

## Renewable energy in 2013

### Introduction

This article updates the information on renewable energy published in the June 2013 edition of Energy Trends, and in the 2013 edition of the Digest of UK Energy Statistics. It also presents additional information to that provided in the “Section 6 Renewables” section of this edition of Energy Trends, including an early indication of the UK’s progress against the Renewable Energy Directive, and discusses key policies that impact on the delivery of renewable energy.

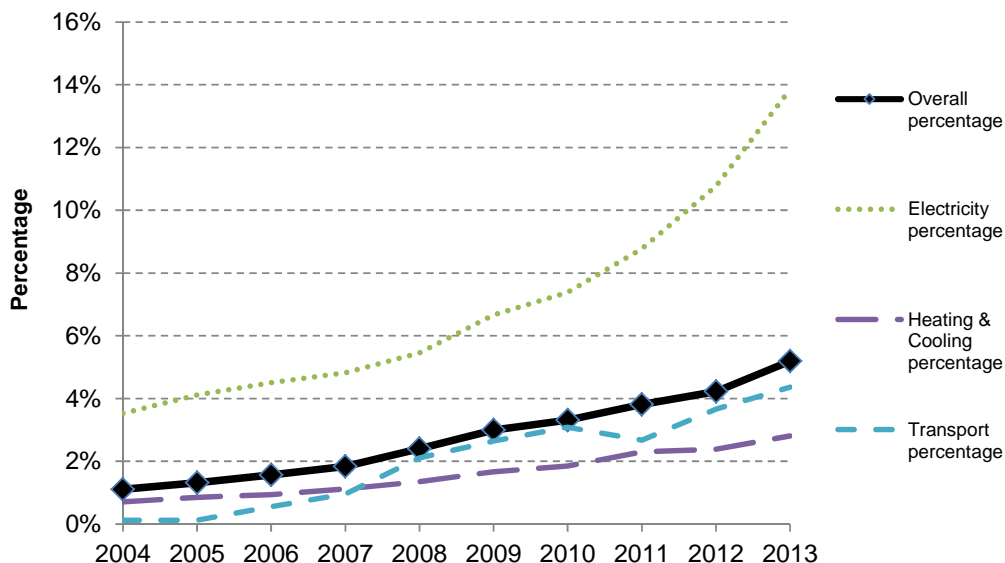
### Key messages

In 2013, renewable energy provisionally accounted for 5.2 per cent of final energy consumption, as measured using the 2009 Renewable Energy Directive (RED) methodology. This is an increase from the 2012 position of 4.2 per cent, reflecting a significant growth in the contribution of renewable electricity whilst renewable heating and transport contributions also rose. The next interim target under the RED is for an average of 5.41 per cent across 2013 and 2014 (see page 54).

The amount of electricity generated from renewables sources in 2013 was 53,667 GWh, a 30 per cent increase on 2012. Wind generation was the largest contributor to the overall increase in renewable electricity generation; offshore wind increased by 52 per cent and onshore wind by 40 per cent, taking total wind generation to 28,434 GWh. Generation from solar photovoltaics was up by 51 per cent on 2012, while plant biomass generation more than doubled, largely a result of increased generation due to the conversion of coal plant to dedicated biomass. Hydro generation meanwhile fell by 11 per cent, due to lower rainfall in catchment areas.

Generation from wind represented 53 per cent of total renewable electricity generation in 2013, compared with 34 per cent for bioenergy, 9 per cent for hydro and 4 per cent for solar photovoltaics. The increases in wind generation were driven by high growth in installed capacity, as well as higher wind speeds across the year, and especially the final quarter.

**Chart 1: Progress against Renewable Energy Directive**



Renewable electricity generation capacity increased by 4.2 GW (27 per cent) to 19.7 GW. The main sources of this increase were onshore wind (up 1.6 GW, 27 per cent), solar photovoltaics (up 1.0 GW, 59 per cent), plant biomass (up 0.8 GW, 67 per cent) and offshore wind (up 0.7 GW, 23 per cent).

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The weather had a major impact on renewable electricity generation during 2013. Average wind speeds were 0.4 knots higher than in 2012; although broadly similar to the average over the last five years, it was the windiest December (which is the month in the year when the most installed capacity is operational) in the last 13 years. Countering this, average rainfall levels (in hydro catchment areas) were 9.2 per cent lower than in 2012. Whilst these factors affect the raw 2013 generation outputs of renewables, the Renewable Energy Directive measure uses a normalisation approach to smooth the year on year impacts of differing wind and rain patterns.

Heat from renewable sources increased by 19 per cent during 2013 (to 1,729 ktoe). This includes heat supported by the Renewable Heat Incentive and Renewable Heat Premium Payment schemes.

Renewable biofuels used for transport rose by 14 per cent (to 1,091 ktoe), accounting for 3.5 per cent by volume of road transport fuels in 2013. Bioethanol, as a proportion of motor spirit, increased by 0.4 percentage points to 4.5 per cent, whilst biodiesel as a proportion of DERV rose by 0.4 percentage points to 2.8 per cent.

### **The normalisation approach**

Generation from wind and hydro sources are very dependent on the weather (wind speeds and rainfall). In order to negate the effects of variable generation due to weather differentials from one year to the next, the 2009 Renewable Energy Directive (RED) measure specifies the normalisation of wind and hydro generation. Normalisation is carried out by calculating generation by applying an average load factor to current capacity. For wind, the load factor is calculated as the average of the past five years (including the present one), with current capacity taken as an average of the start and end of year capacity. For hydro, the load factor is the average of the past 15 years, applied to capacity at the end of the current year. The generation figures obtained from this procedure replace the actual generation figures for wind and hydro in the RED calculation.

### **Renewable electricity targets**

Renewable electricity's share of all electricity ranged from 13.9 per cent to 14.9 per cent, under the three measures (RED, Renewables Obligation and International Basis) in 2013. Section 6 of the March 2014 edition of Energy Trends contained provisional estimates for the international and Renewable Energy Directive (RED) measures of the share of electricity obtained from renewable sources. These data have now been revised following receipt of new data, and an additional measure, reflecting the Renewables Obligation (RO) definition, has been added. All measures are shown in Table 1 at the end of this article.

On the "international definition basis" renewables provided 14.9 per cent of the electricity generated in the United Kingdom in 2013, a 3.5 percentage point increase on the 2012 proportion. Total electricity generation from renewables in 2013, as shown in Table 3 at the end of this article, amounted to 53,667 GWh, an increase of 12,453 GWh (30 per cent) on 2012. Chart 2 shows the growth in the proportion of electricity generation from renewable sources and also progress under the RO, which is measured as a proportion of UK electricity sales; the RO measure grew by 3.3 percentage points to 14.1 per cent in 2013.

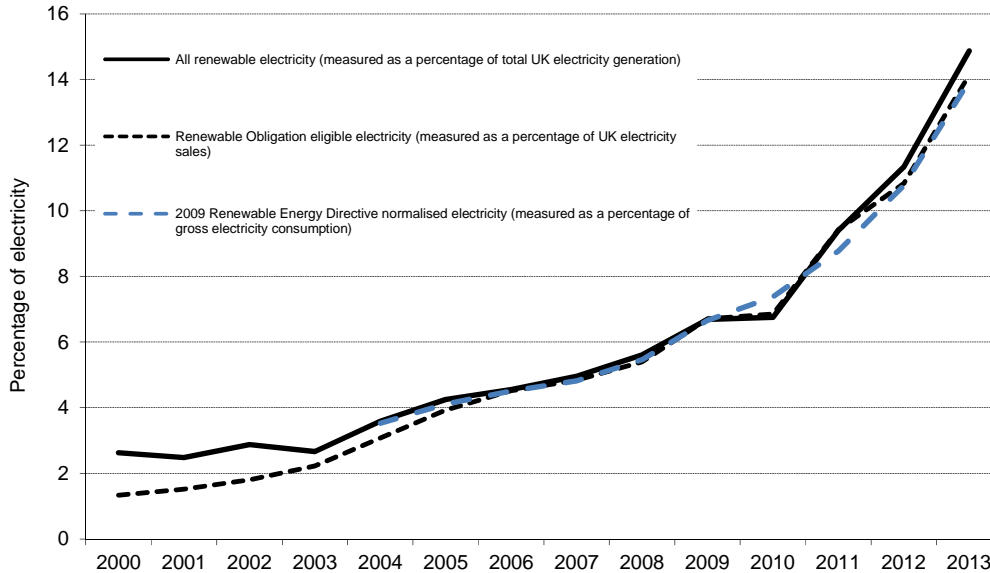
The RED introduced a further measure, which involves normalising wind and hydro generation over 5 and 15 year periods respectively, and measuring against gross electricity consumption.<sup>1</sup> In 2011, higher than average wind speeds and rain fall resulted in the normalised measures showing lower increases than non-normalised measures; however this pattern was reversed in 2012. In

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<sup>1</sup> See page 54 for further details of the methodology behind the RED

2013, higher than average wind speeds once again resulted in the normalised measure showing a lower increase; this reduction was only partially offset by a positive normalisation adjustment to hydro, on account of lower than average rainfall. In 2013, the normalised electricity component of the Renewable Energy Directive increased by 3.1 percentage points, to 13.9 per cent.

**Chart 2: Growth in electricity generation from renewable sources since 2000**



The normalised electricity component of the 2009 Renewable Energy Directive measure is also shown in Chart 2; by comparing this line with the non-normalised lines, it illustrates the impact that low wind speeds and little rain had on renewable electricity generation in 2010, and how this was reversed in 2011, returning to more normal levels in 2012. In 2013, normalisation again reduced the impact that high wind speeds had on generation.

### Renewable electricity generation

The largest absolute increase in generation came from onshore wind, rising by 4,880 GWh to 16,992 GWh, due to increased capacity and higher wind speeds across 2013. Similar factors helped offshore wind generation increase by 3,892 GWh to 11,411 GWh (52 per cent higher).

Generation from plant biomass rose by 4,850 GWh, to 8,933 GWh, more than double the previous year's contribution. This was due to the conversion of one of Drax (coal power station)'s six units to burn dedicated biomass, as well as increased generation from the Tilbury conversion (despite its closure under the Large Combustion Plant Directive in August 2013), following the fire in 2012. The conversion of the Drax unit, as well as Ironbridge, resulted in a further reduction (1,474 GWh) in the co-firing of renewables with fossil fuels.

Greater uptake of solar photovoltaics, particularly from larger schemes supported by the Renewables Obligation, as well as smaller schemes under the Feed in Tariff, led to generation in 2013 increasing by over one half on 2012 (by 685 GWh, from 1,351 GWh to 2,036 GWh).

Other sources showing increases during the year included anaerobic digestion (an increase of 208 GWh, 42 per cent higher), sewage gas (42 GWh, 5.8 per cent higher), and landfill gas (15 GWh, 0.3 per cent higher).

Generation from hydro fell by 587 GWh (11 per cent) due to reduced rain fall, while biodegradable waste (by 46 GWh, 2.3 per cent) and animal biomass (by 14 GWh, 2.2 per cent) also fell.

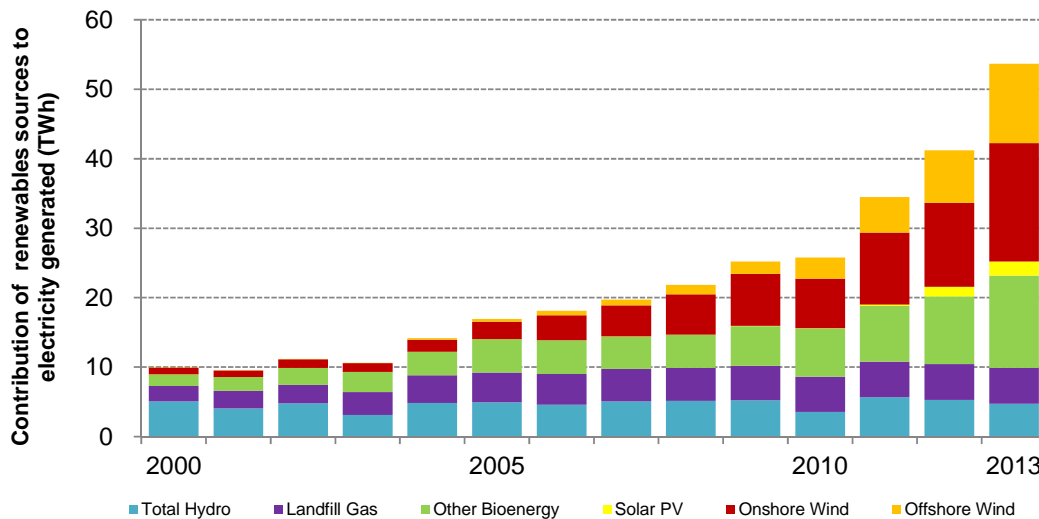
Onshore wind continued to be the leading individual technology for the generation of electricity from renewable sources during 2013, with 32 per cent of renewables generation coming from this

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source; a further 21 per cent came from offshore wind, and 8.8 per cent came from hydro. However the combined generation from the variety of different bioenergy sources accounted for 34 per cent of renewable generation, with plant biomass accounting for almost one half of bioenergy generation and landfill gas accounting for 28 per cent. Despite the large annual increase, just 3.8 per cent of renewable generation came from solar photovoltaics.

Total generation from bioenergy sources was 24 per cent higher than in 2012, with wind being 45 per cent higher, whilst hydro's contribution was 11 per cent lower. Chart 3 shows the growth in generation, by main renewable source, since 2000.

**Chart 3: Electricity generation by main renewable source since 2000**



Note: Hydro bar includes shoreline wave/tidal (0.006TWh in 2013)

## Renewable electricity capacity

Total renewable electricity capacity at the end of 2013, as shown in Table 3, amounted to 19.7 GW, compared with 15.5 GW at the end of 2012; this excludes the capacity within conventional generation station that was used for co-firing (less than 0.1 GW). The largest contributor towards this 27 per cent capacity increase was 1,614 MW from onshore wind, with a further 1,033 MW from solar photovoltaics and 701 MW from offshore wind. Plant biomass capacity increased by 783 MW, with the extra capacity from two new conversions (Drax unit one and Ironbridge) exceeding the reduction from the closure of Tilbury during the year.

In capacity terms, onshore wind accounted for 38 per cent of capacity, followed by offshore wind (19 per cent), solar photovoltaics (14 per cent), plant biomass (9.9 per cent), hydro (8.6 per cent) and landfill gas (5.3 per cent).

## Load factors

Load factors express the average hourly quantity of electricity generated as a percentage of the average capacity at the beginning and end of the year. Load factors for most technologies are presented in Table 4. As well as the traditionally calculated load factors, additional load factors are also calculated only for those schemes that have operated throughout the calendar year with an unchanged configuration. These differences are particularly prominent for plant biomass, where the large capacity (750MW) and operational changes in 2011 at the (now closed) Tilbury

generation station, and the fire there during 2012, reduced traditionally calculated load factors. Wind speeds and rainfall levels have also had a major impact on load factors.<sup>2</sup>

### **Heat production**

Around 15 per cent of renewable sources were used to generate heat during 2013. The four categories of renewable heat production in the United Kingdom are the direct combustion of various forms of bioenergy (84 per cent of the total), active solar heating, geothermal, and heat pumps. Together they produced energy equivalent to 1,729 thousand tonnes of oil equivalent (or 20.1 TWh) in 2013, a 19 per cent increase during the year. Using the Renewable Energy Directive methodology, renewable heat sources accounted for 2.8 per cent of total heat demand in 2013, a 0.5 percentage point increase on 2012.

Renewables used to generate heat have grown in recent years, following a decline up to 2005 as a result of tighter emission controls which discouraged on-site burning of biomass, especially wood waste. Policies such as the Renewable Heat Incentive (RHI) and Renewable Heat Premium Payment (RHPP) schemes are designed to support renewable heat production. Around 3 per cent of renewable heat during 2013 was supported through the receipt of RHI payments (50 thousand tonnes of oil equivalent, or 586 GWh). Domestic use of wood is the main contributor to renewables used for heat – comprising around 35 per cent of the renewable heat total. Non-domestic use of wood and wood waste, and plant biomass formed the next largest components, at around 20 per cent each. Heat pumps (mainly in the domestic sector) contributed around 5 per cent of the renewable heat total.

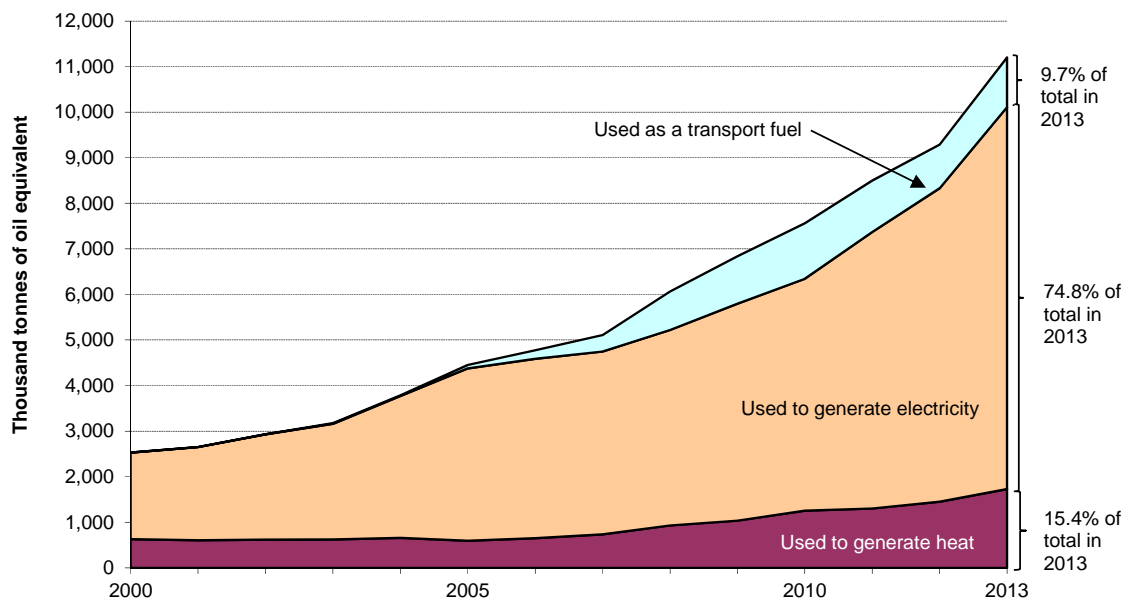
### **Liquid biofuels for transport**

Liquid biofuels for transport comprised around 10 per cent of total renewable sources. Two road transport fuels, biodiesel and bioethanol, are sold blended with diesel and petrol. Figures from HM Revenue and Customs based on road fuel taxation statistics show that 766 million litres of biodiesel and 819 million litres of bioethanol were consumed in 2013; biodiesel consumption was 21 per cent higher than in 2012, whilst bioethanol consumption was 5.8 per cent higher. Biodiesel has a higher energy content than bioethanol, meaning that the combined total energy content of these fuels equates to 1,091 thousand tonnes of oil equivalent, 14 per cent higher than in 2012. During 2013, biodiesel accounted for 2.8 per cent of diesel, and bioethanol 4.5 per cent of motor spirit; the combined contribution of biodiesel and bioethanol was 3.5 per cent by volume, 0.4 percentage points higher than in 2012. The Renewable Energy Directive introduced various sustainability criteria for transport biofuels; certain biofuels derived from waste products (for example, waste cooking oil) have extra weighting when monitoring progress against the transport component, but not the overall target, of the Directive.

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<sup>2</sup> The load factors reported in Table 4 draw on data on ROCs produced by Ofgem, but at the time that this article was written the ROC data for 2013 were still provisional. In particular this can have an impact on the schemes included in the unchanged configuration definition as new data could include or remove particular schemes. This should be kept in mind if users subsequently reanalyse these results.

**Chart 4: Trends in the use of renewable energy for heat, electricity, and transport**



### All renewable fuels

When renewables used for transport and heat are combined with the use of renewable sources for electricity generation, renewable sources accounted for 5.2 per cent of the United Kingdom's total primary energy requirements in 2013, up from 4.3 per cent in 2012. Use of non-biodegradable wastes accounted for an additional 0.3 per cent of primary energy. The trends in the use of renewable energy for transport, heat and electricity are shown in Chart 4; data are shown in Table 5 disaggregating the totals by various technologies.

On the basis for measuring progress towards the Renewable Energy Directive (RED), provisionally in the UK during 2013, 5.2 per cent of final energy consumption was from renewable sources. This is an increase from the 2012 figure of 4.2 per cent, and 3.8 per cent in 2011.

In addition to the headline figure, the RED monitors three constituent parts separately, and these are shown in Table 2. It should be noted that the overall figure is not a simple calculation based around the three constituent parts. The finalised 2013 figures for all member states will be published by Eurostat during 2015. The RED introduced interim targets for member states to achieve on their route to attaining the 2020 proportion. The UK was broadly in line with its first interim target of 4.04 per cent across 2011-2012, achieving 4.01 per cent. The second interim target, across 2013 and 2014, is 5.41 per cent, and will be reported against in June 2015.

### EU Renewable Energy Directive

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 the EU's energy to come from renewable sources by 2020. During 2008, a Directive was negotiated on this basis and resulted in the agreement of country "shares" of this target being included in the final 2009 Renewable Energy Directive. For the UK, 15 per cent of **final energy consumption** - calculated on a net calorific basis (i.e. excluding the energy required to evaporate the water content from the fuel; and as opposed to the gross basis that is generally used in presenting data in *Energy Trends* and *the Digest of UK Energy Statistics*), and with a cap on fuel used for air transport - should be accounted for by energy from renewable sources. In reporting against these measures, normalised wind and hydro is used (see "the normalisation approach" box).

## UK renewables policy

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

- Putting in place appropriate financial incentives to bring forward and support the take-up of renewable energy, including the “banded” Renewables Obligation (RO), the Electricity Market Reform (EMR), Feed-in Tariffs (FiTs) for small scale (under 5 MW) electricity generation, the Renewable Heat Incentive (RHI) tariff domestic and non-domestic schemes, the Renewable Heat Premium Payment Scheme (for households), and the Renewable Transport Fuel Obligation (RTFO);
- Identifying and removing the most significant non-financial barriers to renewables deployment, including measures to improve existing grid connection arrangements; and
- Overcoming supply chain blockages and promoting business opportunities in the renewables sector in the UK.

### The Renewables Obligation (RO)

The Renewables Obligation<sup>3</sup> is an obligation on electricity suppliers to source a specific, and annually increasing, proportion of electricity sales from eligible renewable sources, or pay a penalty; this is intended to incentivise an increase in the level of renewable generating capacity and so contribute to our climate change targets.

The Office for Gas and Electricity Markets (Ofgem), which administers the RO, issues **Renewables Obligation Certificates (ROCs)** to qualifying renewables. 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. Suppliers present ROCs to Ofgem to demonstrate their compliance with the obligation.

When the Obligation was first introduced, 1 ROC was awarded for each MWh of renewable electricity generated. In 2009, ‘banding’ was introduced into the RO, meaning different technologies now receive different numbers of ROCs depending on their costs, relative market maturity, and potential for large scale deployment. A list of technologies eligible for the RO, details of the RO banding review, and the level of ROCs received, is available at:

[www.gov.uk/calculating-renewable-obligation-certificates-rocs](http://www.gov.uk/calculating-renewable-obligation-certificates-rocs)

### The Electricity Market Reform (EMR)

EMR will replace the RO in 2017. The reforms tackle the risks and uncertainties of the underlying economics of different forms of electricity generation by offering long term contracts for low carbon energy.

Companies will get, in effect, a fixed and secure price at which they can sell their electricity to consumers. This will allow investors to be confident about the returns of their capital in advance of investing billions into new infrastructure schemes. It will also encourage banks to lend at cheaper rates because the projects are less risky.

Further details of the reforms are available at:

<https://www.gov.uk/government/policies/maintaining-uk-energy-security--2/supporting-pages/electricity-market-reform>

### Feed-in Tariffs (FiTs)

Feed-in tariffs are a financial support scheme for eligible low-carbon electricity technologies, aimed at small-scale installations with a capacity of less than 5 Megawatts (MW). FiTs support new anaerobic digestion (AD), solar photovoltaic (PV), small hydro and wind, by requiring electricity suppliers to make payments (generation tariffs) to these generators based on the number of

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<sup>3</sup> 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.

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kilowatt hours (kWh) they generate. An additional guaranteed export tariff is paid for electricity generated that is not used on site and exported to the grid. The scheme also supports micro combined heat and power installations with an electrical capacity of 2kW or less, as a pilot programme.

PV installations increased rapidly at the start of the FIT scheme. The rate of increase slowed significantly after August 2012 following tariff reductions introduced after a comprehensive review of the scheme. A depression mechanism was also introduced following the comprehensive review. This cost control mechanism allows solar PV tariffs to decrease every 3 months (depending on deployment levels). Tariffs for Non-PV technologies depress every year (with a six-month contingent depression if deployment is high in the first half of the year).

Tariff changes implemented as a result of the review only affect new entrants to the scheme. Policy information and statistical reports relating to FiTs can be found at:

[www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/feed-in-tariffs-scheme](http://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/feed-in-tariffs-scheme) and [www.gov.uk/government/organisations/department-of-energy-climate-change/series/feed-in-tariff-statistics](http://www.gov.uk/government/organisations/department-of-energy-climate-change/series/feed-in-tariff-statistics)

The latest tariffs can be found on Ofgem's website:

[www.ofgem.gov.uk/environmental-programmes/feed-tariff-fit-scheme/tariff-tables](http://www.ofgem.gov.uk/environmental-programmes/feed-tariff-fit-scheme/tariff-tables)

### **Renewable Heat Incentive (RHI) and Renewable Heat Premium Payment**

The RHI scheme is a government financial incentive scheme introduced to encourage a switch to renewable heating systems in place of fossil fuels. The tariff based scheme is split into two parts:

- The non-domestic RHI scheme which has been open to commercial, industrial, public sector, not for profit and community generators of renewable heat since November 2011.
- The domestic RHI scheme which opened on 9 April 2014 and is available to homeowners, private and social landlords and people who build their own homes.

Further information on this scheme, including details of the technologies, can be found at:

[www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi](http://www.gov.uk/government/policies/increasing-the-use-of-low-carbon-technologies/supporting-pages/renewable-heat-incentive-rhi).

The RHPP voucher scheme made one-off payments to householders to help them buy renewable heating technologies. This scheme closed on the 31 March 2014 prior to the introduction of the domestic RHI scheme. Further information on the RHPP can be found at: [www.gov.uk/renewable-heat-premium-payment-scheme](http://www.gov.uk/renewable-heat-premium-payment-scheme).

Data and statistical reports relating to both the RHI and RHPP can be found at:

[www.gov.uk/government/organisations/department-of-energy-climate-change/series/renewable-heat-incentive-renewable-heat-premium-payment-statistics](http://www.gov.uk/government/organisations/department-of-energy-climate-change/series/renewable-heat-incentive-renewable-heat-premium-payment-statistics).

### **Renewable Transport Fuel Obligation (RTFO)**

The Renewable Transport Fuel Obligation 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 4.75 per cent (by volume) of their overall fuel sales are from a renewable source by 2013/14, with incremental levels starting from 2.5 per cent (by volume) for 2008/09. The Department for Transport publish policy and statistical reports on the scheme at:

[www.gov.uk/government/publications/rtfo-guidance](http://www.gov.uk/government/publications/rtfo-guidance) and [www.gov.uk/government/organisations/department-for-transport/series/biofuels-statistics](http://www.gov.uk/government/organisations/department-for-transport/series/biofuels-statistics)



### **Data collection**

The UK collection of renewable energy statistics began 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 STATisticS (RESTATS) database now contains 25 years of data from 1989 to 2013 and this database has been used to provide the detailed figures on renewable sources of energy contained within this article and also within the forthcoming 2014 edition of the Digest of UK Energy Statistics, to be published on 31 July 2014.

### **Regional statistics**

A further renewable statistics article will be produced in the September 2014 edition of Energy Trends, containing a regional breakdown of the renewable electricity generation and capacity statistics.

For further information on renewable energy statistics please contact any of the following

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**Table 1: Percentages of electricity derived from renewable sources**

	2005	2006	2007	2008	2009	2010	2011	2012	2013
Overall renewables percentage – International basis  (Electricity generated from all renewables except non-biodegradable wastes, as a percentage of all <b>electricity generated</b> in the UK)	4.3	4.6	5.0	5.6	6.7	6.8	9.4	11.3	14.9
Percentage on a Renewables Obligation basis  (Electricity generated from renewables eligible for the Renewables Obligation as a percentage of <b>electricity sales</b> by licensed suppliers in the UK)	3.9	4.5	4.8	5.4	6.7	6.9	9.4	10.8	14.1
Percentage on a 2009 Renewable Energy Directive basis  ( <i>Normalised</i> hydro & wind generation combined with actual generation from other sources except non-biodegradable wastes, as a percentage of UK <b>gross electricity consumption, calculated on a net calorific value basis</b> )	4.1	4.5	4.8	5.5	6.7	7.4	8.8	10.8	13.9

**Table 2: Progress against the 2009 Renewable Energy Directive**

	2005	2006	2007	2008	2009	2010	2011	2012	2013
Percentage of <b>electricity</b> from renewable sources (normalised)	4.1	4.5	4.8	5.5	6.7	7.4	8.8	10.8	13.9
Percentage of <b>heating and cooling</b> from renewable sources	0.8	0.9	1.1	1.4	1.7	1.9	2.3	2.4	2.8
Percentage of <b>transport</b> energy from renewable sources	0.1	0.6	1.0	2.1	2.6	3.1	2.7	3.7	4.4
<b>Overall renewable consumption as a percentage of capped gross final energy consumption using net calorific values (normalised) [not directly calculated from</b>	1.4	1.6	1.8	2.4	3.0	3.3	3.8	4.2	5.2

**Table 3: Capacity of, and electricity generated from, renewable sources**

	2011	2012	2013
<b>Installed Capacity (MWe)</b>			
Wind:			
Onshore	4,620.3	5,899.1	7,513.3
Offshore	1,838.0	2,995.2	3,695.7
Shoreline wave / tidal	3.1	6.7	7.2
Solar photovoltaics	994.2	1,746.8	2,779.8
Hydro:			
Small scale	201.6	215.6	221.7
Large scale (1)	1,470.9	1,470.9	1,470.9
Bioenergy:			
Landfill gas	1,050.3	1,036.0	1,041.7
Sewage sludge digestion	198.0	204.4	198.0
Energy from waste (2)	504.1	520.8	552.7
Animal Biomass (non-AD)(3)	110.5	110.5	110.5
Anaerobic digestion	70.3	118.3	149.6
Plant Biomass (4)	1,148.8	1,166.3	1,949.0
Total bioenergy and wastes	3,082.1	3,156.3	4,001.6
<b>Total</b>	<b>12,210.1</b>	<b>15,490.5</b>	<b>19,690.2</b>
Co-firing (5)	338.2	203.5	35.2
<b>Generation (GWh)</b>			
Wind:			
Onshore (6)	10,347	12,112	16,992
Offshore	5,126	7,549	11,441
Shoreline wave / tidal (7)	1	4	6
Solar photovoltaics	244	1,351	2,036
Hydro:			
Small scale (6)	693	653	672
Large scale (1)	4,989	4,631	4,026
Bioenergy:			
Landfill gas	5,092	5,154	5,169
Sewage sludge digestion	764	719	761
Biodegradable energy from waste (8)	1,643	2,034	1,987
Co-firing with fossil fuels	2,964	1,783	309
Animal Biomass (3)	615	643	628
Anaerobic digestion	272	499	707
Plant Biomass (4)	1,749	4,083	8,933
Total bioenergy	13,098	14,914	18,494
<b>Total generation</b>	<b>34,498</b>	<b>41,214</b>	<b>53,667</b>
Non-biodegradable energy from wastes (9)	945	1,170	1,143
<b>Total generation from sources eligible for the Renewable Obligation (10)</b>	<b>29,034</b>	<b>33,428</b>	<b>43,359</b>

(1) Excluding pumped storage stations. Capacities are as at the end of December.

(2) Includes capacity for municipal solid waste, waste tyres, hospital waste, and general industrial waste.

(3) Includes the use of poultry litter and meat & bone.

(4) Includes the use of straw combustion and short rotation coppice energy crops.

(5) This is the proportion of fossil fuelled capacity used for co-firing of renewables based on the proportion of generation accounted for by the renewable source.

(6) Actual generation figures are given where available, but otherwise are estimated using a typical load factor or the design load factor, where known.

(7) Includes electricity from the EMEC test facility.

(8) Biodegradable part only.

(9) Non-biodegradable part of municipal solid waste plus waste tyres, hospital waste and general industrial waste.

(10) See page 54 for definition and coverage.

**Table 4: Load factors for renewable electricity generation**

	Per cent		
	2011	2012	2013
<b>Load factors - based on average beginning and end of year capacity (1)</b>			
Wind	29.8	29.2	32.3
Onshore wind	27.2	26.2	28.9
Offshore wind	36.8	35.6	39.0
Shoreline wave / tidal	3.8	8.3	9.7
Solar photovoltaics	5.1	11.2	10.3
Hydro	39.2	35.8	31.7
Hydro (small scale)	41.0	35.7	35.1
Hydro (large scale)	39.0	35.8	31.2
Bioenergy (excludes cofiring and non-biodegradable wastes)	44.8	47.9	58.0
Landfill gas	56.5	56.2	56.8
Sewage sludge digestion	44.6	40.7	43.2
Energy from waste (3)	40.3	45.2	42.3
Animal Biomass (4)	63.5	66.2	64.9
Anaerobic Digestion	61.6	60.2	60.2
Plant Biomass (5)	27.3	40.2	65.5
<b>All renewable technologies (excluding cofiring and non-biodegradable wastes)</b>	<b>33.6</b>	<b>32.4</b>	<b>34.6</b>
<b>Load factors - for schemes operating on an unchanged configuration basis (2)</b>			
Wind	29.4	28.0	31.0
Onshore wind	27.2	25.6	27.9
Offshore wind	35.0	33.7	37.5
Hydro	41.7	35.3	31.6
Hydro (small scale)	43.2	35.9	35.2
Hydro (large scale)	41.5	35.3	31.3
Bioenergy (excludes cofiring and non-biodegradable wastes)	61.1	62.8	60.0
Landfill gas	59.5	58.5	57.3
Sewage sludge digestion	53.5	48.0	50.2
Energy from waste (3)	40.2	44.5	41.9
Animal Biomass (4)	69.0	66.2	70.4
Anaerobic Digestion	57.5	60.5	57.9
Plant Biomass (5)	60.9	67.2	62.3
<b>All renewable technologies (excluding cofiring and non-biodegradable wastes)</b>	<b>37.2</b>	<b>36.0</b>	<b>35.6</b>

(1) Calculated as the average hourly quantity of electricity generated as a percentage of the average capacity at the beginning and end of the year.

(2) Load factors calculated as above but restricted to those schemes that have operated throughout the calendar year with an unchanged configuration.

(3) Calculation is based on biodegradable energy from waste generation but all energy from waste capacity; this reduces the load factor.

(4) Includes the use of poultry litter and meat & bone.

(5) Includes the use of straw combustion and short rotation coppice energy crops.

**Table 5: Renewable sources used to generate electricity and heat, and for transport fuels** <sup>(1)(2)</sup>

	Thousand tonnes of oil equivalent		
	2011	2012	2013
<b>Used to generate electricity</b> <sup>(3)</sup>			
Wind:			
Onshore	889.6	1,041.4	1,461.1
Offshore	440.7	649.1	983.8
Shoreline wave / tidal <sup>(4)</sup>	0.1	0.3	0.5
Solar photovoltaics	21.0	116.1	175.0
Hydro:			
Small scale	59.6	56.2	57.8
Large scale <sup>(5)</sup>	429.0	398.2	346.2
Bioenergy:			
Landfill gas	1,670.1	1,690.3	1,695.1
Sewage sludge digestion	250.4	235.9	249.6
Biodegradable energy from waste	677.8	838.9	819.8
Co-firing with fossil fuels	763.5	400.5	53.7
Animal Biomass <sup>(6)</sup>	224.0	225.0	226.4
Anaerobic digestion	89.1	163.6	231.7
Plant Biomass <sup>(7)</sup>	553.7	1,062.3	2,079.9
Total bioenergy	4,228.7	4,616.6	5,356.3
<b>Total</b>	<b>6,068.8</b>	<b>6,878.0</b>	<b>8,380.6</b>
Non-biodegradable energy from waste <sup>(8)</sup>	395.9	488.5	477.5
<b>Used to generate heat</b>			
Active solar heating	122.4	152.3	189.5
Bioenergy:			
Landfill gas	13.6	13.6	13.6
Sewage sludge digestion	64.3	63.7	68.3
Wood combustion - domestic	401.9	507.7	600.3
Wood combustion - industrial	281.9	289.5	342.9
Animal Biomass <sup>(9)</sup>	35.8	31.5	29.1
Anaerobic digestion	9.7	15.0	18.7
Plant Biomass <sup>(10)</sup>	288.5	275.1	339.0
Biodegradable energy from waste <sup>(6)</sup>	36.2	34.1	36.2
Total bioenergy	1,131.8	1,230.2	1,448.1
Deep geothermal	0.8	0.8	0.8
Heat Pumps	46.9	68.2	90.6
<b>Total</b>	<b>1,301.9</b>	<b>1,451.5</b>	<b>1,729.1</b>
Non-biodegradable wastes <sup>(8)</sup>	149.6	139.7	148.8
<b>Renewable sources used as transport fuels</b>			
as Bioethanol	367.5	436.9	461.7
as Biodiesel	760.0	520.9	629.4
<b>Total</b>	<b>1,127.5</b>	<b>957.8</b>	<b>1,091.0</b>
<b>Total use of renewable sources and wastes</b>			
Solar heating and photovoltaics	143.4	268.4	364.6
Onshore wind	889.6	1,041.4	1,461.1
Offshore wind	440.7	649.1	983.8
Shoreline wave / tidal	0.1	0.3	0.5
Hydro	488.6	454.4	404.0
Bioenergy	5,360.5	5,846.8	6,804.4
Deep geothermal	0.8	0.8	0.8
Heat Pumps	46.9	68.2	90.6
Transport biofuels	1,127.5	957.8	1,091.0
<b>Total</b>	<b>8,498.3</b>	<b>9,287.3</b>	<b>11,200.7</b>
Non-biodegradable energy from waste <sup>(8)</sup>	545.5	628.2	626.3
<b>All renewables and wastes</b>	<b>9,043.7</b>	<b>9,915.5</b>	<b>11,827.0</b>

(1) Includes some waste of fossil fuel origin.

(2) See the Digest of UK Energy Statistics 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 bioenergy the figures represent the energy content of the fuel used.

(4) Includes the EMEC test facility.

(5) Excluding pumped storage stations.

(6) Includes electricity from poultry litter combustion and meat & bone combustion.

(7) Includes electricity from straw and energy crops.

(8) Non-biodegradable part of municipal solid waste plus waste tyres, hospital waste, and general industrial waste.

(9) Includes heat from farm waste digestion, and meat and bone combustion.

(10) Includes heat from straw, energy crops, paper and packaging.