Chapter 6: Renewable sources of energy

Liz Waters 0747 135 8441 renewablesstatistics@beis.gov.uk

Key headlines

Following a record high in 2020, renewable generation fell by 9.3 per cent though 2021 is still the second highest on record. The decrease is mostly the result of less favourable weather conditions (particularly wind speeds but also sun hours and rainfall). **Renewables’ share of electricity generation was similarly impacted by the weather conditions falling to 39.6 per cent in 2021**, again, second only to the record 43.2 per cent in 2020.

Although new renewable capacity remains modest with 1.8 GW installed in 2021, it is higher than the 0.9 GW installed in 2020, when some projects are likely to have been delayed due to Covid-19 restrictions. Overall, installed capacity grew by 3.7 per cent in 2021.

**Total renewable fuel use decreased by 0.7 mtoe (2.8 per cent)**, largely due to the fall in electricity generation which accounts for the bulk of renewable fuel used (73 per cent). **Renewable heat increased by 0.2 mtoe (4.4 per cent)** and grid injected biogas increased by 2.4 per cent, though the latter remains relatively low in absolute terms (0.6 mtoe).

Renewable fuels include primary energy such as wind, solar, and hydro and thermal fuels including solid fuels, biogases, and liquids. Around three quarters of fuels are used for electricity generation with heat accounting for the next largest share (18 per cent). The remainder is accounted for by liquid biofuels, mostly used in transport, and biogas injected into the National Grid. The latter accounts is a relatively small part of renewable fuels but it has been increasing steadily since 2016. Chart 6.1 shows the demand for each fuel by end use.

**Chart 6.1 Use of renewable fuels, 2021 (Table 6.4)**

*Including non-biodegradable waste*
Solid biomass, including wood, waste wood, animal and plant biomass, represented 36 per cent of total renewable demand in 2021 with nearly 70 per cent being used in electricity generation and the remaining 30 per cent to produce heat. Biogas (landfill and sewage gas, and anaerobic digestion (AD)) has historically been used for electricity generation and heat but has more recently been injected into the gas grid. However, over 71 per cent is still being used for electricity generation, 22 per cent is being injected into the grid (up from 11 per cent in 2016, the first year data became available) with the remaining 7 per cent being used for heat.

Although solid biomass accounts for the largest share of renewable fuel, on an electricity output basis (i.e. generation after conversion losses in thermal generation), offshore and onshore wind show a higher share at 29 per cent and 24 per cent respectively in 2021.

Where Chart 6.1 shows renewable fuel demand, not all fuels are produced domestically, though due to the local nature of primary generation, just a small proportion of renewables is imported or exported. The bulk of net imports is represented by imported biomass (specifically wood pellets) used for electricity generation in large power stations. The renewable energy flow chart overleaf summarises the flows of renewables including production, net imports through to final outputs by sector. It also shows the conversion losses associated with thermal renewable generation. The data are sourced from the commodity balance Table 6.1, and Table 6.2 for electricity outputs.
Renewable generation fell in 2021 by 9.3 per cent: with limited new capacity coming online, the main impacts on generation were the less favourable weather conditions, notably slower wind speeds, fewer hours of sunlight and lower rainfall. **Overall generation fell by 12.6 TWh** to 122.2 TWh, though generation in 2020 was boosted by exceptionally high wind speeds (Storms Ciara and Dennis), and 2021 remains the second highest on record. There was some new capacity for both onshore and offshore wind (0.4 GW and 0.9 GW respectively), but this was insufficient to offset the lower wind speeds. Generation could potentially have been boosted in 2021 too by another notable storm (Storm Aiden), though this had a negative effect due to its ferocity causing outages. Of the 12.6 TWh fall in generation, 11.0 TWh was due to lower wind generation (5.8 TWh for onshore and 5.2 TWh for offshore). Chart 6.2 shows the change in generation between 2020 and 2021 across the technologies both in absolute and percentage terms.

Chart 6.2 Electricity generation by fuel, 2020 – 2021 (Table 6.2)

Lower rainfall in 2021 resulted in the largest fall for hydro in percentage terms of the key technologies at 20 per cent (1.4 TWh), and lower hours of sunlight. Solar PV generation also fell in response to fewer hours of sunlight in 2021.

Within bioenergy, only anaerobic digestion and energy from waste showed notable changes in 2021: a further 67 MW of AD capacity and 16 MW of energy from waste capacity boosted generation by 11 per cent and 4.9 per cent respectively.

**Offshore continues to be the leading wind technology in 2021**, accounting for 55 per cent of all wind generation in 2021. Offshore first outstripped onshore generation in 2019, although offshore capacity still lags onshore. Offshore wind plants benefit from coastal winds that generally blow at stronger speeds and for a longer period. Moreover, offshore turbines tend to be newer and larger devices, thus yielding a higher load factor.

Technologies with a high share of capacity do not necessarily have the highest share of generation because generation is dependent on the load factor. Load factors are the ratio of how much electricity was generated as a proportion of the total generating capacity. Within renewables, load factors can be heavily influenced by weather conditions: wind speeds affect wind load factors, sun hours affect the load factor for solar PV and, to a lesser extent, rainfall affects the load factor for hydro. Chart 6.3 compares the key technologies’ share of capacity and generation for 2021. The load factors for both 2020 and 2021 have been added where the impact of less favourable weather in 2021 can be seen in the lower load factors.
Thermal generation such as bioenergy and waste tend to have high load factors as indicated by the relatively high share of generation compared to capacity. It also tends to be fairly stable and generally varies should any outages occur at large plants. Conversely, solar PV has a very low load factor due to limited hours of sunlight.

On an unchanged configuration basis, where only sites operating for the full year are included, the load factor for overall renewables in 2021 was 37.3 per cent, more than 4 percentage points lower than in 2020 but still the second highest since 2015. Less favourable weather is the main driver for the large fall, with load factors for primary sources, especially wind, standing below their 10-year average. The load factor for thermal technologies also saw a decline, plant biomass decreased to 68.6 per cent but is closer to the long-term average. Load factors for landfill gas continue to decline as extraction rates decrease.

Chart 6.4 shows the historic growth in capacity highlighting the stark slowdown over 2020 and 2021 (though some projects may have been delayed in 2020 due to Covid-19 restrictions). New capacity began to slow after 2018 when 3.8 GW was installed falling to just 0.9 GW in 2020. In 2021, new capacity picked up with 1.8 GW added most of which was in offshore wind (0.9 GW). New capacity reached a peak in 2015 when a total of 6.0 GW was installed, 4.1 GW of which was in solar PV.

Prior to 2011, solar PV capacity formed a very small part of the renewable energy mix representing just 1.0 per cent of total capacity in 2010. However, between then and 2017, solar PV capacity increased significantly, thanks to the support of the Renewable Obligation (RO and the Feed-in Tariff (FiT) schemes, which closed to
new entrants in 2016 and 2019 respectively. Capacity added during those years accounts for 91 per cent of current installed capacity. Although growth has slowed since 2017, solar PV's share of renewable capacity stands at 28 per cent in 2021.

Growth in new wind sites has been more stable, particularly onshore wind, though it has slowed over recent years with just 0.4 GW added in 2021, an increase of 3 per cent. Offshore wind has seen higher levels of new capacity in recent years with more than half being installed since 2016. Wind now represents over half of installed renewable capacity (see wind map on next page showing location by capacity).

The map below shows UK wind farms that were operational at the end of 2021 with a capacity 0.5 MW or more. In addition, there are around 9,000 smaller sites that are not shown. The exact location of some plants could not be determined from the available data. In 2021, there was one new offshore wind plant (Triton Knoll) which accounted for nearly 95 per cent of the new capacity, the remainder consisted of an extension at Kincardine. In addition, there were 30 new onshore wind farms.
Chart 6.5 shows the changes in electricity generation fuel mix since 2000. The overall upward trend in generation is driven by increasing cumulative capacity. However, the impact of year-on-year fluctuations due to temperamental weather conditions can be seen in the above chart. For example, despite the record new capacity in 2015, generation for 2016 remained similar to 2015. Again, this can be seen between 2020 and 2021 with the fall in generation.

Hydro is a mature technology and generation tends to fluctuate from year-on-year in line with rainfall. In contrast, solar PV generation has increased rapidly since 2011 reflecting the surge in new capacity incentivised via the Feed in Tariff (FiT) support scheme. As a result, solar PV’s share of renewable generation increased from just 0.7 per cent in 2011 to 9.9 per cent in 2021.

Bioenergy has seen rapid growth since 2012 as several large power stations converted from coal to plant biomass (mainly wood pellets). Generation from landfill gas peaked at 5.3 TWh in 2011 but has fallen in each year since then as extraction rates have declined at landfill sites. This fall has been offset by an increase in generation from anaerobic digestion, up by 3.1 TWh since 2011 and 0.3 TWh in 2021, nearly 11 per cent.

Chart 6.6 Other renewable fuel uses; heat, transport, and grid injected biogas (Table 6.4)

*Including non-biodegradable waste
Whilst electricity generation represents nearly three quarters of renewable fuel demand, heat also accounts for a sizable proportion (18 per cent) with liquid biofuels (6.3 per cent) and of increasing importance, biogas injected into the grid (2.4 per cent). Between 2020 and 2021, renewable heat increased by 4.4 per cent with most of the increase in energy from waste and wood.

Renewables used in transport are liquid biofuels, which are blended with diesel and motor spirit (petrol). Demand for bioethanol increased 33 per cent in 2021 to 447 ktoe, as road fuels sales increased following the Covid-19 lockdown, and the introduction of E10 petrol at pumps (indicating up to 10 per cent bio content). Conversely consumption of biodiesel fell by 22 per cent to 1,017 ktoe largely due to high demand for used cooking oil (a large proportion of biodiesel) in jet fuel production, and reduced supply during lockdowns. With capacity stable at 522 ktoe and production of bioethanol being only 201 ktoe (a 9.2 per cent increase) in 2021, imports made up for the excess demand. Biodiesel, on the other hand, saw a sharp reduction (22 per cent) in consumption, to 1,017 ktoe. Capacity and production in 2021 remained stable, at 582 ktoe and 447 ktoe respectively.

Until 2016, only minimal amounts of biogas from anaerobic digestion sites were injected into the grid but with support from the Renewable Heat Incentive, it has increased steadily, and since 2018, small quantities of sewage gas have also been injected. Growth in 2021 slowed to 2.4 per cent compared to 9.0 per cent in 2020.

For this edition of DUKES, BEIS have brought forward the usual September Energy Trends article, ‘Aggregated Energy Balances, of which renewables’¹ to improve timeliness. These data are now available in Table 6.5] along with estimates for the renewable proportion of Gross Final Consumption (i.e. before losses) for electricity and heat. The renewable share of transport fuels is on an actual basis as presented in the final consumption by sector chart (Chart 6.8).

Chart 6.7 Renewable energy as a proportion of total gross final consumption (Table 6.5a)

The proportion of electricity from renewables differs to that for generation and supply in that it excludes generation consumed in transport which is allocated to the transport measure. The underlying trend is however similar in that weather impacts are visible particularly between 2020 and 2021. Weather influences can also be seen between 2015 and 2016; despite this being a period of strong renewable capacity growth, generation was flat for the year with lower wind speeds, sun hours and rainfall. The heat measure is based on

renewable fuels allocated to heat in Table 6.4; although some electricity will be consumed for heating purposes, this is allocated to electricity. Although over time, renewable fuels used in transport and heat have increased, both remain modest when compared with renewable electricity. Demand for liquid biofuels fell (the majority of renewable fuels) in 2021, driving the lower share of renewable consumption.

The renewable proportion consumed by sectors, regardless of end use, varies depending on the proportion of electricity consumed versus thermal fuels. Chart 6.8 below highlights how the renewable proportion of renewables for industry has increased and, since 2016, has been in line with other consumers (mostly commercial and public administration). This reflects lower heavy industry consumption usually requiring higher grade heat usually provided by fossil fuels.

**Chart 6.8 Renewables’ share of final energy consumption by sector** *(Table 6.5b)*

All sectors show a fall in their renewables’ share in 2021 in line with lower supply of renewable electricity. The domestic sector also saw higher gas consumption due to lower average temperatures which further suppressed renewables’ share.