Chapter 6: Renewable sources of energy

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Key headlines

Renewable generation increased by 10 per cent in 2022 to a new record of 135.0 TWh. This was just 0.5 per cent higher than the previous record set in 2020 when unusually favourable weather conditions hit the UK. The key driver in 2022 was new capacity and an improvement in weather conditions compared to 2021. Within the technologies, records were set for onshore and offshore wind, solar PV, and anaerobic digestion.

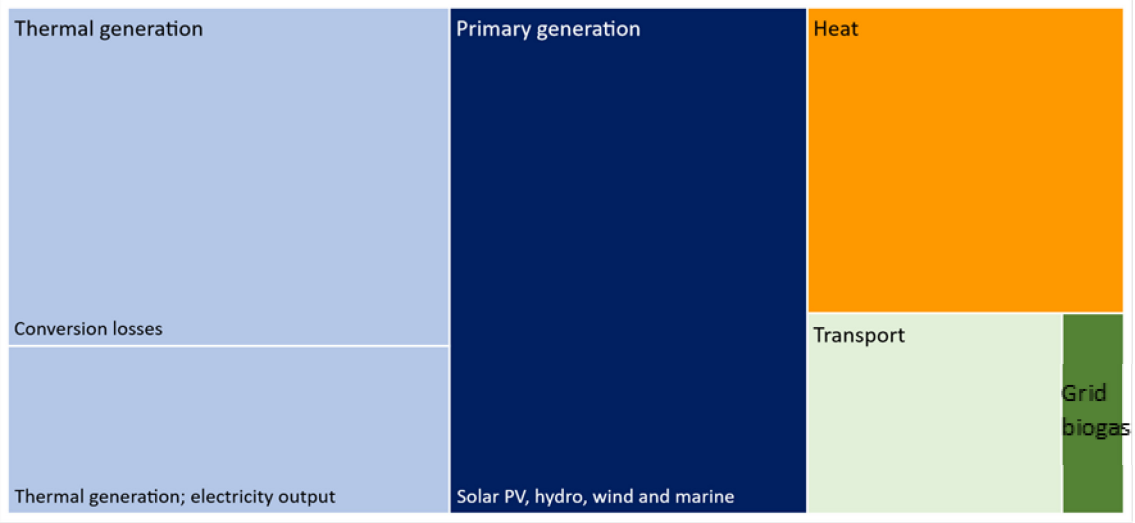
Renewable capacity increased by 7.7 per cent (3.8 GW), the highest growth rate since 2018 and just below the 3.9 GW installed in that year. This remains lower than the average annual growth rate between 2012 and 2018 which was 20 per cent. Of the 3.8 GW new capacity in 2022, 2.7 GW was in offshore wind, 0.7 GW in solar PV, and 0.3 GW in onshore wind.

Renewable heat increased by just 1.1 per cent; increases in heat pumps and plant biomass were somewhat offset by a fall in bioliquids (newly reported in 2023).

As a share of gross final consumption, overall renewables accounted for 14 per cent, an increase of 0.8 percentage points on 2021, a combination of increases in renewable electricity generation and use of biofuels in transport, combined with a slight fall in total gross final consumption.

Renewable fuels include primary energy such as wind, solar, and hydro, and thermal fuels (solid biomass, biogases, and liquids). Thermal fuels are combusted to produce energy and in the case of electricity generation, some is lost during this conversion process. Around 72 per cent of renewable fuels are used for electricity generation, a third of which is lost in the conversion process. Heat accounts for 17 per cent with transport and grid injected biogas accounting for 9 per cent and 2 per cent respectively. Chart 6.1 below shows the demand for all renewable fuels including losses from the conversion process.

Chart 6.1 Renewable fuel[1] demand, 2022 (Table 6.4)



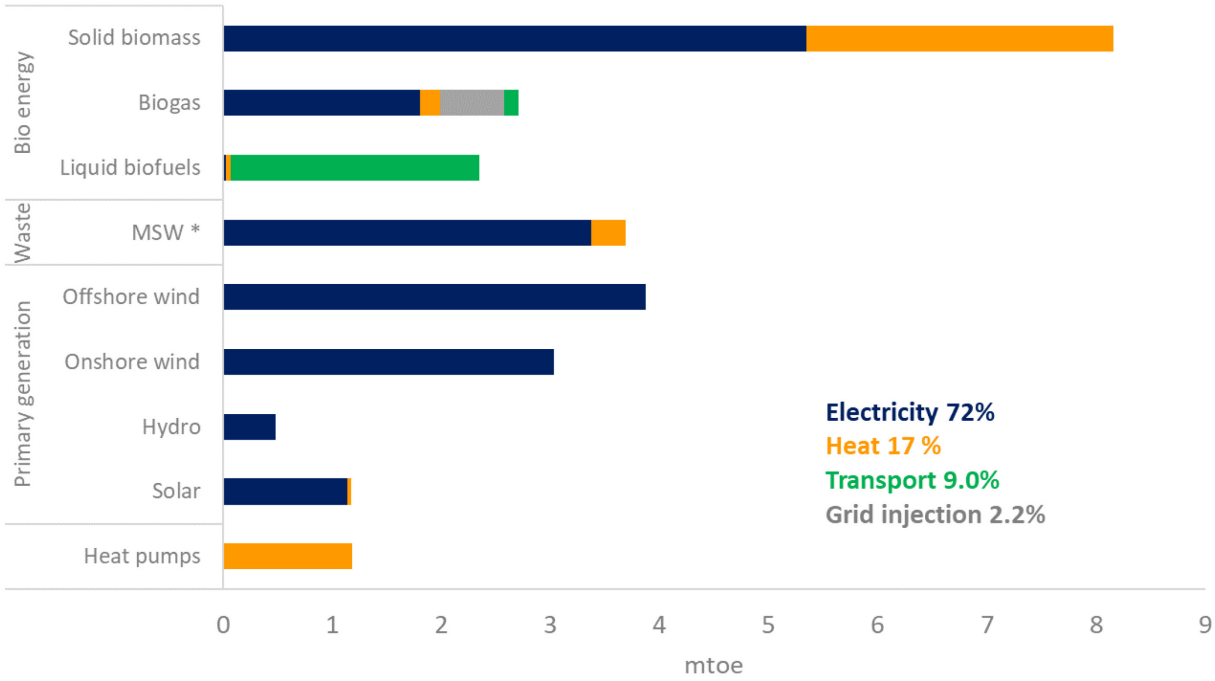
[1] Including non-biodegradable waste

The chart replicates data included in Table 6.4; where this differs to Table 6.2 is the latter includes electricity generation only, i.e. primary generation and thermal generation after losses. The amount of conversion losses depends on the efficiencies of fuels which for renewables varies at around 35 to 40 per cent, with the remainder being lost in conversion. This compares with an efficiency of around 48 per cent for natural gas and around 34 per cent for coal and oil generation.

Some renewable fuels are more versatile than others such as biogases; historically demand had been dominated by electricity generation, but it is now increasingly used for heat generation, injection into the National Grid, and most recently small amounts are consumed within the transport sector. Conversely, primary energy sources such as wind and hydro are consumed solely by the electricity sector and although solar is primarily used in generation, small amounts of solar thermal are used for space and water heating.

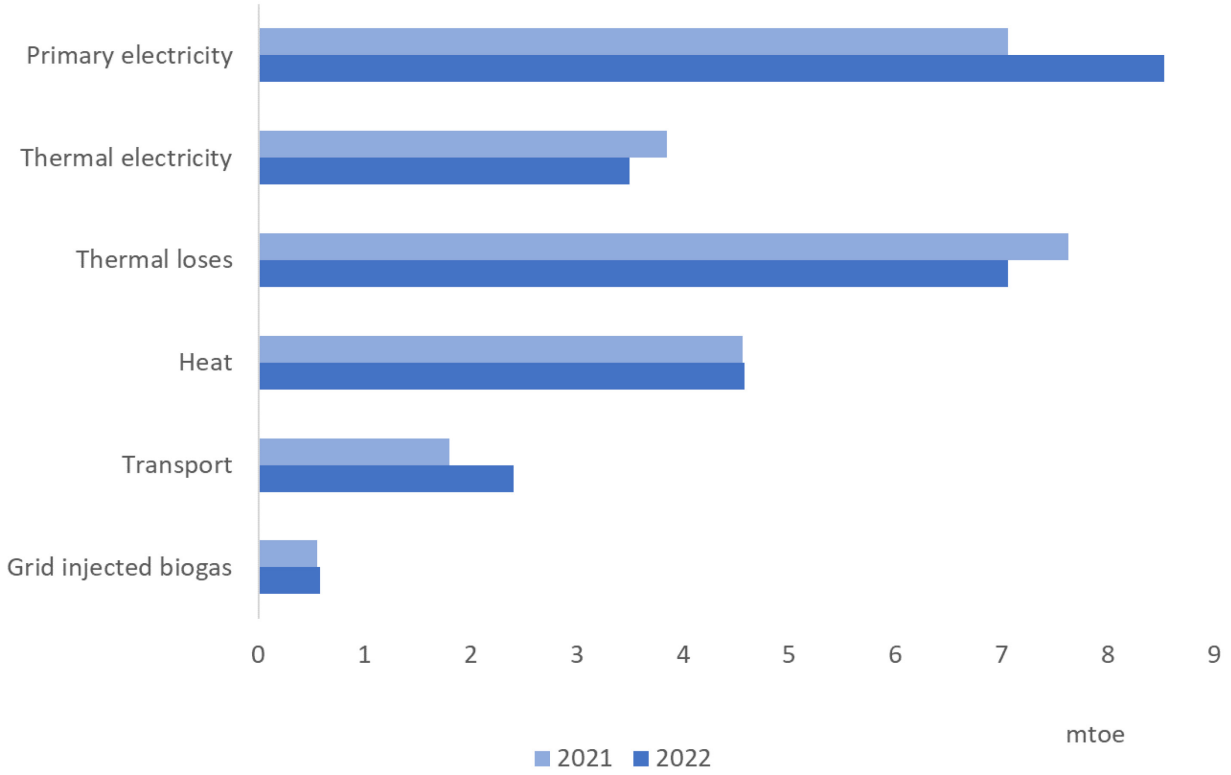
Chart 6.2 shows how the individual fuels and technologies are consumed across the end uses (note: thermal fuels include losses incurred during conversion).

Chart 6.2 Use of renewable fuels, 2022 (Table 6.4)



Between 2021 and 2022, overall renewable fuel demand increased by 4.7 per cent with the majority of the increase being from primary electricity generation, particularly wind. Use of biofuels in transport also increased though generation from thermal renewables fell along with the associated conversion loses. Renewable heat demand increased marginally (by just 0.8 per cent); growth in heat pumps and plant biomass was offset by a fall in liquid biofuel consumption. Chart 6.3 shows how each component of fuel demand changed between 2021 and 2022.

Chart 6.3 Change in renewable fuel demand 2021 to 2022 (Table 6.4)



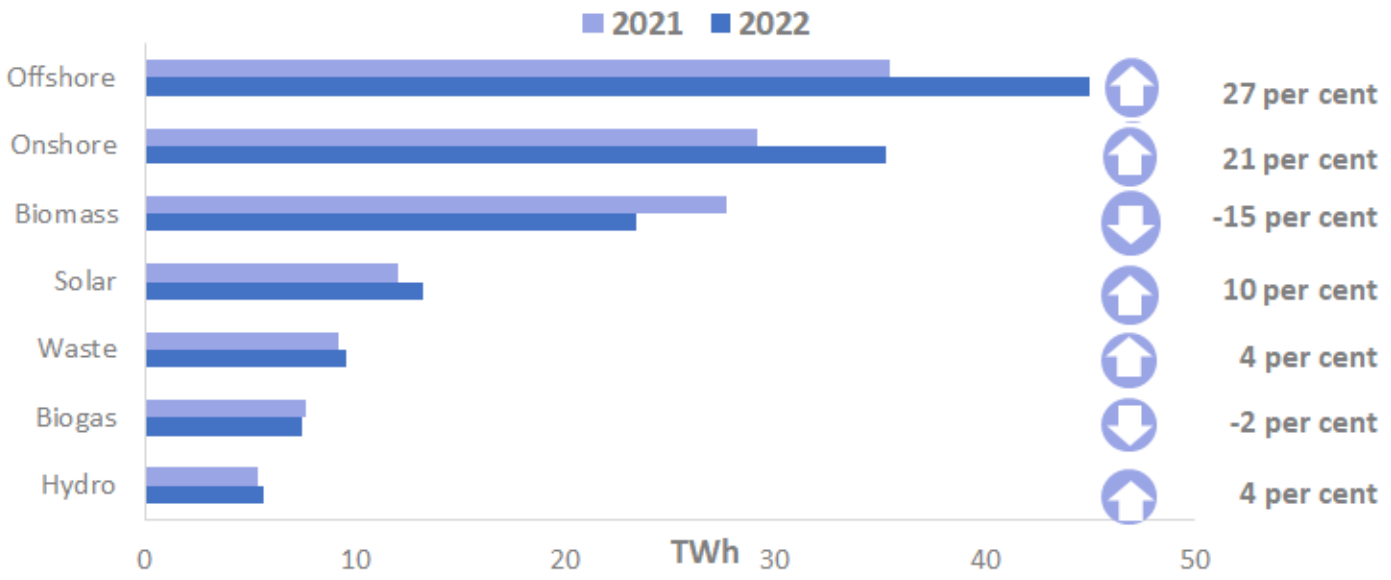
At 135.0 TWh, overall renewable generation set a new record, beating the previous 2020 record by just 0.5 per cent. Although weather conditions in 2022 were more favourable than in 2021, they were less extreme than those experienced in 2020 and it was the new capacity since 2020 that played a major part in achieving the new record.

Both onshore and offshore wind achieved records in 2022; generation from offshore wind increased by 27 per cent and onshore by 21 per cent. Although wind speeds were higher than in 2021, they were still lower than in 2020 and it was new capacity particularly in offshore wind (which increased by 24 per cent), contributed to the new record. At 45.0 TWh, offshore wind generation alone exceeded total renewable generation of ten years ago (41.2 TWh).

Similarly solar PV exceeded its previous record from 2020. As with wind generation, new capacity contributed to the new record but unlike wind speeds, sun hours were higher in 2022 compared to both 2021 and 2020. The impact on generation in 2022 is a 10 per cent increase on 2021 and 6.2 per cent compared to 2020.

Chart 6.4 shows the change in generation between 2021 and 2022 across the technologies both in absolute and percentage terms.

Chart 6.4 Electricity generation by fuel, 2021 – 2022 (Table 6.2)



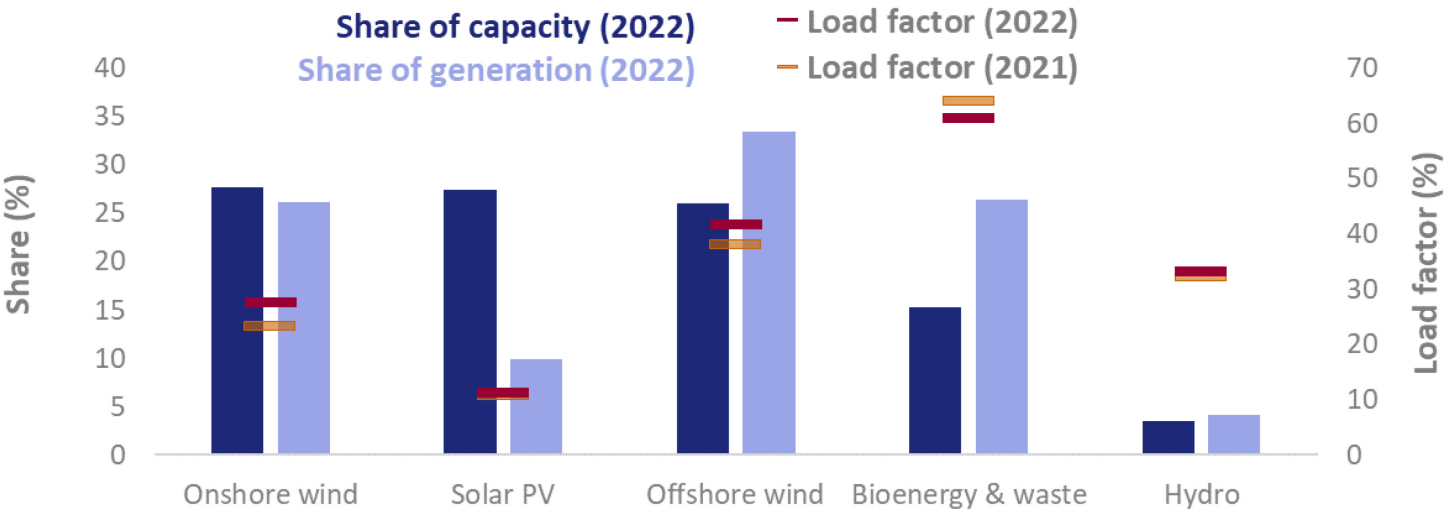
Hydro generation increased by 4.5 per cent in 2022 to 5.6 TWh, though remains lower than the previous record set in 2020 when the UK saw record levels of rainfall. Hydro is an established technology and there has been little new capacity in recent years.

Overall, bioenergy generation fell by 12 per cent to 31.1 TWh, the lowest since 2018. This is largely due to maintenance outages at three large power stations supressing demand for plant biomass (mostly wood pellets). Generation from landfill gas continues to decrease in line with falling yields. **Only anaerobic digestion and energy from waste saw increases in 2022**; generation from anaerobic digestion was a record 3.4 TWh, a 3.5 per cent increase on 2021.

Offshore wind continues to be the leading renewable technology in 2022 for generation, accounting for 56 per cent of all wind generation and a third of all renewable generation in 2022. Offshore first outstripped onshore generation in 2019, and although offshore capacity still lags onshore, the gap has closed. The discrepancy between capacity and generation can be explained by a combination of stronger and more consistent coastal wind speeds, and offshore turbines tend to be newer and larger than onshore, often 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: such as wind speeds, sun hours and, to a lesser extent, rainfall. Chart 6.5 compares the key technologies' share of capacity and generation for 2022. The load factors for both 2021 and 2022 have been added where the impact of more favourable weather in 2022 can be seen in the higher load factors.

Chart 6.5 Relative share of capacity and generation and load factors 2022 (Table 6.3)

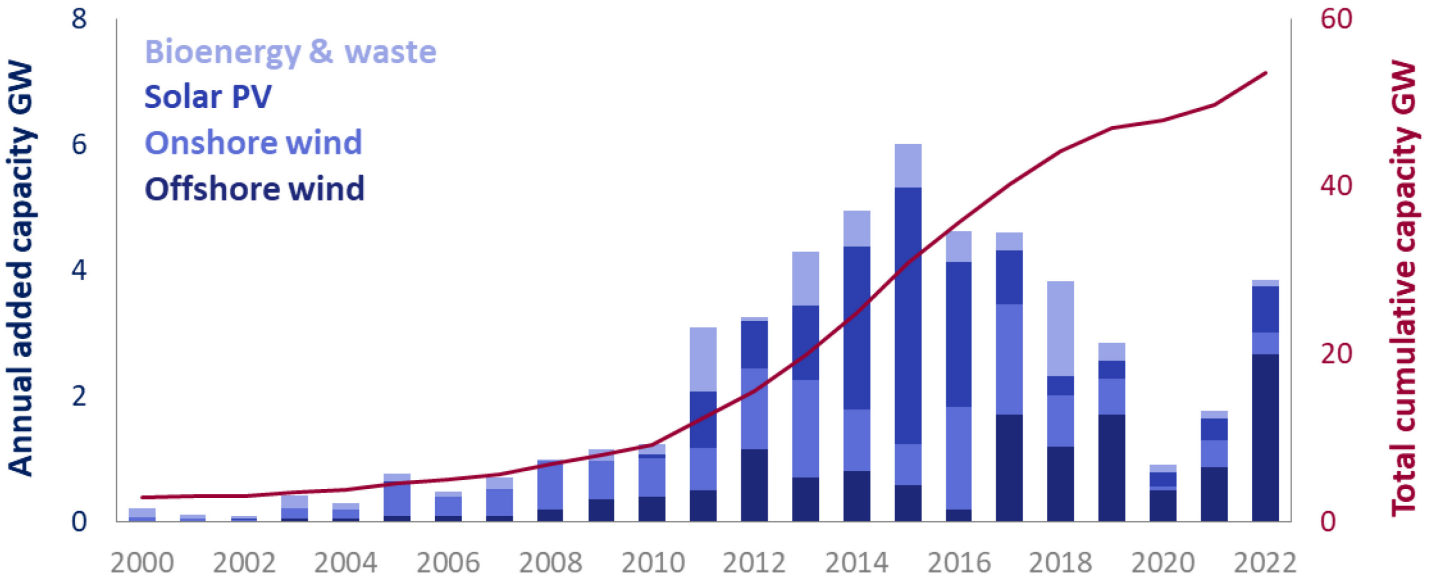


Thermal generation such as bioenergy and waste tend to have high, stable load factors varying only when outages occur at major power plants. Conversely, solar PV has a very low load factor due to limited hours of sunlight in the UK.

On an unchanged configuration basis, where only sites operating for the full year are included, the load factor for overall renewables in 2022 was 38.1 per cent. This was 0.8 percentage points higher than in 2021 and the second highest since 2015. The load factors were driven by more favourable weather conditions including higher average wind speeds and longer average sun hours. Load factors also increased for hydro and solar PV. This was partially offset by a fall in the load factor for bioenergy, particularly for plant biomass, which was the lowest since 2013, due to outages. Load factors for landfill gas continue to decline as extraction rates decrease.

Chart 6.6 shows the historic growth in capacity highlighting the stark slowdown over 2020 and 2021 (some projects may have been delayed in 2020 due to Covid-19 restrictions). New capacity was much higher in 2022 and was at a similar volume to that last seen in 2018, capacity growth was driven by three large offshore wind projects. New capacity began to slow after 2018 when 3.8 GW was installed falling to just 0.9 GW in 2020. 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.

Chart 6.6 Annual added capacity 2000 to 2022 (Table 6.2)



Since 2002, large scale solar PV was eligible for the Renewables Obligation (RO), however, up until 2010, when the Feed-in Tariff (FiT) was launched, solar PV still represented just 1.0 per cent of renewable generation capacity. In 2022, solar PV's share of renewable capacity stood at 27 per cent with the majority of new capacity (86 per cent) being installed between 2011 and 2017, when growth began to slow; the Renewable Obligation closed to new entrants in 2016 and the FiT in April 2019. Growth has since improved and during 2022 there were more domestic solar panels installed than in any year since 2015[2].

Growth in new wind sites has been more stable, particularly onshore wind, though it has slowed over recent years with just 0.3 GW added in 2022 (an increase of 2.4 per cent) and 0.4 GW added in 2021. Offshore wind has seen much higher levels of new capacity in recent years with 62 per cent of total capacity being installed since 2016. Wind now represents around 54 per cent of installed renewable capacity (see wind map at the end of this chapter showing location by capacity). In 2022 there was 2.7 GW of new capacity, including three new plants: Hornsea 2 in England (1,386 MW), Moray East in Scotland (950 MW) and the first part of Seagreen, also in Scotland (270 MW at the end of 2022).

Chart 6.7 Trends in generation by technology 2000 to 2022 (Table 6.2)

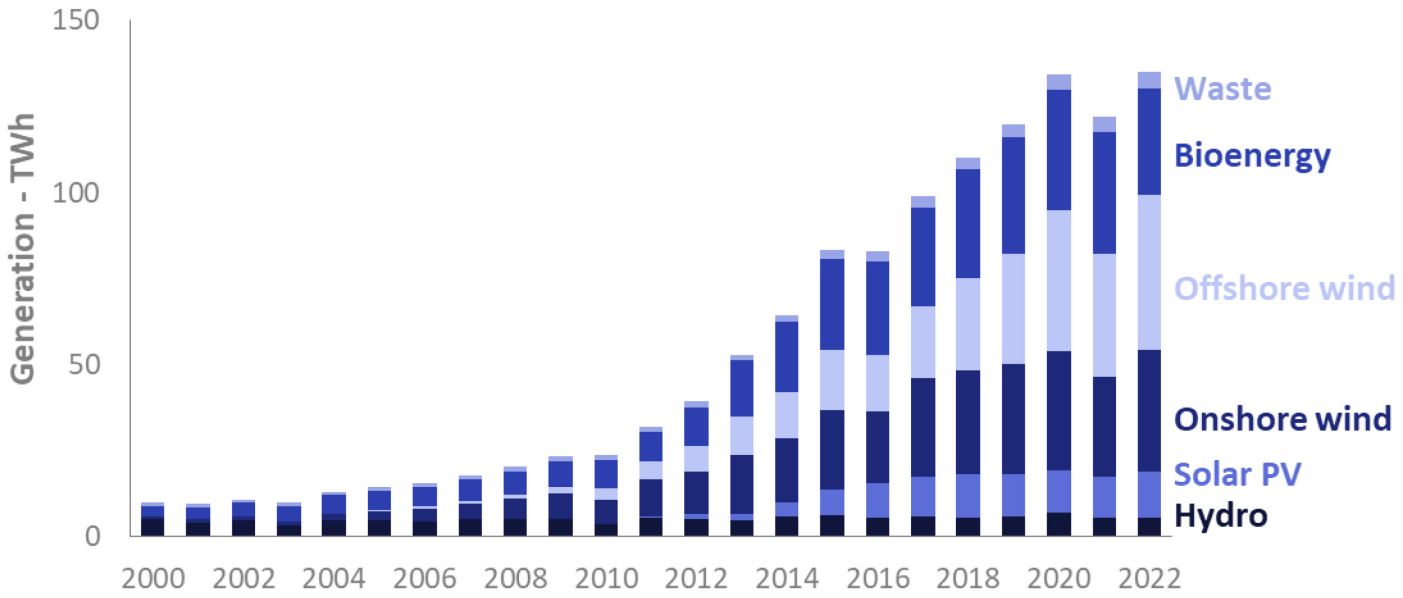


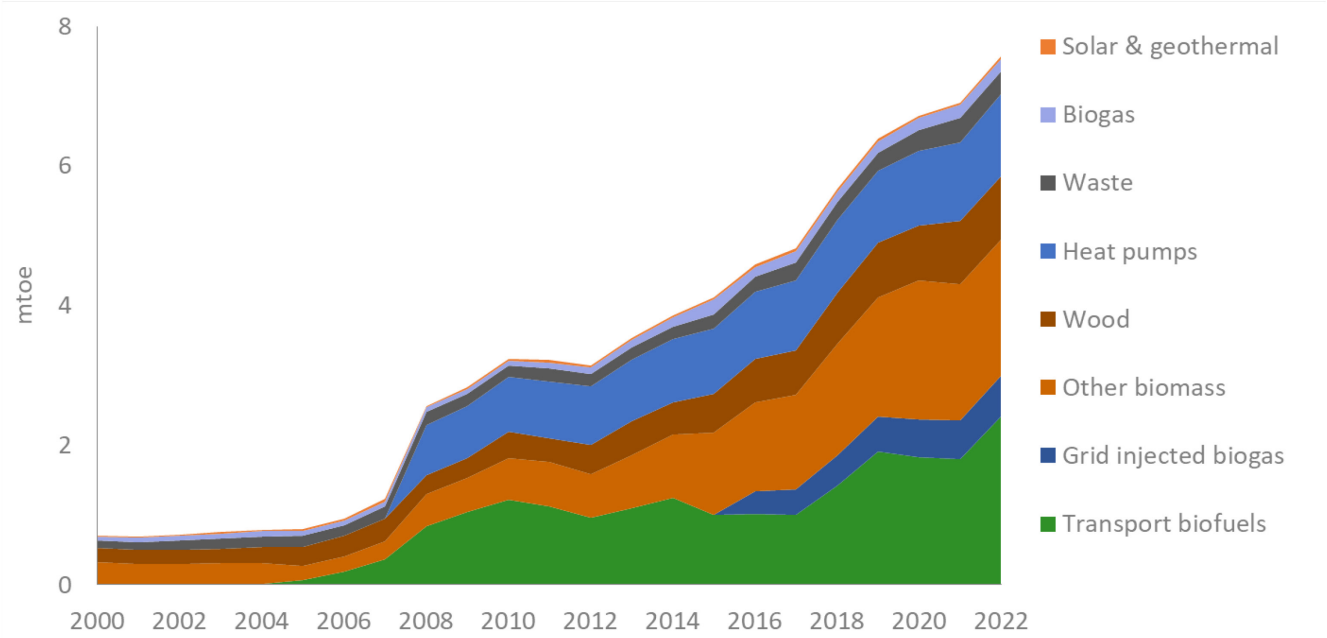
Chart 6.7 shows the changes in electricity generation fuel mix since 2000. The overall upward trend in generation is driven by increasing cumulative capacity. However, there are year-on-year fluctuations due to weather conditions. For example, despite the record capacity installed in 2015, generation for 2016 remained similar to 2015. This can also be seen with a fall in generation in 2021. Generation in 2022 is the highest on record but only marginally higher than in 2020.

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 9.8 per cent in 2022.

[2] For more information see the solar deployment tables at: https://www.gov.uk/government/statistics/solar-photovoltaics-deployment

Bioenergy has seen rapid growth since 2012 as several large power stations converted from coal to plant biomass (mainly wood pellets), and although the outages supressed generation in 2022, it remains almost five times higher than in 2012. 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 more than offset by a seven-fold increase in anaerobic digestion since 2012.

Chart 6.8 Other renewable fuel uses[3]; heat, transport, and grid injected biogas (Table 6.4)



Whilst electricity generation represents almost three quarters of renewable fuel demand, heat also accounts for a sizable proportion (17 per cent), followed by transport biofuels (9.0 per cent) and biogas injected into the gas grid (just above 2.2 per cent).

Renewable heat demand is largely met by biomass, mostly wood, accounting for 61 per cent of fuel in 2022, with the next largest share being heat pumps (26 per cent). The remainder is largely made up of wastes and biogases (6.9 per cent and 4.0 per cent respectively), with bioliquids and primary sources (such as active solar heating and geothermal) accounting for around 1 per cent each.

Renewables used in transport are liquid and gaseous biofuels, supplied either as additives or as replacement ("drop-in") for fossil fuels. Among liquid biofuels, biogasoline and biodiesel dominate the fuel mix, representing 90 per cent of transport demand when combined. Since 2018, small but rapidly increasing amounts of new biofuels became available in the UK. In 2022, 5.4 per cent of renewable transport fuels were biogases, up from less than 1 per cent in 2018, while bio-LPGs (bio propane and bio butane) accounted for 0.6 per cent, though supply is particularly volatile. Bio-jet fuel is newly reported in this edition of DUKES with effect from 2021, and in 2022, accounts for 4.0 per cent of all transport renewables but only 1 per cent of aviation demand.

When compared to 2021, demand for transport biofuels grew by 34 per cent to 2,406 ktoe, driven by the rebound of transport sector after Covid-19 and by policy changes. Strong growth in bio gasoline (up 41 per cent in 2022) is driven by the introduction of E10 petrol (i.e. up to 10 per cent bio content) at the pump as well as the general increase in transport fuel use.

[3] Including non-biodegradable waste

Consumption of biodiesel increased by 30 per cent in 2022 but this is likely an artificial trend observed after a depression in biodiesel supply during 2021, largely due to a shortage of used cooking oil (the main feedstock for biodiesel) during lockdowns. When compared with 2019, biodiesel demand has increased by less than 3 per cent.

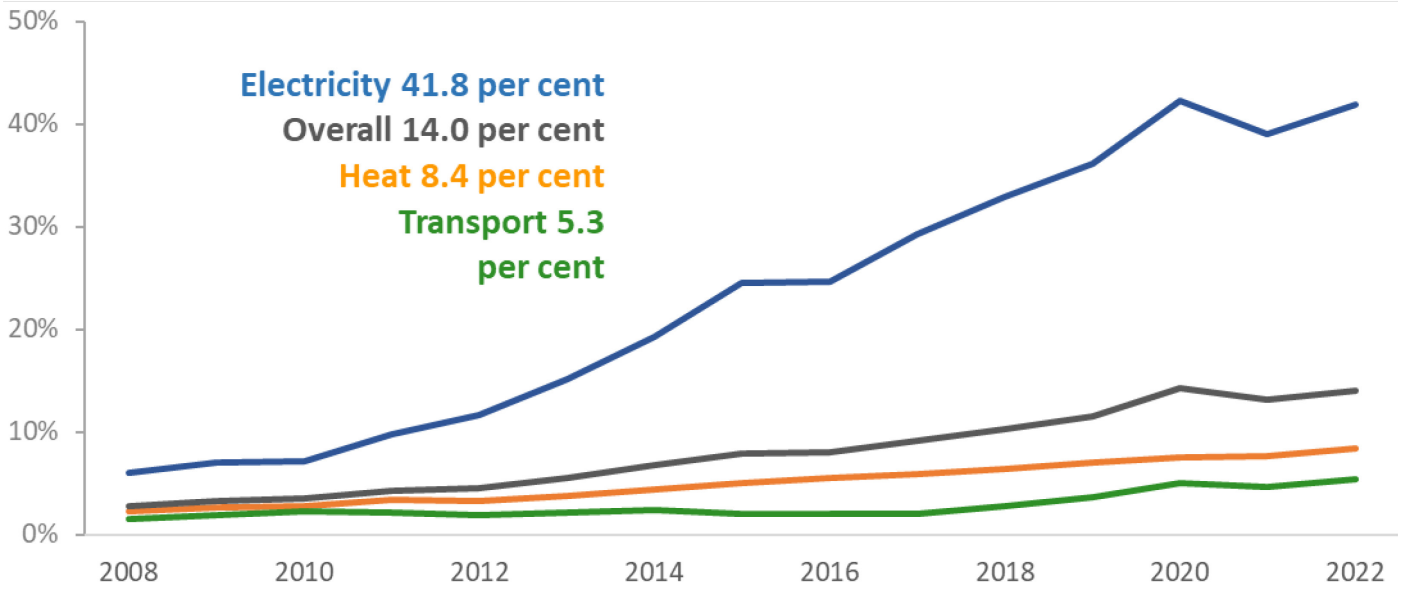
Indigenous production of bioliquids increased in 2022, but still lags demand. With capacity stable at 504 ktoe per annum and production of bioethanol being only 251 ktoe in 2022 (though 25 per cent higher than in 2021), imports met the excess demand. Biodiesel capacity, however, increased to 596 ktoe per annum but production stalled at 442 ktoe in 2022.

Biogas injected into the National Grid increased by 4.9 per cent in 2022 driven by anaerobic digestion. 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.

To place renewable energy in context, Table 6.5 provides a measure for the share of renewables across the various energy flows, as well as 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 6.9).

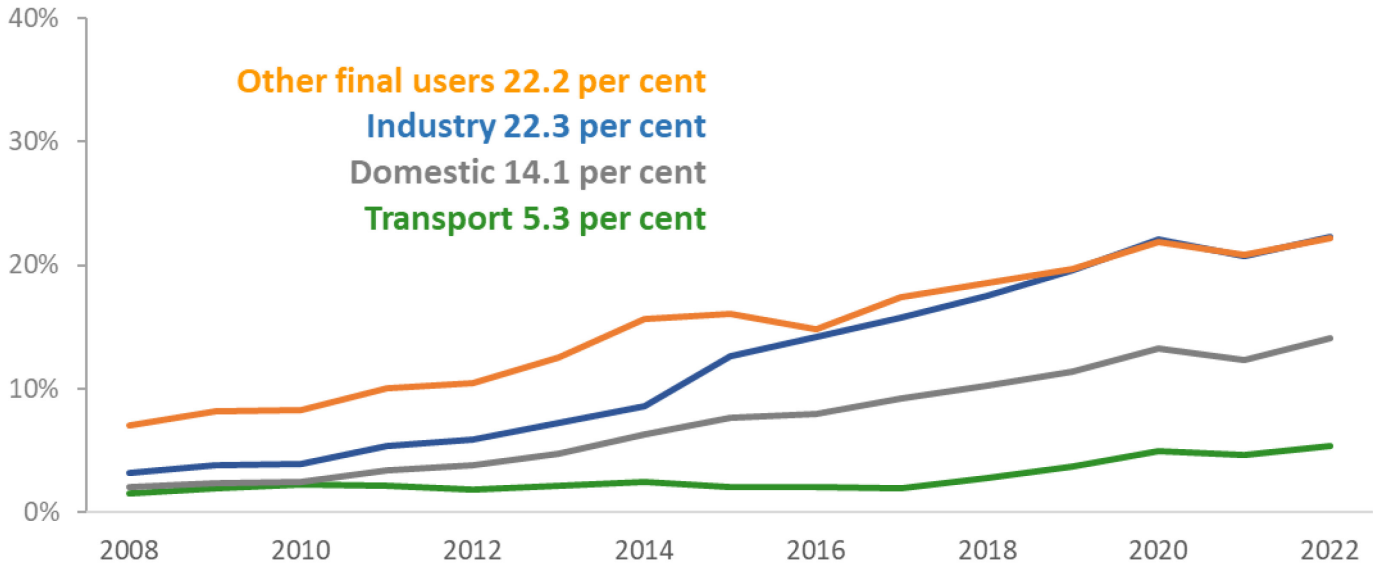
The proportion of electricity from renewables differs to that for generation and supply in that it excludes generation ultimately consumed in transport which is allocated to the transport measure. The underlying trend is however similar in that weather impacts are visible particularly between 2020 and 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 (mostly consumed in transport) soared in 2022, driving the higher share of renewable consumption.

Chart 6.9 Renewable energy as a proportion of total gross final consumption (Table 6.5a)



The renewable proportion consumed by sectors, regardless of end use, varies depending on the proportion of electricity consumed versus thermal fuels. Chart 6.10 below highlights how the proportion of renewables for industry has increased and, since 2016, has been in line with 'other' consumers (commercial and public administration). This reflects lower heavy industry consumption that requires higher grade heat usually provided by fossil fuels.

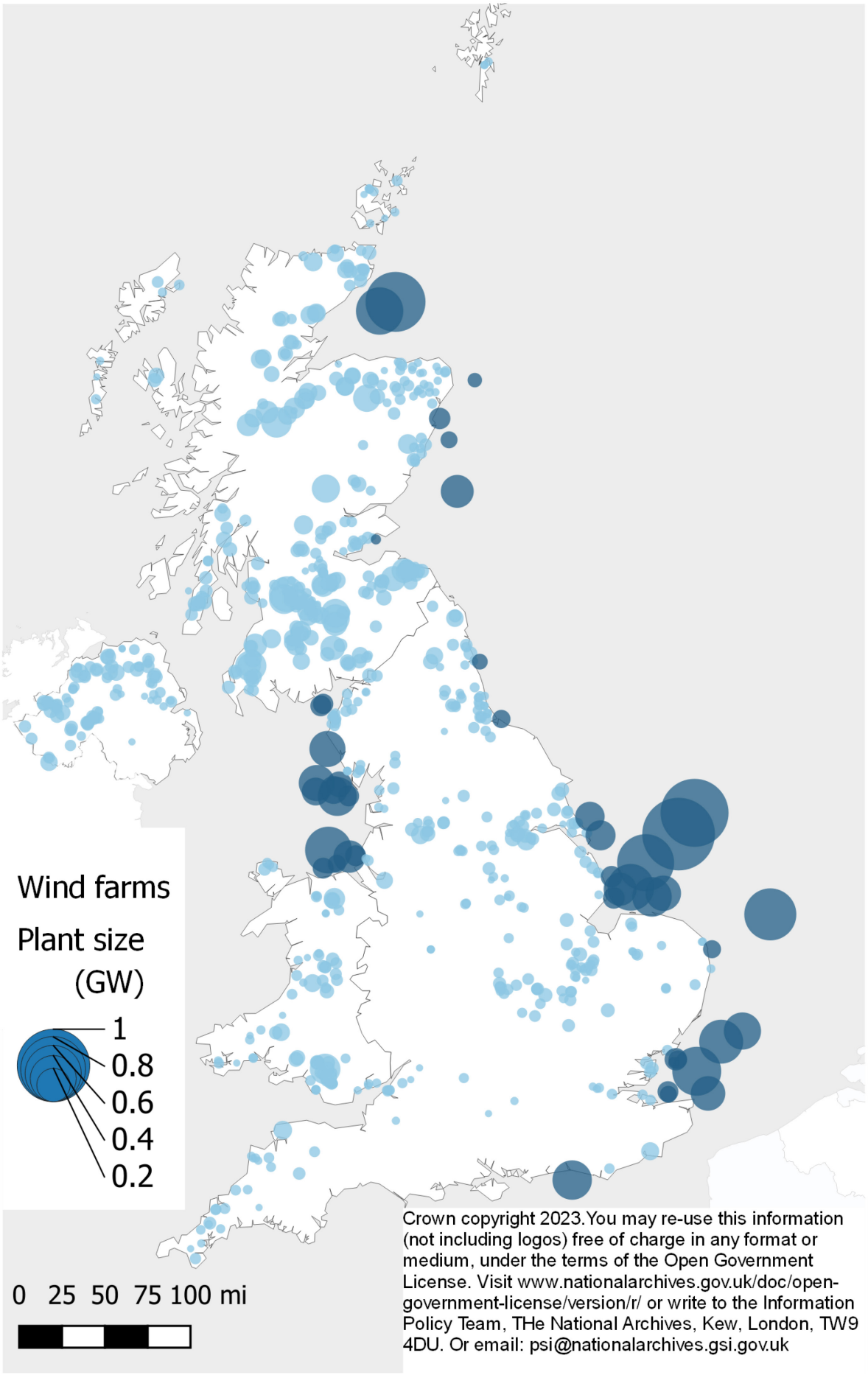
Chart 6.10 Renewables' share of final energy consumption by sector (Table 6.5b)



All sectors show an increase, in line with an increase in renewable electricity supply. The domestic sector saw the largest increase in its renewable share of consumption (1.8 percentage points) which is likely driven by lower gas demand in households due to warmer weather during 2022 and changes in consumer behaviour driven by higher energy prices.

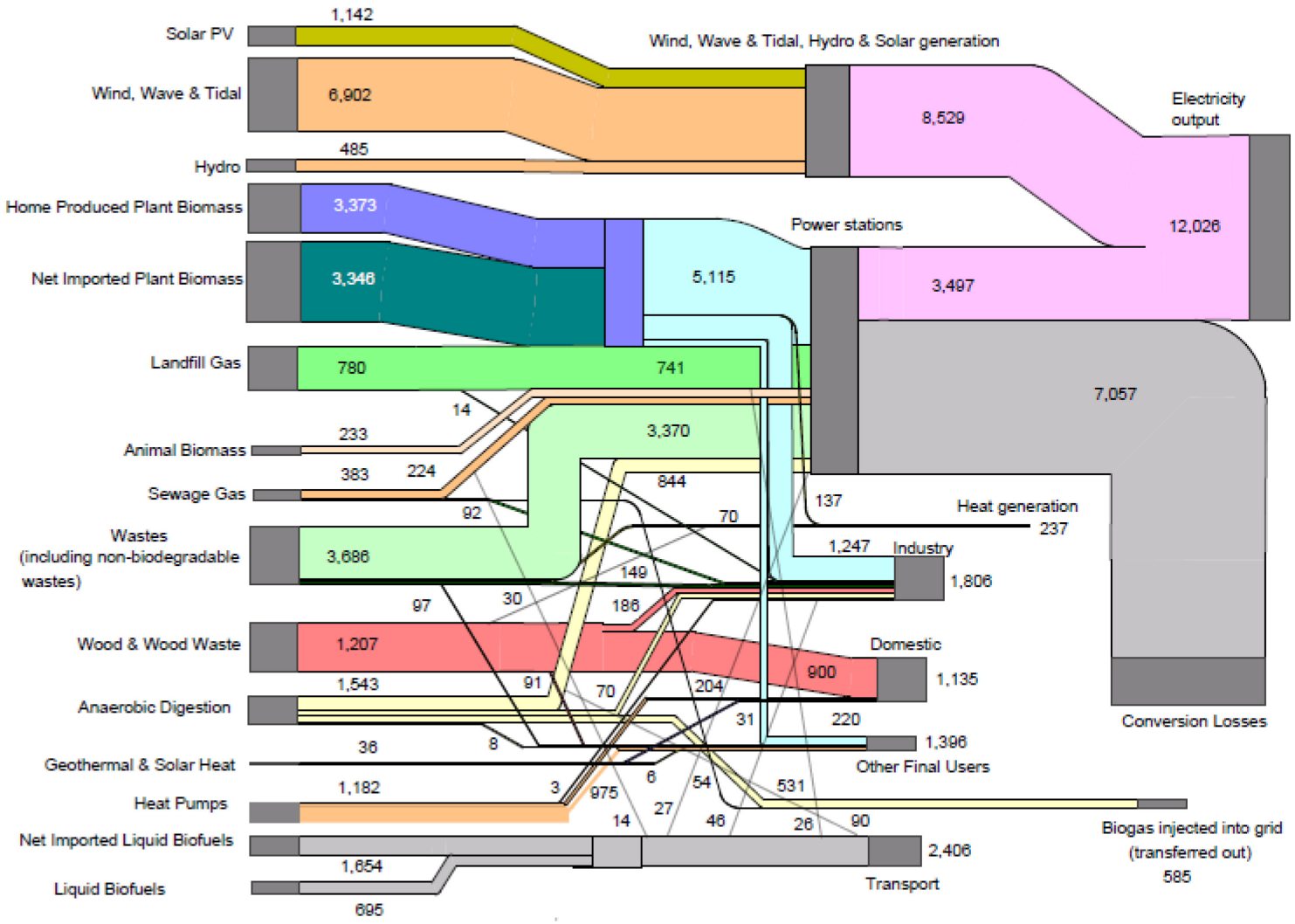
The map below shows UK wind farms that were operational at the end of 2022 with a capacity 0.5 GW or more; there are around 9,000 sites below this threshold and other sites are excluded due to a lack of precise location data. The locations are representative and not exact.

Map of UK wind capacity 2022



Renewable energy flow chart 2022 (Tables 6.1 and 6.2)

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.



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