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 covers the use of renewables to generate electricity, the burning of renewable fuels to produce heat either in boilers (or cookers) or in combined heat and power (CHP) plants, and the use of liquid biofuels for transport. The chapter includes some 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 these wastes are still shown in the tables of this chapter but as "below the line" items.

7.2 The data summarise the results of DECC surveys of electricity generators, information from CHP schemes, and an ongoing study undertaken by the AEA on behalf of DECC 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.

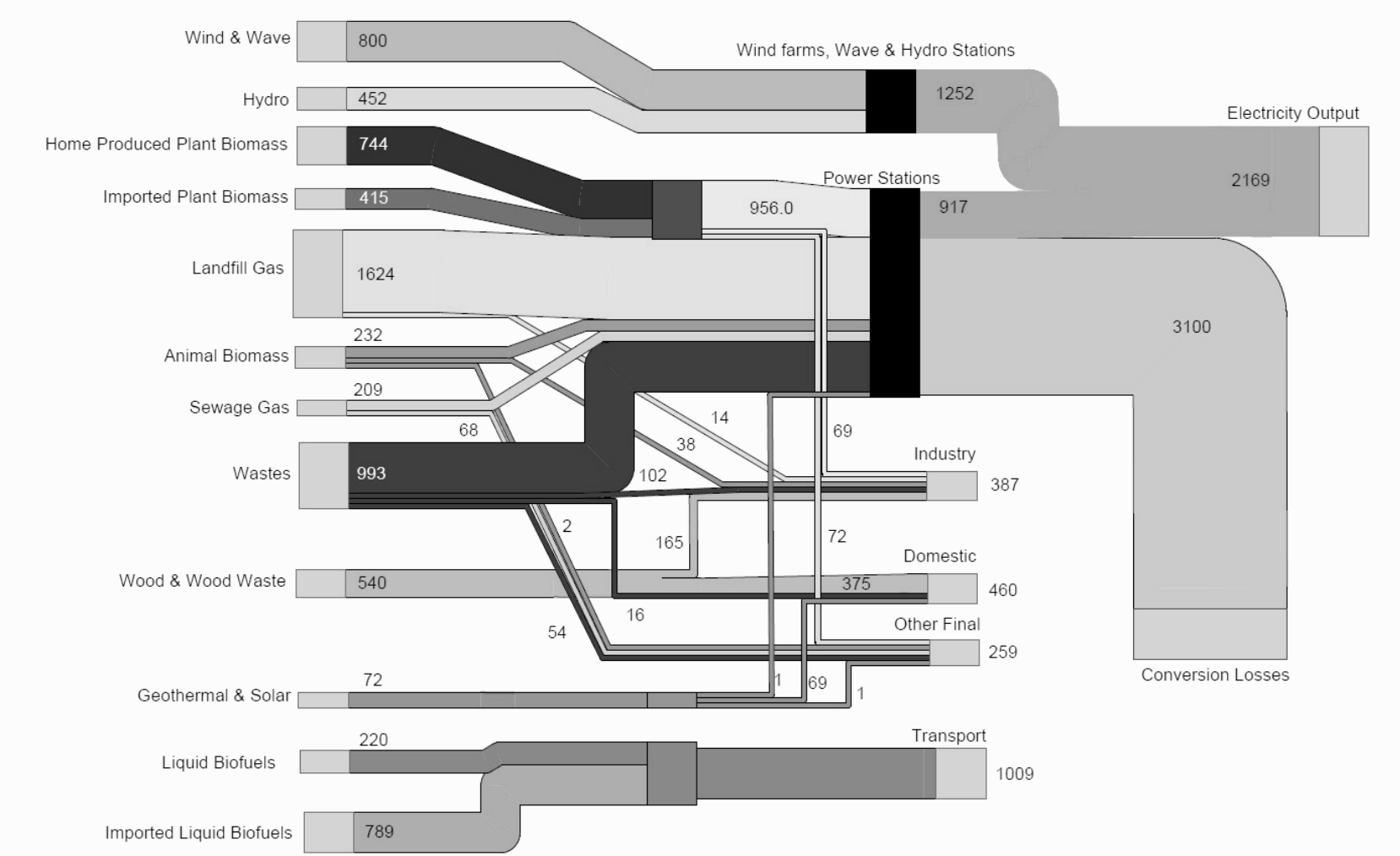
7.3 The AEA study started in 1989, when all relevant renewable energy sources were identified and, where possible, information was collected on the amounts of energy derived from each source. The renewable energy sources identified were the following: active solar heating; photovoltaics; onshore and 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 21 years of data from 1989 to 2009. Information on RESTATS has recently been combined with data obtained from monitoring the planning process for new renewable installations to ensure it is comprehensive.

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, and in a guidance note on the DECC website at: www.decc.gov.uk/en/content/cms/statistics/source/renewables/renewables.aspx

7.5 A renewable energy flow chart for 2009, showing the flows of renewables from fuel inputs through to consumption, is included 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 in this chapter (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, measurement, or differences between supply and demand. These balance tables are followed by 5-year tables showing capacity of, and electricity generation from, renewable sources (Table 7.4), and electricity generation only from sources eligible for the Renewables Obligation (RO) (Table 7.5). Table 7.6 shows renewable sources used to generate electricity, to generate heat, and for transport purposes in each of the last five years. Table 7.7 shows the UK's progress against the 2008 EU Renewable Energy Directive target; the layout of this table has been amended compared with the version in the 2009 edition of the Digest; it now contains more detail on the separate components of the target . A long-term trends commentary and table (Table 7.1.1) covering the use of renewables to generate electricity, to generate heat, and as a transport fuel is available on DECC's energy statistics web site and accessible from the Digest of UK Energy

Renewables flow chart 2009 (thousand tonnes of oil equivalent)



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

Statistics home page: www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx
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 Obligation

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; the proportion is measured against total electricity sales (as shown in Table 5.5 contained in the electricity chapter of this Digest). 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 Renewables Directive, see paragraph 7.9, below). All stations outside the United Kingdom (the UK includes its territorial waters and the continental shelf) are also excluded. 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 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 in Table 7.1.2 on the DECC energy web site (see paragraph 7.6, above).

Renewables Directives

7.9 The European Union's Renewables Directive (Directive 2001/77/EC) ('RD') came into force in October 2001. It proposed that Member States adopt national targets for renewables that were 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 was that renewables sources eligible under the RD should account for 10 per cent of UK electricity **consumption** by 2010; the denominator for this target is shown as "total demand" in Table 5.1 contained in the electricity chapter of this Digest. 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. During 2008 a new Renewable Energy Directive (Directive 2009/29/EC) ('RED') was negotiated on this basis and resulted in agreement of country "shares" of this target. For the UK, its share is that 15 per cent of **final energy consumption** - calculated on a net calorific value basis, and with a cap on fuel used for air transport - should be accounted for by energy from renewable sources by 2020 (see paragraphs 7.30 to 7.33, below). The Government published, as part of its Low Carbon Transition Plan, a UK Renewable Energy Strategy in July 2009, setting out policy measures and scenario based analysis showing how the UK aimed to meet the 15 per cent target.

UK Renewables Policy

7.10 The United Kingdom has a number of measures to increase renewables deployment. These include:

- Putting in place appropriate financial incentives to bring forward and support the take-up of renewable energy, including "banding" the Renewables Obligation and the introduction of feed in tariffs for small scale electricity generation from April 2010;

- Identifying and removing the most significant non-financial barriers to renewables deployment, including measures to improve existing grid connection arrangements; and

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

- Overcoming supply chain blockages and promoting business opportunities in the renewables sector in the UK.

The Renewables Obligation

7.11 The Renewables Obligation (RO)[2] is an obligation on electricity suppliers to supply a specific and growing proportion of electricity from eligible renewable sources in order to increase the level of renewable generating capacity and so contribute to our climate change targets. Examples of RO eligible sources are listed in Table 7A. The Office for Gas and Electricity Markets (Ofgem), which administers the RO, issues Renewables Obligation Certificates (ROCs) to qualifying renewables generators as evidence that the electricity has been generated and supplied or used in a permitted way in the United Kingdom. These certificates may be sold by generators directly to licensed electricity suppliers or traders. ROCs can be traded separately from the electricity to which they relate.

Table 7A: Examples of eligible Renewables Obligation sources of energy

Wind energy (offshore and onshore)	Geothermal (hot dry rock and aquifers)
Tidal and tidal stream	All biodegradable material
Wave energy	Landfill gas and sewage gas
Photovoltaics	Co-firing of biomass with fossil fuel
Hydro power [excluding hydro power from plants exceeding 20 MW DNC]	Agriculture and forestry wastes, and energy crops

7.12 The Renewables Obligation Order (ROO) 2009[3] introduced a number of changes including the introduction of "banding". This provides increased support to technologies that are less well-developed or further from the market, such as offshore wind (1.5 ROCs/MWh), wave and tidal (2 ROCs/MWh), and dedicated energy crops (2 ROCs/MWh). Advanced gasification and pyrolysis, as well as anaerobic digestion, also now receive 2 ROCs/MWh. Following an early review of the banding for offshore wind, the level of support for this technology further increased from 1.5 ROCs/MWh to 2 ROCs/MWh for stations or capacity accredited between 1 April 2010 and 31 March 2014[4]. Onshore wind continues to receive 1 ROC/MWh. New developments in the more established renewable technologies now receive less support; for example, sewage gas receives 0.5 ROCs/MWh and landfill gas receives 0.25 ROCs/MWh.

Feed-in Tariffs

7.13 Feed in tariffs (FITs)[5] are a financial support scheme for eligible low-carbon electricity technologies, aimed at small-scale installations up to a maximum capacity of 5 Megawatts (MW). FITs support new anaerobic digestion, hydro, solar photovoltaic and wind projects up to that 5MW limit, by requiring electricity suppliers to make payments (generation tariffs) to generators based on the number of kilowatt hours (kWh) they generate. An additional guaranteed export tariff of 3p per kWh is paid for electricity generated that is not used on site and exported to the grid. The scheme will also support the first 30,000 micro combined heat and power installations with an electrical capacity of 2kW or less, as a pilot programme.

Commodity balances for renewables in 2009 (Table 7.1), 2008 (Table 7.2) and 2007 (Table 7.3)

7.14 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

[2] The Renewables Obligation covering England and Wales and the analogous Renewables (Scotland) Obligation came into effect in April 2002. Northern Ireland introduced a similar Renewables Obligation in April 2005.

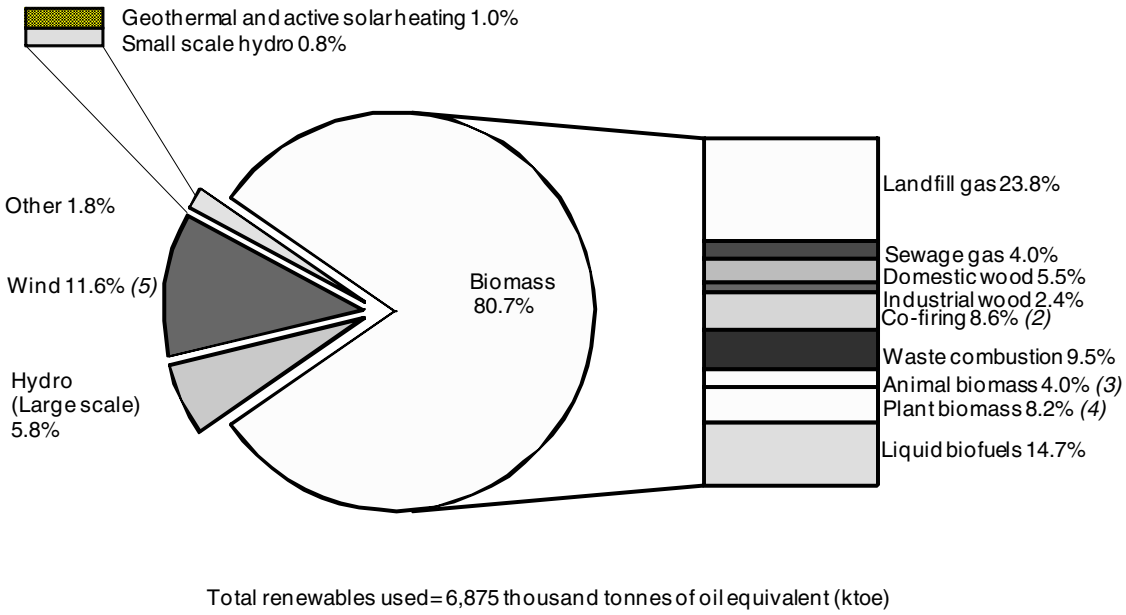
[3] The Renewables Obligation Order (ROO) 2009 came into effect on 1 April 2009.

[4] This increased level of support will apply to the whole station accredited within the period or to all of the additional capacity accredited in the period. It therefore includes any turbines that form part of the station or the additional capacity, even if some of those turbines are yet to be installed.

[5] The Feed-in Tariff scheme (FITs), introduced on 1 April 2010 provides a guaranteed payment, made directly by electricity suppliers, for each unit of low-carbon electricity generated by small-scale projects up to 5MW capacity and for each unit of electricity generated that is not used on site and exported to the grid.

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. The largest contribution to renewables in **input** terms (81 per cent) is from biomass, with wind generation and large-scale hydro electricity production contributing the majority of the remainder as Chart 7.1 shows. 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 2009 *(1)*



(1) Excludes all passive use of solar energy and all (509 ktoe) non-biodegradable wastes. In this chart renewables are measured in primary input terms.
(2) Biomass co-fired with fossil fuels in power stations; imported 6.0 per cent of total renewables, home produced 2.6 per cent
(3) 'Animal biomass` includes farm waste, poultry litter, and meat and bone combustion.
(4) 'Plant biomass' includes straw and energy crops.
(5) 'Wind' includes energy from shoreline wave and tidal generation, but this accounted for less than 0.1ktoe

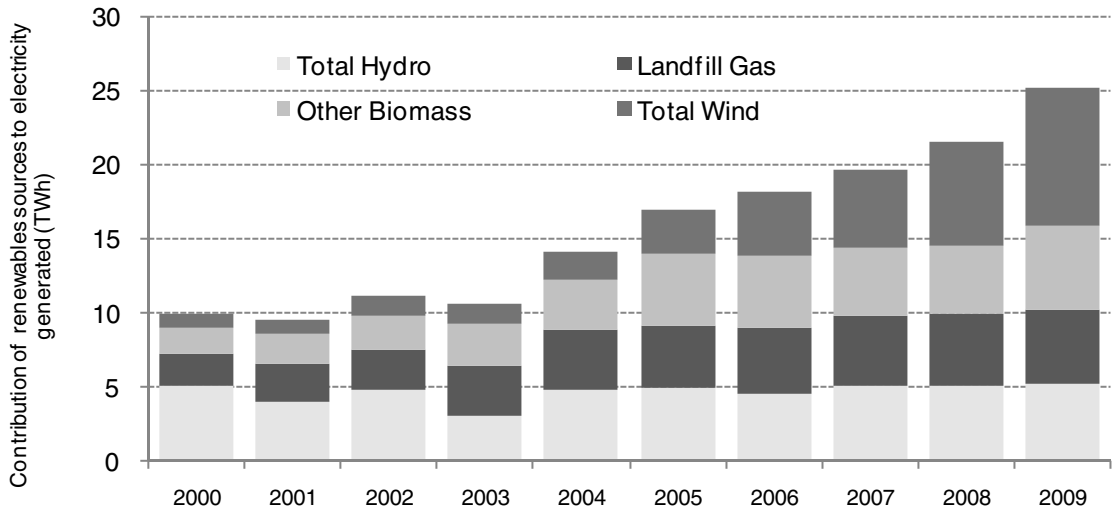
7.15 Nearly three-quarters (71 per cent) of the renewable energy (excluding non-biodegradable wastes) produced in 2009 was transformed into electricity. This is a similar proportion to that recorded in 2008, but a decrease from 79 per cent in 2007 and 83 per cent in 2006, because the use of biofuels for transport use has grown at a faster rate than the use of renewables for electricity generation. 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 the inputs are deemed to be equal to the electricity produced for hydro, wind, wave and solar (see Chapter 5, paragraph 5.66). However 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 180, illustrates).

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

7.16 Table 7.4 shows the capacity of, and the amounts of electricity generated from, each renewable source. Total electricity generation from renewables in 2009 amounted to 25,222 GWh, an increase of 3,642 GWh (+17 per cent) on 2008. The main contributors to this substantial increase were 1,772 GWh from onshore wind (+31 per cent), 435 GWh (+33 per cent) from offshore wind, 541

GWh (+95 per cent) from plant biomass, 285 GWh (+23 per cent) from combustion of biodegradable municipal solid waste, 195 GWh (+4 per cent) from landfill gas, and 193 GWh from the co-firing of biomass with fossil fuels. Generation from wind (both onshore and offshore) was the largest renewables technology in output terms in 2009, with 37 per cent of the electricity generated by renewable sources being from wind, 21 per cent was from hydro sources, 20 per cent from landfill gas, 7 per cent from co-firing, and 15 per cent from other biomass. Chart 7.2 shows the amount of electricity generated, split into four renewable source categories, since 2000.

Chart 7.2: Electricity generation by main renewable sources since 2000



7.17 Renewable sources provided 6.7 per cent of the electricity generated in the United Kingdom in 2009, 1.2 percentage points higher than in 2008. Table 7B and Chart 7.2 show the growth in the proportion of electricity produced from renewable sources. The table also includes the progress towards the electricity renewables target set under the RO (see paragraph 7.7 above and paragraph 7.23, below), and progress towards the 2001 RD and 2008 RED (see paragraph 7.9 above); the growth path for the RD and RED follows a very similar trend to the international definition basis.

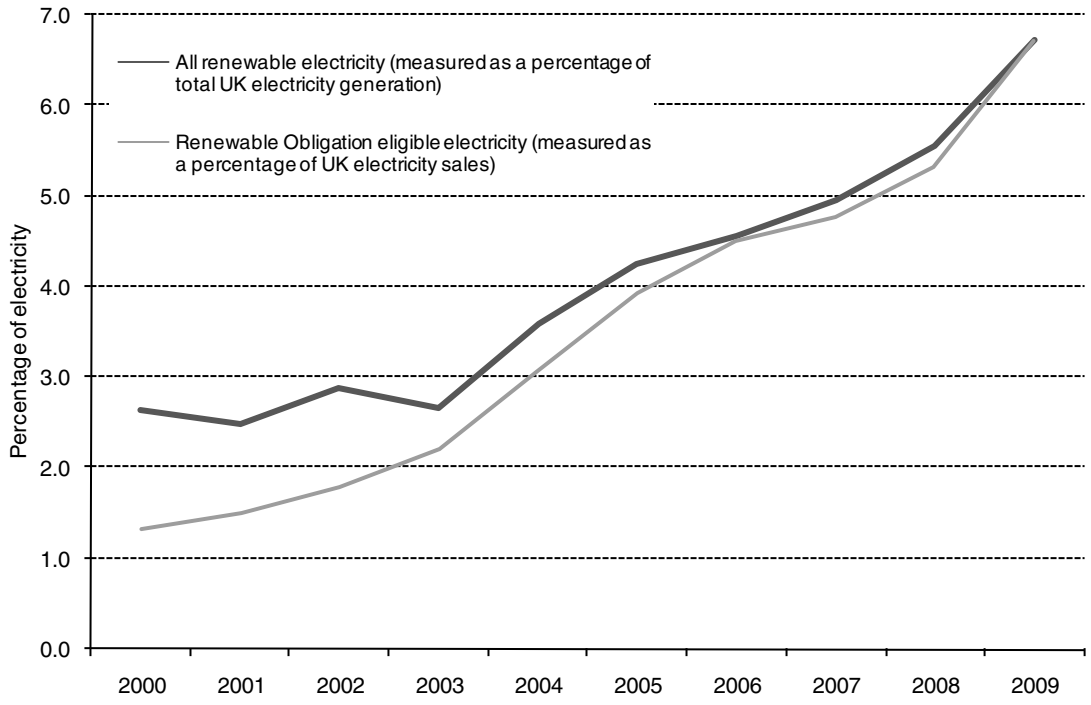
Table 7B: Percentages of electricity derived from renewable sources

	2005	2006	2007	2008	2009
Overall renewables percentage (international basis)	4.3	4.6	5.0	5.6	6.7
Percentage on a Renewables Obligation basis	3.9	4.5	4.8	5.3	6.7
Percentage on a 2001 Renewables Directive basis	4.2	4.5	4.9	5.4	6.7
Percentage on a 2008 Renewable Energy Directive basis	4.1	4.5	4.8	5.4	6.7

7.18 As shown in Table 7B, during 2009 renewable generation measured using the RO basis also increased to 6.7 per cent, as a proportion of electricity sales by licensed suppliers. The increases in the percentages shown in Table 7B are mainly due to growth in the numerators (ie the renewables element). However reduced electricity generation, sales and consumption have also helped increase the percentages by reducing the denominators in the calculations: between 2008 and 2009 electricity generation (used as the denominator in the international basis calculation) fell by 3.3 per cent; similarly electricity sales by licensed suppliers (for the RO basis) fell by 5.5 per cent; electricity demand (for the RD basis) was 5.2 per cent lower; and gross electricity consumption (for the RED measure) fell by 5.2 per cent. Since the introduction of the RO in 2002 generation from wind has increased on average by one third each year.

7.19 Installed generation capacity reached 8,031 MWe at the end of 2009, an increase of 1,127 MWe (+18 per cent) during the year. The main contributors to this increase were 663 MWe (+24 per cent) from onshore wind, 355 MWe (+61 per cent) from offshore wind, 81 MWe (+41 per cent) from plant biomass and 77 MWe (+8 per cent) from landfill gas.

Chart 7.3: Growth in electricity generation from renewable sources since 2000

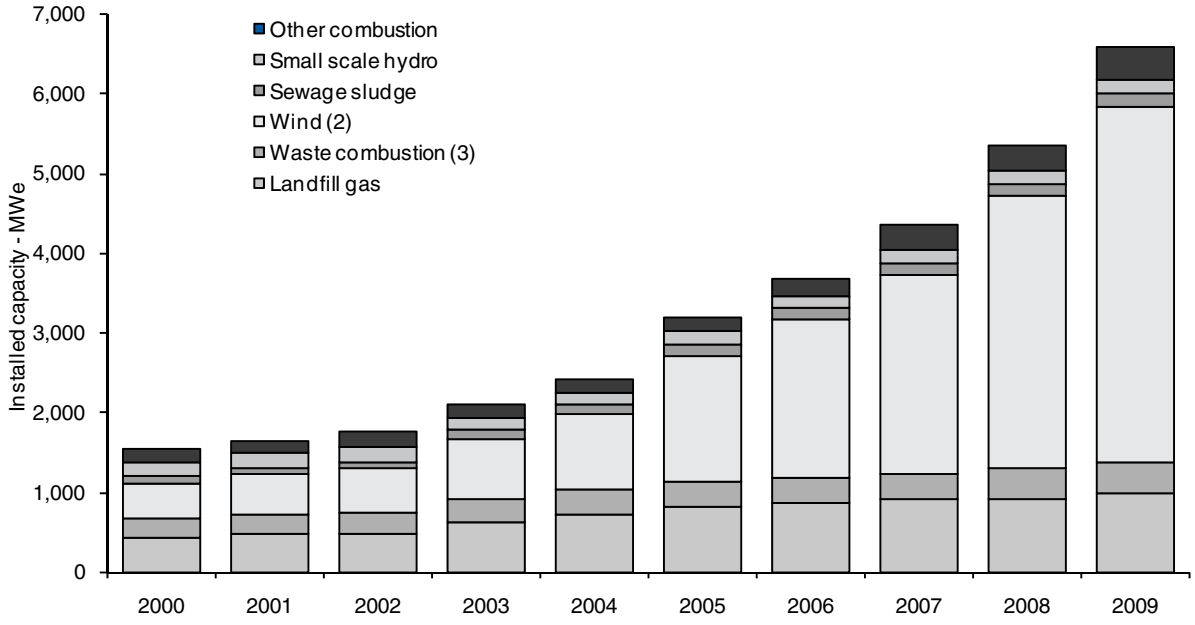


7.20 Chart 7.4 (which covers all renewables capacity except large scale hydro) illustrates the continuing increase in the electricity generation capacity from all significant renewable sources. This upward trend in the capacity of renewable sources will continue as recently consented onshore and offshore windfarms and other projects come on stream. The map, shown on page 189, shows the location of wind farms in operation at the end of December 2009, together with an indication of the capacity.

7.21 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. For instance, the dry weather in 2006 resulted in a reduced hydro load factor, and the lowest average wind speeds since 2005 had an adverse impact on wind load factors during 2009. Plant load factors for all generating plant in the UK are shown in Chapter 5, Table 5.10.

7.22 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 7.81 to 7.83 for the full definitions. In 2009, this “unchanged configuration” load factor for onshore wind farms was slightly lower than the all-onshore factor, whilst the opposite was true for offshore wind farms. The off-shore capacity at Rhyl Flats (90MW) which came on line on 28 December 2009, had the impact of reducing the all-offshore factor by 1½ percentage points.

Chart 7.4: Electrical generating capacity of renewable energy plant (excluding large-scale hydro)[1]



(1) Large scale hydro capacity was 1,459 MWe in 2009.

(2) Wind includes both onshore and offshore and also includes an estimate for solar photovoltaics (26.5 MWe in 2009) and shoreline wave (2.5 MWe in 2009).

(3) All waste combustion plant is included because both biodegradable and non-biodegradable wastes are burned together in the same plant.

Electricity generated from renewable sources: Renewables Obligation basis (Table 7.5)

7.23 Electricity generated in the UK from renewable sources eligible under the RO in 2009 was 19 per cent greater than in 2008. This compares with growth of 12 per cent and 6 per cent in 2008 and 2007 respectively. Chart 7.3 shows the growth in the proportion of electricity produced from renewable sources under the Renewables Obligation and international definitions. Table 7B shows electricity eligible under the RO as a percentage of electricity sales. RO eligible generation has increased by more than 15 TWh since its introduction in 2002, an increase of 266 per cent, although some of this is due to existing hydro stations being refurbished and thus becoming within the scope of the RO definition, as opposed to new capacity being installed. This compares with an all-renewable electricity generation figure that has increased by 127 per cent over the same period, but from a higher starting level.

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

7.24 Between 2008 and 2009 there was an increase of 14.6 per cent in the **input** of renewable sources into electricity generation. Wind grew by 31.1 per cent, hydro by 1.8 per cent; biomass use increased by 13.2 per cent.

7.25 Table 7.6 also shows the contribution from renewables to heat generation. Around 14 per cent of renewable sources were used to generate heat in 2009. Renewables used to generate heat declined to a low point in 2005 but since then increased by 62 per cent to 966 ktoe. The decline was mainly due to tighter emissions controls discouraging on-site burning of biomass, especially wood waste by industry. Domestic use of wood accounts for 39 per cent of all renewables used for heat; plant biomass is the second largest component, at 21 per cent.

Liquid Biofuels

7.26 It is estimated that 223 million litres of biodiesel were produced in the UK in 2009, under half the amount produced in 2007 (485 million litres). 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; further information on this is given in Chapter 3 (see page 61). However, it was estimated that around 1 per cent was used in 2008 to generate electricity. Until 31 March 2010, the duty payable on biodiesel (and bioethanol) was 20 pence per litre less than the duty payable on road diesel and petrol; in blended fuels the duty payable is proportionate to the duty payable on the constituent fuels. The duty differential was removed on 1 April 2010, except for biodiesel production from waste cooking oil. The HMRC figures show that 1,044 million litres of biodiesel were consumed in 2009, up from 886 million litres in 2008, and 347 million litres in 2007. Therefore around 821 million litres of biodiesel were imported in 2009. The total annual capacity for biodiesel production in the UK in 2010 is estimated to be 463 million litres. This reduced capacity, compared to that reported in last year's Digest, is due to continuing adverse market conditions with a number of significant producers going out of business in 2009 and other plant operating at reduced output.

7.27 HMRC data show that 317 million litres of bioethanol was consumed in the UK in 2009; this continues a trend of increasing bioethanol use that started with 85 million litres in 2005, and is 54 per cent higher than 2008. Only one large scale UK plant was in production in 2009, and so the majority of the bioethanol was imported.

7.28 The HMRC data have been converted from litres to tonnes of oil equivalent and the data are now shown in both the commodity balances (Tables 7.1 to 7.3) and in Table 7.6. In addition these data are also included in the aggregate energy balances (Tables 1.1 to 1.3). The tables show the increasing contribution that liquid biofuels are making towards total renewable sourced energy. In 2009 15 per cent of the renewable sources used in the UK in primary input terms were liquid biofuels for transport, up from 14 per cent in 2008, 7 per cent in 2007, and less than half a per cent in 2003.

7.29 A further source of statistical information on liquid biofuels is from the Renewable Fuels Agency (RFA). The RFA were set up to implement the Renewable Transport Fuel Obligation (RTFO), which came into force on 15 April 2008. The RFA administers the monthly reporting process required of fuel companies under the RTFO, issuing Renewable Transport Fuel certificates in proportion to the quantity of biofuels registered. AEA are working closely with the RFA in relation to the provision of data on the sustainability of biofuels – a key aspect of the data required for the Renewable Energy Directive, and DECC hope to use this data in future years.

Renewable sources data used to indicate progress under the EU Renewable Energy Directive 2008 (Table 7.7)

7.30 As discussed in paragraph 7.9, the Renewable Energy Directive has a target for the UK to obtain 15 per cent of its energy from renewable sources by 2020. The target uses a slightly different definition of renewable and total energy than is used in the rest of the Digest. 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. Gross final energy consumption (which is calculated on a net calorific value basis) also 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. Additionally, the Directive includes a cap on the proportion that air transport can contribute to the total; this cap is currently 6.18 percent; certain fuels also receive a higher weighting in the calculation, with full details being set out in the Directive, which is available at:
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF.

7.31 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 to 2009 have been calculated on a net calorific value basis and are available in Table I.1 at:
www.decc.gov.uk/en/content/cms/statistics/source/total/total.aspx

7.32 The layout of Table 7.7 has been altered since it was introduced for the first time in the 2009 edition of the Digest. It brings together the relevant renewable energy and final energy consumption data to show progress towards the target of 15 per cent of UK energy consumption to be sourced from

renewables by 2020, and also shows the proportions of electricity, heat and transport energy coming from renewables sources.

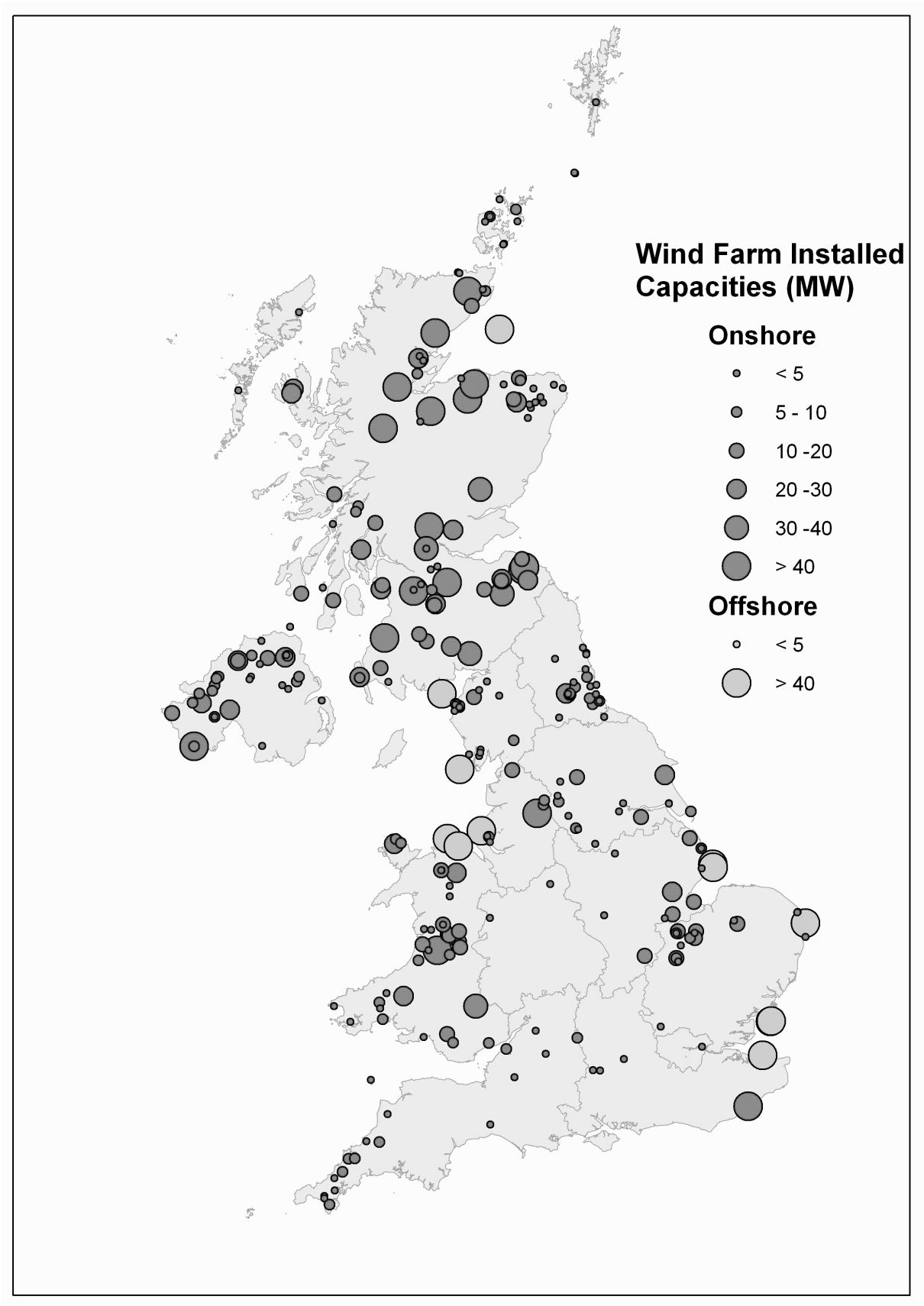
Table 7C: Percentages of energy derived from renewable sources

	2005	2006	2007	2008	2009
Percentage of capped gross final energy consumption (ie the basis proposed by Eurostat for the Renewable Energy Directive)	1.4	1.6	1.8	2.4	3.0
Percentage of primary energy demand (ie the basis previously quoted in this Digest)	1.8	2.0	2.2	2.6	3.1

7.33 Table 7C shows that overall, renewable sources, excluding non-biodegradable wastes and passive solar design (see paragraph 7.37), continues to increase and provided 3.1 per cent of the United Kingdom's total primary energy requirements in 2009. On the basis used to monitor the Renewable Energy Directive, the UK percentage rose by 0.6 percentage points in 2009 to 3.0 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 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 gross final energy consumption percentage will overtake the primary energy demand percentage. A proportion of the increase in both these percentages can be attributed to a reduced energy consumption / demand; for instance the "capped gross final energy consumption" used as the denominator in the Renewable Energy Directive measure was 6.7 per cent lower in 2009 compared to 2008, whilst the renewable component increased by 15.6 per cent – if the denominator in 2009 had remained the same as it was in 2008, the contribution of renewable energy would have been around 0.2 percentage points lower.

7.34 A proportion of the electricity imported into the United Kingdom is certified as being exempt from the Climate Change Levy (CCL) because it has been produced from renewable sources. The UK cannot count this electricity as contributing towards its EU renewables target because its origin is other EU Member States and it is already being counted in their own electricity generation figures. It is estimated by the Office of the Gas and Electricity Markets (Ofgem) that imports of electricity counted as CCL exempt amounted to 6,817GWh in 2009; this compares to 7,589 GWh in 2008, and 2,173 GWh in 2007.

The Location of Wind Farms in the United Kingdom, as at 31 December 2009.



Technical notes and definitions

7.35 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 223 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 5.66). 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 7.80, below).

7.36 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 DECC energy web site.

Use of existing solar energy

7.37 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

7.38 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 DECC). For 2009, an estimated 113 GWh for domestic hot water generation replaces gas and electricity heating; for swimming pools, an estimated 493 GWh generation replaces gas (45 per cent), oil (45 per cent) or electricity (10 per cent).

Photovoltaics

7.39 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. The PV installed capacity in the UK increased from 10.9 MW in 2005 to 14.3 MW in 2006, 18.1 MW in 2007, 22.5 MW in 2008 and an estimated 26.5 MW in 2009. There have been significant increases in capacity and generation of PV in recent years due to increased support from policy incentives; firstly through the Major Photovoltaic Demonstration Programme between 2002 and 2006 and then the Low Carbon Buildings Programme (LCBP) between April 2006 and May 2010. The LCPB provided grants for photovoltaic installations, alongside other microgeneration technologies and was divided into two streams; Phase 1 for private households and Phase 2 for public-sector buildings and charitable bodies – Phases 1 and 2 closed to new PV applications on 24th May and 3rd February 2010 respectively. Support for PV, and other microgeneration technologies, is now provided through a system of Feed-In Tariffs (also known as the Clean Energy Cashback scheme) introduced in April 2010. This provides householders and communities who generate their own electricity with regular payments through their energy supplier. Payments consist of a tariff for each unit of electricity generated together with a second tariff for each unit of electricity that is then exported to grid. Tariffs are to be linked to the Retail Price Index and support for individual PV schemes will last for 25 years. Specific tariff levels are dependant on size and type of installation (i.e. retro-fit, new build or standalone).

Onshore wind power

7.40 Onshore wind is one of the most mature renewable energy technologies. The UK has an excellent onshore wind resource with wind speeds particularly good in Scotland, Northern Ireland and Wales, (less so in England, particularly the South East). A wind turbine extracts energy from the wind by means of a rotor (usually a three-bladed horizontal-axis rotor) that can be pitched to control the rotational speed of a shaft linked via a gearbox to a generator.

7.41 The UK's first commercial wind farm, the Delabole wind farm in Cornwall, began generating electricity in November 1991. Installed capacity has increased every year since, although installation rates vary year on year; the maximum installed in one year of 737MW (in 2008). The introduction of the Renewables Obligation (RO) has proved a more attractive incentive to developers than the NFFO it replaced and the rate of installation of new wind farms has increased since its introduction in April 2002. As at end December 2009, the UK has about 3.5 GW of installed capacity, from more than 500 wind schemes in the UK. Turbine size has steadily increased over the years and the average new turbine size is around 2.5MW. The increased tower height associated with the increased turbine size has increased wind capture (wind speed generally increases with height above ground level) and turbine design has improved and become more sophisticated – both of these leading to improvements in efficiency over the early models, prompting many of the early projects to re-power (replacing ageing turbines with more efficient ones). 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 7.82 and 7.83 regarding load factors) and the wind farm installed capacity

7.42 The Energy Act 2008 established enabling powers for the introduction of Feed-in Tariffs (FITs) to supplement the RO and incentivise small-scale low-carbon electricity generation (including wind), up to a maximum limit of 5 megawatts (MW) capacity. A consultation process commenced in 2009 on how Government intended the FITs scheme to work, including the proposed tariff levels. FITs are predicted to stimulate fast growth in the small-medium wind market (15–100kW), in which generated energy is predominantly used to satisfy on-site demand[6]. Small wind system technology can be subdivided into three categories: micro wind turbines (0–1.5kW), small wind turbines (1.5–15kW) and small–medium wind turbines (15–100kW). The two main designs are the horizontal axis wind turbines (HAWT) and vertical axis wind turbines (VAWT).

7.43 In terms of operational characteristics, siting considerations and the value and nature of the market, small-scale wind systems vary markedly from large-scale units. They can be off-grid or on-grid, mobile or fixed, free-standing or building-mounted, and can form part of combined installations, most commonly with photovoltaic systems. As a result, they have a greater range of applications compared to large-scale wind turbines and can be sited on board boats, in commercial, public and domestic settings or as single or multiple installations providing power to communities. With the arrival of new financial incentives it is anticipated that the main growth market will be for those applications connecting to the grid, with free-standing turbines continuing to make up the greatest share of installations. It is estimated there were around 14,280 small wind system units (up to 100kW) deployed in the UK up to the end of 2008.[7], with an installed generating capacity of around 26 MW. Approximately 80 per cent of all small-scale turbine units are micro-wind turbines that provide around 9 MW of generating capacity. Electricity generated from small-scale wind has been estimated to have reached between 16 to 33 GWh.

Offshore wind power

7.44 The UK has the largest offshore wind resource in the world, with relatively shallow waters and strong winds extending far into the North Sea. Offshore wind is expected to make the single biggest contribution towards the Government's target of 15 per cent of energy from renewable sources by 2020.

7.45 Offshore winds tend to flow at higher speeds and are more consistent than on land, thus allowing turbines to produce more electricity (because the potential energy produced from the wind is directly proportional to the cube of the wind speed, increased wind speeds of only a few miles per hour can produce a significantly larger amount of electricity). Due to economies of scale, offshore turbines

[6] Renewable-UK, "Small Wind Systems – UK Market Report" (April 2010)
[7] UK Small-Scale Wind Survey: Installed Capacity, Annual Generation & Market Growth (AEA 2009)

are also larger than their onshore counterparts. Today's operational offshore wind turbines are essentially marinised versions of land-based turbines. The current commercially available turbines have a rated capacity of between 3 MW and 5 MW. Design variations currently being pursued include increasing turbine capacities (up to 10 MW), direct drive generators (removing the need for transmission gearboxes and offering the prospect of simplicity and high reliability) and floating concepts are also being developed as they are considered by many to be more viable (both economically and environmentally) in deeper waters. In addition, onshore constraints such as planning, noise effects and visual impact are reduced offshore.

7.46 The UK offshore wind industry is now the largest in the world. As at the end of 2009, 12 offshore wind farms have been built around the UK coastline, equating to 941 MW of installed capacity. The operational projects are Barrow (90MW), Blyth (4MW), Burbo Bank (90MW), Gunfleet Sands I&II (173MW), Kentish Flats (90MW) Lynn and Inner Dowsing (194MW), North Hoyle (60MW), Rhyl Flats (90MW), Robin Rigg I&II (180MW) and Scroby Sands (60MW). In addition, Beatrice (10 MW) provides electricity to the neighbouring offshore oil platform although its capacity and generation are not included in the UK figures.

7.47 In January 2010, The Crown Estate announced the successful bidders for each of the nine new Round 3 offshore wind zones, potentially totalling 32GW in capacity. This is considered sufficient to ensure that the 25GW that has been enabled by the Government's SEA for offshore renewable energy can be achieved. This is in addition to the 8GW already enabled across Rounds 1 and 2. The combined total of all leasing rounds is over 49GW (including sites in Scottish Territorial Waters and Round 1/2 extensions).

Wave and Tidal Stream Power

7.48 Ocean waves are created by the interaction of winds with the surface of the sea. Because of the UK's position on the north eastern rim of the Atlantic it has some of the highest wave power levels in the world. Tidal currents are created by the movement of the tides, often magnified by local topographical features such as headlands, and channels. Tidal current energy is the extraction of energy from this flow, analogous to the extraction of energy from moving air by wind turbines. A recent study estimated that the available UK resource could be up to 22 TWh per year.

7.49 The UK is currently seen as the world leader in wave and tidal stream energy. Many of the leading device concepts were developed in the UK, including the Limpet, the Pelamis, the Aquamarine Oyster, the Seagen tidal turbine and several others. A number of developments in support for wave and tidal stream have occurred in the past year. These include:

- In March 2010 the Crown Estate announced the results of its Pentland Firth and Orkney Waters wave and tidal commercial leasing round. They have granted leases for six wave and four tidal sites in the waters off the north of Scotland. If fully developed, these sites could have a nameplate capacity totalling 1.2 GW.
- The Scottish Government's enhanced ROC bands (5 ROCs/MWh for wave and 3 for tidal stream) came into force in July 2009.
- The South West Regional Development Agency's (SWRDA's) proposed Wave Hub off the north coast of Cornwall is now under construction, managed by subsea and pipeline engineering company J P Kenny.
- In September 2009 DECC's Marine Renewables Proving Fund, with a value of £22M, was introduced, and in December 2009 the award of grants to Atlantis Resources Corporation, Aquamarine Power, Hammerfest Strøm UK, Marine Current Turbines, Pelamis Wave Power and Voith Hydro were announced.
- In March 2010 Scottish Enterprise launched a £12M Wave and Tidal Energy: Research, Development and Demonstration Support fund (WATERS).
- A full scale device deployment also occurred during the last year - a 315 kW nameplate capacity Aquamarine Oyster device – a nearshore bottom mounted hinged flap device designed to operate in around 10m of water – was installed at EMEC in the 2nd half of 2009.

Large scale hydro

7.50 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 DECC 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 included under "large scale" before 2004 are now under "small scale". There is some 1,459 MW of installed capacity for large-scale hydroelectric schemes in the UK. In 2008, the Glendoe project, the largest hydro scheme built for many years, went operational but is currently experiencing difficulties. 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 5.64).

Small scale hydro

7.51 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. The results from this exercise were supplemented with a survey of small-scale schemes undertaken in 2008 which essentially helped to 'clean up' the data. Currently there is 186 MW of installed small-scale hydro schemes. Of this, 58 per cent is owned by small-scale energy producers with the remainder owned by major power producers. Of the 344 schemes in existence, around three quarters (77 per cent) claim ROCs, with 45 schemes having current NFFO contracts. There was a small increase in installed capacity during 2009 of 13 MW.

Geothermal aquifers

7.52 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

7.53 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 benefited considerably from NFFO and this can be seen from the large rise in the amount of electricity generated since 1992. Ofgem's ROCs database 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 DECC, and covered the period up to the end of 2007, as part of data cleansing activities. In 2009 the number of operating landfill gas sites increased by 16, with a corresponding increase in installed capacity of 77 MW.

(b) Sewage sludge digestion

7.54 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 DECC (see Chapter 6). Within the CHAPSTATS database the majority of the data are gathered through the CHP Quality Assurance (CHPQA) Programme. However, many sewage treatment works are not part of the CHPQA Programme, and to allow these CHP schemes to be included in the statistics data provided to Ofgem, via the ROC registers, is used. In respect of these schemes, estimates of electrical efficiencies and heat to power ratios typical of the technology and capacity are used to determine fuel inputs and heat outputs. In this year's statistics, data for 11 percent of the schemes (22 per cent of the capacity) were from CHPQA and data for 89 per cent of the schemes (78 per cent by capacity) were from RESTATS (i.e. ROCs registers).

(c) Domestic wood combustion

7.55 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. 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.

7.56 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 and, following peer review, are now confident enough to remain with the historic changes to these data, made in 2008, the first time since the survey began in 1989. This was based a 50 per cent growth rate over a 2 to 3 year period based on anecdotal information and subsequently supported from other sources (HETAS, National Association of Chimney Sweeps and discussions with a risk assessor acting on behalf of insurance companies). In 2008, the Forestry Commission undertook a wood fuel study but figures for end use were not gathered. As such, DECC have decided to remain with our current approach, which may be revised at a later date when we have better information. Discussions are currently underway with the Forestry Commission with the view to making further improvements.

(d) Industrial wood combustion

7.57 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. Follow-up surveys in 2000 and 2006 highlighted that the in-house use of wood was in decline than in 1996 due to the imposition of more stringent emissions control. There is, however, increased interest in off-site use of untreated wood for space heating in schools, hospitals, nursing homes, government buildings, etc. In 2009, a follow up survey of industrial wood use was undertaken, together with an an analysis of schemes receiving funding under the Bio-Energy Capital Grants Scheme (BECGS) which has seen significant growth in the biomass heating sector over the last 5 years. The analysis was repeated in 2010 to include data from Rounds 1-5 with many installations between 50 kW - 500 kW. Improved data on large industrial sites was provided by the Wood Panel Industries Federation (WPIF). They represent the majority of wood combustion for heating (consuming 395 thousand tonnes of wood) and in 2008-09 generated 1,639 GWh. The results from the BECGS data highlighted strong generating 175 GWh (consuming 65 thousand tonnes of wood); it is anticipated that this installed figure will more than double by March 2011.

(e) Energy crops and forestry residues

7.58 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) but progress is slow. Some SRC from the plantings made for the ARBRE project (see below), have been used for co-firing in coal-fired power stations. Approximately 1,000 hectares of Miscanthus are being grown in the Staffordshire area to supply the Eccleshall 2.6 MWe power station supported by the Bioenergy Capital Grant scheme. Support for the growing of energy crops continues as part of the Rural Development Programme for England (RDPE) 2007-2013 administered by Natural England.

7.59 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 is believed to have been abandoned. However, SembCorp Utilities UK has completed a 32 MW wood-burning power station, burning a mix of SRC, 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. The Port Talbot Bioenergy Plant, a 14 MW electric scheme firing mostly forestry residues and saw mill co-product entered service in June 2008.

(f) Straw combustion

7.60 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 40 MW straw fired power station near Ely, Cambridgeshire is currently the only electricity generation scheme in operation.

(g) Waste combustion

7.61 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.

7.62 In 2009, 22 waste-to-energy plants were in operation, burning municipal solid waste (MSW), refuse derived fuel (RDF) and general industrial waste (GIW).

7.63 **Municipal solid waste combustion** (MSW): 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 7.64 below. 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.

7.64 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 $\pm$ 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. MSW comprises domestic waste plus other feedstocks, such as, general industrial waste, building demolition waste and tree clippings from civil amenities. A 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 became the UK standard for the last several years. The UK domestic waste has had a biodegradable content of 67.5 per cent $\pm$ 1 per cent and this accounts for about 62.5 per cent of the energy generated from its combustion. Following the result of recent work, it has been calculated that 63.5 per cent of MSW is now formed of biodegradable material (average of Wales and Scotland using English EA guidance method), one percentage point above previous years. We have therefore used this figure for this years' survey but we will continue to review on an annual basis.

7.65 **General industrial waste combustion** (GIW): 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.

7.66 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.

7.67 **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 7.64, above).

7.68 Information on hospital waste incineration has continued to be based on a RESTATS survey, carried out by AEA in 2007, and updated in 2010, which aimed to establish if there were any changes and developments in the market. A list of sites that reclaim energy was obtained from the Environment Agency clinical waste incineration database; this was integrated in to the findings of the previous RESTATS survey, the combined list was then cleaned to ensure the contact information is both up-to-date and still relevant. Relevant sites were contacted to confirm their operational status and verify the electrical installed capacity and generation. The results 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 which 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.

7.69 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. One of the earlier poultry litter projects was modified to be fuelled mainly by meat and bone; two additional schemes fuelled primarily by meat and bone have also been built.

7.70 Anaerobic Digestion (AD) produces energy from wet wastes (e.g., animal slurries) in the form of biogas; this gas can be used for process heat and electricity generation. AD fermentation only occurs very slowly at the ambient temperatures found in nature and so commercially it is carried out in large heated prefabricated digestion tanks, either under mesophilic (35^{o}C) or thermophilic (55^{o}C) conditions. Different bacteria predominate at each operating temperature. These facilities would be fed primarily with farm wastes together with non-toxic, industrial organic wastes from food processing and preparation activities. The liquid digestate fertiliser may be returned to the farms when the timing for land application was right, thereby ensuring that its nutrients are better utilised.

7.71 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; data are also gathered via Ofgem's ROCs Register. 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. There are currently 10 power generation schemes in operation, the largest of these being the centralised anaerobic digestion scheme at Holsworthy supported under NFFO 5. A new survey will be undertaken in 2011.

(h) Co-firing of biomass with fossil fuels

7.72 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.

7.73 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 originally 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.

7.74 The scheme was later extended to allow longer for an energy crop market to develop and to recognise the need to reduce CO2 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 is no cap 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. From 2010/11 the cap has been set at 12.5 per cent; prior to this it was set at 10 per cent.

7.75 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 which came into effect in 'Renewables Obligation 2009' on 1 April 2009. Co-firing with non-energy crops has been moved into a band receiving 0.5 ROC per MWh. 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 (liquid biofuels)

7.76 In the UK biodiesel is defined for taxation purposes as diesel quality liquid fuel produced from biomass or waste vegetable and animal oils and fats, 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 liquid fuel consisting of ethanol produced from biomass and capable of being used for the same purposes as light oil. For further information, see HMRC Notice 179E: Biofuels and other fuel substitutes, October 2009, available at http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageVAT_ShowContent&id=HMCE_CL_000205&propertyType=document#P22_1468

7.77 The Renewable Transport Fuel Obligation (RTFO), introduced in April 2008, placed a legal requirement on transport fuel suppliers (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 are from a renewable source by 2013/14, with incremental levels of 2.5 per cent (by volume) for 2008/09, 3.25 per cent (by volume) in 2009/10, and 3.5 per cent (by volume) in 2010/11. Figures from HM Revenue and Customs based on road fuel taxation statistics show that 1,044 million litres of biodiesel and 317 million litres of bioethanol were consumed in 2009, up from 886 million litres and 206 million litres, respectively, in 2008 and from 347 million litres and 153 million litres, respectively, in 2007. During 2009 biodiesel accounted for 4.2 per cent of diesel, and bioethanol 1.4 per cent of motor spirit; the combined contribution of biodiesel and bioethanol was 2.9 per cent. 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

7.78 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 fuels. The main renewable fuel used in CHP is sewage gas, closely followed by other biomass.

7.79 Chapter 6 of this Digest summarises information on the contribution made by CHP to the United Kingdom's energy requirements in 2005 to 2009 using the results of annual studies undertaken to identify all CHP schemes (CHAPSTATS). 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 2005 to

2009. Corresponding data for 1996 to 2004 are available on the DECC energy web site. The information contained in those tables is therefore a subset of the data contained within the tables presented in this chapter. There are occasionally differences in the numbers reported by CHAPSTATS compared with RESTATS that are primarily attributed to whether the electricity is considered to be 'good quality'; further details on 'good quality' CHP are to be found in Chapter 6. In addition, there are oddities with some CHP facilities where biomass and fossil fuels are both burnt (though not always as co-firing). The total installed capacity recorded for the site under CHAPSTATS can cover multiple generators, some of which only handle fossil fuels (eg. gas turbines). As it would be misleading to record the entire capacity reported in RESTATS as being potentially available for renewables generation, only the appropriate capacity figures are recorded.

Generating capacity and load factor

7.80 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, i.e. 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 DECC energy web site.

7.81 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.

7.82 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 DECC energy web site at www.decc.gov.uk/en/content/cms/statistics/publications/trends/trends.aspx, although here the term "capacity factor" was used.

7.83 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:

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

7.84 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.

Contact : *Steve Dagnall,*
AEA
steve.dagnall@aeat.co.uk
0870 190 6092

Julian Prime
DECC Energy Statistics Team
julian.prime@decc.gsi.gov.uk
0300 068 5054

7.1 Commodity balances 2009

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	165	375	272	744	277	1,638
Other sources	-	-	-	-	-	-
Imports	-	-	-	415	-	-
Exports	-	-	-	-	-	-
Marine bunkers	-	-	-	-	-	-
Stock change *(1)*	-	-	-	-	-	-
Transfers	-	-	-	-	-	-
Total supply	**165**	**375**	**272**	**1,159**	**277**	**1,638**
Statistical difference *(2)*	-	-	-	-	-	-
Total demand	**165**	**375**	**272**	**1,159**	**277**	**1,638**
Transformation	**-**	**-**	**232**	**956**	**209**	**1,624**
Electricity generation	-	-	232	956	209	1,624
Major power producers	-	-	168	475	-	-
Autogenerators	-	-	64	481	209	1,624
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	**165**	**375**	**40**	**203**	**68**	**14**
Industry	**165**	**-**	**38**	**69**	**-**	**14**
Unclassified	165	-	38	69	-	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	**-**	**375**	**2**	**134**	**68**	**-**
Domestic	-	375	-	-	-	-
Public administration	-	-	-	-	68	-
Commercial	-	-	-	-	-	-
Agriculture	-	-	2	134	-	-
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 and tidal included is less than 0.1 ktoe.

7.1 Commodity balances 2009 (continued)

Renewables and waste

Thousand tonnes of oil equivalent

Waste *(4)* and tyres	Geothermal and active solar heat	Hydro	Wind wave and tidal *(5)*	Liquid biofuels	Total renewables	
						Supply
1,165	72	452	800	220	6,181	Production
-	-	-	-	-	-	Other sources
-	-	-	-	789	1,203	Imports
-	-	-	-	-	-	Exports
-	-	-	-	-	-	Marine bunkers
-	-	-	-	-	-	Stock change *(1)*
-	-	-	-	-	-	Transfers
1,165	**72**	**452**	**800**	**1,009**	**7,384**	**Total supply**
-	-	-	-	-	-	**Statistical difference** *(2)*
1,165	**72**	**452**	**800**	**1,009**	**7,384**	**Total demand**
993	**2**	**452**	**800**	**-**	**5,269**	**Transformation**
993	2	452	800	-	5,269	Electricity generation
52	-	369	594	-	1,658	Major power producers
941	2	83	206	-	3,611	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**
172	**70**	**-**	**-**	**1,009**	**2,115**	**Final consumption**
102	**-**	**-**	**-**	**-**	**387**	**Industry**
102	-	-	-	-	387	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
-	-	-	-	**1,009**	**1,009**	**Transport**
-	-	-	-	-	-	Air
-	-	-	-	-	-	Rail
-	-	-	-	1,009	1,009	Road
-	-	-	-	-	-	National navigation
-	-	-	-	-	-	Pipelines
70	**70**	**-**	**-**	**-**	**719**	**Other**
16	69	-	-	-	460	Domestic
45	0	-	-	-	114	Public administration
9	0	-	-	-	9	Commercial
-	-	-	-	-	136	Agriculture
-	-	-	-	-	-	Miscellaneous
-	**-**	**-**	**-**	**-**	**-**	**Non energy use**

7.2 Commodity balances 2008

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	162r	359	296	487r	232r	1,574
Other sources	-	-	-	-	-	-
Imports	-	-	-	416	-	-
Exports	-	-	-	-	-	-
Marine bunkers	-	-	-	-	-	-
Stock change *(1)*	-	-	-	-	-	-
Transfers	-	-	-	-	-	-
Total supply	**162r**	**359**	**296**	**903r**	**232r**	**1,574**
Statistical difference *(2)*	-	-	-	-	-	-
Total demand	**162r**	**359**	**296**	**903r**	**232r**	**1,574**
Transformation	**-**	**-**	**253**	**715**	**179r**	**1,560**
Electricity generation	-	-	253	715	179r	1,560
Major power producers	-	-	170	524	-	-
Autogenerators	-	-	83	191	179r	1,560
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	**162r**	**359**	**42**	**188r**	**52r**	**14**
Industry	**162r**	**-**	**40**	**56**	**-**	**14**
Unclassified	162r	-	40	56	-	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	**-**	**359**	**2**	**132r**	**52r**	**-**
Domestic	-	359	-	-	-	-
Public administration	-	-	-	-	52r	-
Commercial	-	-	-	-	-	-
Agriculture	-	-	2	132r	-	-
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 2008 (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	Total renewables	
						Supply
1,002	58	444	610	294	5,518r	Production
-	-	-	-	-	-	Other sources
-	-	-	-	532	948	Imports
-	-	-	-	-	-	Exports
-	-	-	-	-	-	Marine bunkers
-	-	-	-	-	-	Stock change *(1)*
-	-	-	-	-	-	Transfers
1,002	**58**	**444**	**610**	**825**	**6,466r**	**Total supply**
-	-	-	-	-	-	**Statistical difference** *(2)*
1,002	**58**	**444**	**610**	**825**	**6,466r**	**Total demand**
817	**1**	**444**	**610**	**5**	**4,586r**	**Transformation**
817	1	444	610	5	4,586r	Electricity generation
56	-	363	461	-	1,574	Major power producers
761	1	81	150	5	3,012r	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**
185	**57**	**-**	**-**	**821**	**1,880r**	**Final consumption**
119	**-**	**-**	**-**	**-**	**391r**	**Industry**
119	-	-	-	-	391r	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
-	-	-	-	**821**	**821**	**Transport**
-	-	-	-	-	-	Air
-	-	-	-	-	-	Rail
-	-	-	-	821	821	Road
-	-	-	-	-	-	National navigation
-	-	-	-	-	-	Pipelines
66	**57**	**-**	**-**	**-**	**668r**	**Other**
16	56	-	-	-	430	Domestic
39	0	-	-	-	92r	Public administration
11	0	-	-	-	12	Commercial
-	-	-	-	-	134r	Agriculture
-	-	-	-	-	-	Miscellaneous
-	**-**	**-**	**-**	**-**	**-**	**Non energy use**

7.3 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	101	332	270	506r	215r	1,547
Other sources	-	-	-	-	-	-
Imports	-	-	-	378	-	-
Exports	-	-	-	-	-	-
Marine bunkers	-	-	-	-	-	-
Stock change *(1)*	-	-	-	-	-	-
Transfers	-	-	-	-	-	-
Total supply	**101**	**332**	**270**	**884r**	**215r**	**1,547**
Statistical difference *(2)*	-	-	-	-	-	-
Total demand	**101**	**332**	**270**	**884r**	**215r**	**1,547**
Transformation	**-**	**-**	**223**	**776**	**165r**	**1,534**
Electricity generation	-	-	223	776	165r	1,534
Major power producers	-	-	146	422	-	-
Autogenerators	-	-	77	354	165r	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	**101**	**332**	**48**	**109r**	**51r**	**14**
Industry	**101**	**-**	**46**	**25**	**-**	**14**
Unclassified	101	-	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	**-**	**332**	**2**	**83r**	**51r**	**-**
Domestic	-	332	-	-	-	-
Public administration	-	-	-	-	51r	-
Commercial	-	-	-	-	-	-
Agriculture	-	-	2	83r	-	-
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 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	Total renewables	
						Supply
956	47	438	453	396	5,262r	Production
-	-	-	-	-	-	Other sources
-	-	-	-	-	378	Imports
-	-	-	-	-34	-34	Exports
-	-	-	-	-	-	Marine bunkers
-	-	-	-	-	-	Stock change *(1)*
-	-	-	-	-	-	Transfers
956	**47**	**438**	**453**	**362**	**5,606r**	**Total supply**
-	-	-	-	-	-	**Statistical difference** *(2)*
956	**47**	**438**	**453**	**362**	**5,606r**	**Total demand**
785	**1**	**438**	**453**	**-**	**4,374r**	**Transformation**
785	1	438	453	-	4,374r	Electricity generation
58	-	356	307	-	1,288	Major power producers
727	1	81	147	-	3,085r	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**	**1,233r**	**Final consumption**
90	**-**	**-**	**-**	**-**	**276**	**Industry**
90	-	-	-	-	276	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**	**-**	**-**	**-**	**594r**	**Other**
23	45	-	-	-	400	Domestic
39	0	-	-	-	90r	Public administration
19	0	-	-	-	20	Commercial
-	-	-	-	-	85r	Agriculture
	-	-	-	-	-	Miscellaneous
-	**-**	**-**	**-**	**-**	**-**	**Non energy use**

7.4 Capacity of, and electricity generated from, renewable sources

	2005	2006	2007	2008	2009
Installed Capacity (MWe) (1)					
Wind:					
Onshore	1,351.2	1,650.7	2,083.4	2,820.2	3,483.2
Offshore (2)	213.8	303.8	393.8	586.0	941.2
Shoreline wave / tidal	0.5	0.5	0.5	0.5	2.5
Solar photovoltaics	10.9	14.3	18.1	22.5	26.5
Hydro:					
Small scale	157.9	153.4	166.2	173.3	186.3
Large scale (3)	1,343.2	1,361.4	1,358.7	1,456.5	1,458.5
Biomass:					
Landfill gas	817.8	856.2	900.6	908.3	984.9
Sewage sludge digestion	137.8r	144.6r	151.0r	148.5r	157.7
Municipal solid waste combustion	314.6	326.5	326.4	375.9	392.0
Animal Biomass (4)	86.6	88.9	114.4	114.4	119.3
Plant Biomass (5)	99.5	132.4	189.5	197.7r	278.5
Total biomass and wastes	1,456.4	1,548.6r	1,681.9r	1,744.7r	1,932.4
Total	**4,533.8r**	**5,032.6r**	**5,702.6r**	**6,803.7r**	**8,030.6**
Co-firing (6)	308.8	310.2	247.6	226.9	254.7
Generation (GWh)					
Wind:					
Onshore (7)	2,501	3,574	4,491	5,792	7,564
Offshore (8)	403	651	783	1,305	1,740
Solar photovoltaics	8	11	14	17	20
Hydro:					
Small scale	444	478	534	568	598
Large scale (3)	4,478	4,115	4,554	4,600	4,664
Biomass:					
Landfill gas	4,290	4,424	4,677	4,757	4,952
Sewage sludge digestion	466r	447r	502r	547r	638
Municipal solid waste combustion (9)	964	1,083	1,177	1,226	1,511
Co-firing with fossil fuels	2,533	2,528	1,956	1,613	1,806
Animal Biomass (10)	468	434	555	587	620
Plant Biomass (11)	382	363	409	568	1,109
Total biomass	9,102r	9,279r	9,276r	9,298r	10,636
Total generation	**16,936**	**18,108r**	**19,652r**	**21,580r**	**25,222**
Non-biodegradable wastes (12)	578	651	707	736	874
Load factors (per cent) (13)					
Onshore wind	26.4	27.2	27.5	27.0	27.4
Offshore wind	27.2	28.7	25.6	30.4	26.0
Hydro	37.5	34.8	38.2	37.4	36.7
Biomass (excluding co-firing)	58.5	56.2	56.7	56.1r	60.3
Total (including wastes)	41.2	38.7	39.1	37.8	37.4
Load factors on an unchanged configuration basis (per cent) (14)					
Onshore wind	28.1	26.7	27.3	29.4	26.9
Offshore wind (from 2006 only)	..	27.5	28.3	34.9	33.7

(1) Capacity on a DNC basis is shown in Long Term Trends Table 7.1.1 available on the DECC web site - see paragraph 7.80.
(2) From 2007 onwards 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 amount 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 and tidal, but this amounts to less than 1 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 7.81.
(14) For a definition see paragraphs 7.82 and 7.83.

7.5 Electricity generated from renewable sources - Renewables Obligation basis

GWh

	2005	2006	2007	2008	2009
Generation : Renewables Obligation basis					
Wind:					
Onshore (1)	2,501	3,574	4,491	5,792	7,564
Offshore (2)	403	651	783	1,305	1,740
Solar photovoltaics	8	11	14	17	20
Hydro:					
Small scale (1)	444	478	534	568	598
Other hydro including refurbished large scale	1,542	1,969	1,912	1,926r	2,016
Biomass:					
Landfill gas	4,290	4,424	4,677	4,757	4,952
Sewage sludge digestion	466r	447r	502r	547r	638
Co-firing with fossil fuels	2,533	2,528	1,956	1,613	1,806
Animal Biomass (3)	468	434	555	587	620
Plant Biomass (4)	382	363	409	568	1,109
Total biomass	8,138r	8,196r	8,098r	8,072r	9,126
Total renewables generation on an obligation basis (5)	**13,036r**	**14,879r**	**15,833r**	**17,680r**	**21,063**

(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 and tidal, but this amounts to less than 1 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 paragraph 7.7 for definitions.

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

Thousand tonnes of oil equivalent

	2005	2006	2007	2008	2009
Used to generate electricity (3)					
Wind:					
Onshore	215.1	307.3	386.2	498.0	650.4
Offshore (4)	34.6	56.0	67.3	112.2	149.6
Solar photovoltaics	0.7	0.9	1.2	1.5	1.7
Hydro:					
Small scale	38.2	41.1	46.0	48.8	51.4
Large scale (5)	385.0	353.9	391.6	395.5	401.0
Biomass:					
Landfill gas	1,407.2	1,451.1	1,533.9	1,560.3	1,624.2
Sewage sludge digestion	152.8r	146.7r	164.6r	179.3r	209.4
Municipal solid waste combustion (6)	426.3	479.0	486.8	506.8	624.5
Co-firing with fossil fuels	830.7	829.0	641.4	528.9	592.3
Animal Biomass (7)	161.5	148.5	222.5	253.3	231.9
Plant Biomass (8)	125.2	119.0	134.1	186.3	363.8
Liquid biofuels	-	-	-	4.8	-
Total biomass	3,103.6r	3,173.3r	3,183.2r	3,219.6r	3,646.0
Total	**3,777.2r**	**3,932.5**	**4,075.4r**	**4,275.7r**	**4,900.2**
Non-biodegradable wastes (9)	262.0	293.7	298.3	310.3	368.6
Used to generate heat					
Active solar heating	29.4	36.3	44.9	55.7	69.5
Biomass:					
Landfill gas	13.6	13.6	13.6	13.6	13.6
Sewage sludge digestion	52.9r	44.6r	50.6r	52.4r	67.9
Wood combustion - domestic	265.6	298.8	332.0	358.6	375.2
Wood combustion - industrial	93.1	97.0	101.2	162.3r	164.6
Animal Biomass (10)	14.4	24.9	47.8	42.4	40.3
Plant Biomass (11)	92.4r	103.0r	108.8r	188.1r	203.0
Municipal solid waste combustion (6)	33.7	33.7	33.7	31.5	31.3
Total biomass	565.8r	615.6r	687.8r	848.8r	895.8
Geothermal aquifers	0.8	0.8	0.8	0.8	0.8
Total	**596.0r**	**652.7r**	**733.5r**	**905.4r**	**966.0**
Non-biodegradable wastes (9)	127.5	111.6	137.3	153.7	140.4
Renewable sources used as transport fuels					
as Bioethanol	47.9	53.4	85.8	115.8	177.9
as Biodiesel	26.1	134.4	275.9	705.0	830.7
Total	**74.1**	**187.8**	**361.7**	**820.7**	**1,008.6**
Total use of renewable sources and wastes					
Solar heating and photovoltaics	30.1	37.2	46.1	57.2	71.2
Onshore and offshore wind (4)	249.7	363.3	453.5	610.3	800.0
Hydro	423.2	394.9	437.5	444.4	452.4
Biomass	3,669.4r	3,788.9r	3,871.0r	4,068.5r	4,541.8
Geothermal aquifers	0.8	0.8	0.8	0.8	0.8
Transport fuels	74.1	187.8	361.7	820.7	1,008.6
Total	**4,447.2r**	**4,772.9r**	**5,170.6r**	**6,001.8r**	**6,874.9**
Non-biodegradable wastes (9)	389.5	405.3	435.6	464.1	509.0
All renewables and wastes (12)	**4,836.7r**	**5,178.2r**	**5,606.3r**	**6,465.9r**	**7,383.8**

(1) Includes some waste of fossil fuel origin.
(2) See paragraphs 7.35 to 7.84 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 and tidal but this is less than 0.1 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.

7.7 Renewable sources data used to indicate progress under the EU Renewable Energy Directive 2008 (measured using net calorific values)

Thousand tonnes of oil equivalent

	2005	2006	2007	2008	2009
Electricity generation:					
Normalised hydro generation *(1)*	393	395	393	422	422
Normalised wind generation *(2)*	242	351	444	602	803
Electricity generation from renewables other than wind, hydro, and compliant biofuels	783	799	799	801	916
Electricity generation from compiant biofuels	-	-	-	-	-
Total renewable generation from all compliant sources	1,419	1,545	1,636	1,825	2,141
Total Gross Electricity Consumption	34,717	34,476	34,238	33,991	32,231
Percentage of electricity from renewable sources	4.1%	4.5%	4.8%	5.4%	6.6%
Heat:					
Renewable energy for heating and cooling	569	608	693	851	899
Total Gross energy consumption for heating and cooling	65,104	62,429	59,962	60,802	55,000
Percentage of heating and cooling energy from renewable sources	0.9%	1.0%	1.2%	1.4%	1.6%
Transport:					
Road transport renewable electricity	-	-	-	-	-
Non-road transport renewable electricity	31	32	35	42	50
Biofuels	69	180	349	798	978
Total electricity consumption in transport	758	708	740	779	754
Total petrol and diesel consumption in transport	42,008	42,546	42,650	41,397	39,667
Percentage of transport energy from renewable soruces	0.2%	0.5%	0.9%	2.0%	2.5%
Overall target:					
Renewables used for:					
Electricity generation	1,419	1,545	1,636	1,825	2,141
Heat	569	608	693	851	899
Transport	69	180	349	798	978
Total Final Consumption of Renewable Energy	2,057	2,334	2,679	3,474	4,018
Total Final Energy Consumption *(3)*	150,333	148,141	145,636	145,151	135,468
plus Distribution losses for electricity	2,399	2,367	2,308	2,401	2,298
plus Distribution losses for heat	-	-	-	-	-
plus Consumption of electricity in the electricity and heat generation sectors	1,537	1,591	1,521	1,399	1,417
plus Consumption of heat in the electricity and heat generation sectors	-	-	-	-	-
Gross Final Energy Consumption (GFEC)	154,269	152,099	149,466	148,950	139,182
of which Air transport	13,163	13,299	13,211	12,755	12,094
Air transport as a proportion of GFEC	8.53%	8.74%	8.84%	8.56%	8.69%
Air transport cap specificed in Directive	6.18%	6.18%	6.18%	6.18%	6.18%
Capped air transport	9,534	9,400	9,237	9,205	8,601
Capped Gross Final Energy Consumption (CGFEC)	150,639	148,200	145,492	145,401	135,690
Renewables consumption as a percentage of Capped Gross Final Energy Consumption	1.4%	1.6%	1.8%	2.4%	3.0%

(1) Based on a 15 year average hydro load factor; excludes generation from pumped storage.
(2) Based on a 5 year average wind load factor.
(3) Total final consumption less non-energy use, as shown in Annex I, Table I.1, available on the DECC website