice.

(4) Municipal solid waste, general industrial waste and hospital waste.

(5) The amount of shoreline wave included is less than 0.05 ktoe.

7.3 Commodity balances 2005 (continued)

Renewables and waste

Thousand tonnes of oil equivalent

Waste *(4)* and tyres	Geothermal and active solar heat	Hydro	Wind and wave *(5)*	Liquid biofuels for transport	Total renewables	
						Supply
849	31r	423	250	8	4,354	Production
-	-	-	-	-	-	Other sources
-	-	-	-	66	487	Imports
-	-	-	-	-	-	Exports
-	-	-	-	-	-	Marine bunkers
-	-	-	-	-	-	Stock change *(1)*
-	-	-	-	-	-	Transfers
849	**31r**	**423**	**250**	**74**	**4,841r**	**Total supply**
-	-	-	-	-	-	**Statistical difference** *(2)*
849	**31r**	**423**	**250**	**74**	**4,841r**	**Total demand**
688	**1**	**423**	**250**	**-**	**4,041r**	**Transformation**
688	1	423	250	-	4,041	Electricity generation
89	-	329r	-	-	1,160	Major power producers
599	1	94r	250	-	2,881r	Autogenerators
-	-	-	-	-	-	Heat generation
-	-	-	-	-	-	Petroleum refineries
-	-	-	-	-	-	Coke manufacture
-	-	-	-	-	-	Blast furnaces
-	-	-	-	-	-	Patent fuel manufacture
-	-	-	-	-	-	Other
-	-	-	-	-	-	**Energy industry use**
-	-	-	-	-	-	Electricity generation
-	-	-	-	-	-	Oil and gas extraction
-	-	-	-	-	-	Petroleum refineries
-	-	-	-	-	-	Coal extraction
-	-	-	-	-	-	Coke manufacture
-	-	-	-	-	-	Blast furnaces
-	-	-	-	-	-	Patent fuel manufacture
-	-	-	-	-	-	Pumped storage
-	-	-	-	-	-	Other
-	-	-	-	-	-	**Losses**
161	**30r**	**-**	**-**	**74**	**800r**	**Final consumption**
68	**-**	**-**	**-**	**-**	**189r**	**Industry**
68	-	-	-	-	189r	Unclassified
-	-	-	-	-	-	Iron and steel
-	-	-	-	-	-	Non-ferrous metals
-	-	-	-	-	-	Mineral products
-	-	-	-	-	-	Chemicals
-	-	-	-	-	-	Mechanical engineering, etc
-	-	-	-	-	-	Electrical engineering, etc
-	-	-	-	-	-	Vehicles
-	-	-	-	-	-	Food, beverages, etc
-	-	-	-	-	-	Textiles, leather, etc
-	-	-	-	-	-	Paper, printing, etc
-	-	-	-	-	-	Other industries
-	-	-	-	-	-	Construction
-	-	-	-	**74**	**74**	**Transport**
-	-	-	-	-	-	Air
-	-	-	-	-	-	Rail
-	-	-	-	74	74	Road
-	-	-	-	-	-	National navigation
-	-	-	-	-	-	Pipelines
93	**30r**	**-**	**-**	**-**	**538r**	**Other**
23	30r	-	-	-	340r	Domestic
51	-	-	-	-	105r	Public administration
10	-	-	-	-	10	Commercial
-	-	-	-	-	74	Agriculture
9	-	-	-	-	9	Miscellaneous
-	**-**	**-**	**-**	**-**	**-**	**Non energy use**

7.4 Capacity of, and electricity generated from, renewable sources

	2003	2004	2005	2006	2007
Installed Capacity (MWe) *(1)*					
Wind:					
Onshore	678.4	809.4	1,351.2	1,650.7	2,083.4
Offshore *(2)*	63.8	123.8	213.8	303.8	393.8
Shoreline wave	0.5	0.5	0.5	0.5	0.5
Solar photovoltaics	6.0	8.2	10.9	14.3r	14.3
Hydro:					
Small scale	130.0	142.9	157.9	153.4r	166.2
Large scale *(3)*	1,354.5	1,355.9	1,343.2	1,361.4r	1,358.7
Biomass:					
Landfill gas	619.1	722.2	817.8	856.2	900.6
Sewage sludge digestion	123.7r	131.9r	139.6r	146.4r	151.7
Municipal solid waste combustion	298.8	307.4	321.4	326.5	326.4
Animal Biomass *(4)*	94.4	86.5	86.6	88.9	114.4
Plant Biomass *(5)*	89.5	89.8	99.5	132.4	189.5
Total biomass and wastes	1,225.5r	1,337.8r	1,464.9r	1,550.4r	1,682.6
Total	**3,458.7r**	**3,778.4r**	**4,542.4r**	**5,034.4r**	**5,699.5**
Co-firing (6)	92.4	146.2	308.8	310.2	247.6
Generation (GWh)					
Wind:					
Onshore *(7)*	1,276	1,736	2,501	3,574	4,491
Offshore *(8)*	10	199	403	651	783
Solar photovoltaics	3	4	8	11r	11
Hydro:					
Small scale *(9)*	150	283	444	478r	534
Large scale *(3)*	2,987	4,561	4,478	4,115r	4,554
Biomass:					
Landfill gas	3,276	4,004	4,290	4,424	4,677
Sewage sludge digestion	394r	440r	470r	456r	517
Municipal solid waste combustion *(9)*	965	971	964	1,083	1,177
Co-firing with fossil fuels	602	1,022	2,533	2,528	1,956
Animal Biomass *(10)*	535	565	468	434	555
Plant Biomass *(11)*	402	362	382	363	409
Total biomass	6,174r	7,364r	9,107r	9,288r	9,291
Total generation	**10,600r**	**14,147r**	**16,940r**	**18,116r**	**19,664**
Non-biodegradable wastes *(12)*	579	583	578	651	707
Load factors (per cent) *(13)*					
Onshore wind	24.1	26.6	26.4	27.2r	27.5
Offshore wind (from 2004 only)	..	24.2	27.2	28.7r	25.6
Hydro	23.3	37.1	37.5	34.9r	38.2
Biomass (excluding co-firing)	62.4r	61.7r	58.3r	56.1r	56.8
Total (including wastes)	36.5	43.2r	41.1r	38.7r	39.2
Load factors on an unchanged configuration basis (per cent) *(14)*					
Onshore wind	26.2	29.2	28.1	26.7	27.3
Offshore wind (from 2006 only)	..	..	..	26.7r	28.3

(1) Capacity on a DNC basis is shown in Long Term Trends Table 7.1.1 available on the BERR web site - see paragraph 7.74.
(2) In 2007 excludes Beatrice (10 MW) which was only supplying an offshore oil platform.
(3) Excluding pumped storage stations. Capacities are as at the end of December.
(4) Includes the use of farm waste digestion, poultry litter and meat and bone.
(5) Includes the use of waste tyres, straw combustion, short rotation coppice and hospital waste.
(6) This is the proportion of fossil fuelled capacity used for co-firing of renewables based on the proportion of generation accounted for by the renewable source.
(7) Actual generation figures are given where available, but otherwise are estimated using a typical load factor or the design load factor, where known.
(8) Latest years include electricity from shoreline wave but this amounts to less than 0.05 GWh. Generation by Beatrice excluded (see note 2).
(9) Biodegradable part only.
(10) Includes the use of farm waste digestion, poultry litter combustion and meat and bone combustion.
(11) Includes the use of straw and energy crops.
(12) Non-biodegradable part of municipal solid waste plus waste tyres, hosptal waste and general industrial waste.
(13) Load factors are calculated based on installed capacity at the beginning and the end of the year - see paragraph 7.75.
(14) For a definition see paragraphs 7.76 and 7.77.

7.5 Electricity generated from renewable sources - Renewables Obligation basis and Renewables Directive basis

GWh

	2003	2004	2005	2006	2007
Generation : Renewables Obligation basis					
Wind:					
Onshore *(1)*	1,276	1,736	2,501	3,574	4,491
Offshore *(2)*	10	199	403	651	783
Solar photovoltaics	3	4	8	11r	11
Hydro:					
Small scale *(1)*	150	283	444	478r	534
Other hydro including refurbished large scale	560	1,353	1,710	1,672r	2,020
Biomass:					
Landfill gas	3,276	4,004	4,290	4,424	4,677
Sewage sludge digestion	394r	440r	470r	456r	517
Co-firing with fossil fuels	602	1,022	2,533	2,528	1,956
Animal Biomass *(3)*	535	565	468	434	555
Plant Biomass *(4)*	402	362	382	363	409
Total biomass	5,209r	6,393r	8,143r	8,204r	8,114
Total renewables generation on an obligation basis *(5)*	**7,207r**	**9,968r**	**13,209r**	**14,590r**	**15,953**
Generation : Renewables Directive basis					
Wind:					
Onshore *(1)*	1,276	1,736	2,501	3,574	4,491
Offshore *(2)*	10	199	403	651	783
Solar photovoltaics	3	4	8	11r	11
Hydro:					
Small scale *(1)*	150	283	444	478r	534
Large scale *(6)*	2,987	4,561	4,478	4,115r	4,554
Biomass:					
Landfill gas	3,276	4,004	4,290	4,424	4,677
Sewage sludge digestion	394r	440r	470r	456r	517
Municipal solid waste combustion *(7)*	965	971	964	1,083	1,177
Co-firing with fossil fuels	602	1,022	2,533	2,528	1,956
Animal Biomass *(3)*	535	565	468	434	555
Plant Biomass *(4)*	402	362	382	363	409
Total biomass	6,174r	7,364r	9,107r	9,288r	9,291
Total renewables generation on a directive basis *(5)*	**10,600r**	**14,147r**	**16,940r**	**18,116r**	**19,664**
Imports of electricity certified as CCL exempt *(8)*	2,865	3,522	3,522	3,475	..

(1) Actual generation figures are given where available, but otherwise are estimated using a typical load factor or the design load factor, where known.
(2) Includes electricity from shoreline wave but this amounts to less than 0.05 GWh.
(3) Includes the use of farm waste digestion, poultry litter combustion and meat and bone combustion.
(4) Includes the use of straw and energy crops.
(5) See paragraphs 7.7 and 7.8 for definitions.
(6) Excluding pumped storage stations.
(7) Biodegradable part only.
(8) Mainly hydro electricity exported to England from France. In the 2005 Digest these figures were included within the Renewables Directive basis but, following clarification by the European Commission, they were removed and are included in this table for information. Ofgem were not able to provide the 2007 figure at the time of publication.

7.6 Renewable sources used to generate electricity and heat and for transport fuels[1][2]

Thousand tonnes of oil equivalent

	2003	2004	2005	2006	2007
Used to generate electricity *(3)*					
Wind:					
Onshore	109.7	149.3	215.1	307.3	386.2
Offshore *(4)*	0.8	17.1	34.6	56.0	67.3
Solar photovoltaics	0.3	0.3	0.7	0.9r	0.9
Hydro:					
Small scale	12.9	24.3	38.2	41.0	46.0
Large scale *(5)*	256.9	392.2	385.0	353.9r	391.6
Biomass:					
Landfill gas	1,074.5	1,313.1	1,407.2	1,451.1	1,533.9
Sewage sludge digestion	129.3r	144.3r	154.3r	149.4r	169.5
Municipal solid waste combustion *(6)*	445.8	429.5	426.3	479.0	486.8
Co-firing with fossil fuels	197.3	335.1	830.7	829.0	641.4
Animal Biomass *(7)*	172.4	182.3	161.5	148.5	222.5
Plant Biomass *(8)*	131.8	118.8	125.2	119.0	134.1
Total biomass	2,151.3r	2,523.1r	3,105.1r	3,176.0r	3,188.2
Total	**2,531.8r**	**3,106.3r**	**3,778.7r**	**3,935.2r**	**4,080.1**
Non-biodegradable wastes *(9)*	273.8	263.9	262.0	293.7	298.3
Used to generate heat					
Active solar heating	19.8	24.6	29.4	36.3	44.9
Biomass:					
Landfill gas	13.6	13.6	13.6	13.6	13.6
Sewage sludge digestion	52.4r	54.8r	53.6r	45.7r	51.6
Wood combustion - domestic	207.8r	250.8r	286.6r	322.4r	358.3
Wood combustion - industrial	195.6	195.6	80.9	80.9	80.9
Animal Biomass *(10)*	0.3	2.0	14.4	24.9	47.8
Plant Biomass *(11)*	71.9	71.9	85.7	87.3	97.3
Municipal solid waste combustion *(6)*	33.7	33.7	33.7	33.7	33.7
Total biomass	575.3r	622.4r	568.5r	608.7r	683.2
Geothermal aquifers	0.8	0.8	0.8	0.8	0.8
Total	**595.9r**	**647.8r**	**598.7r**	**645.8r**	**728.9**
Non-biodegradable wastes *(9)*	117.1	115.7	127.5	111.6	137.3
Renewable sources used as transport fuels					
as Bioethanol	-	-	47.9	53.4	85.8
as Biodiesel	15.1	16.7	26.1	134.4	276.0
Total	**15.1**	**16.7**	**74.1r**	**187.8**	**361.8**
Total use of renewable sources and wastes					
Solar heating and photovoltaics	20.0	24.9	30.1	37.2r	45.8
Onshore and offshore wind *(4)*	110.5	166.4	249.7	363.3	453.5
Hydro	269.8	416.5	423.2	394.9r	437.6
Biomass	2,726.5r	3,145.4r	3,673.6r	3,784.7r	3,871.4
Geothermal aquifers	0.8	0.8	0.8	0.8	0.8
Transport fuels	15.1	16.7	74.1	187.8	361.8
Total	**3,142.8r**	**3,770.8r**	**4,451.4r**	**4,768.7r**	**5,170.8**
Non-biodegradable wastes *(9)*	390.9	379.6	389.5	405.3	435.6
All renewables and wastes *(12)*	**3,533.7r**	**4,150.4r**	**4,840.9r**	**5,174.0r**	**5,606.5**

(1) Includes some waste of fossil fuel origin.
(2) See paragraphs 7.33 to 7.77 for technical notes and definitions of the categories used in this table
(3) For wind, solar PV and hydro, the figures represent the energy content of the electricity supplied but for biomass the figures represent the energy content of the fuel used.
(4) Latest years includes electricity from shoreline wave but this is less than 0.05 ktoe.
(5) Excluding pumped storage stations.
(6) Biodegradable part only.
(7) Includes electricity from farm waste digestion, poultry litter combustion and meat and bone combustion.
(8) Includes electricity from straw and energy crops.
(9) Non-biodegradable part of municipal solid waste plus waste tyres, hospital waste, and general industrial waste.
(10) Includes heat from farm waste digestion, meat and bone combustion and sewage sludge combustion.
(11) Includes heat from straw, energy crops, paper and packaging.
(12) The figures in this row correspond to the total demand and total supply figures in Tables 7.1, 7.2 and 7.3.