Department for Energy Security & Net Zero

Energy Trends

UK, July to September 2024

About this release

Information on energy production, trade, and consumption in the UK for total energy and by specific fuels.

In this release

Data tables

Additional data are available online as part of the Energy Trends series:

Total energy
Coal and derived gases
Oil and oil products
Gas
Electricity
Renewables

This publication is based on a snapshot of survey data from energy suppliers. New data are incorporated in line with the revisions policy.

Percentage change from Quarter 3 2023, primary energy basis

(Mtoe basis)	Production	Imports	Exports	Demand
Total energy	**-3.9%**	**+5.5%**	**+8.8%**	**-1.0%**
Coal	**-79%**	**+4.1%**	**+207%**	**-60%**
Primary oil	**-4.0%**	**-6.5%**	**-1.7%**	**-3.2%**
Petroleum products	**-1.8%**	**+1.3%**	**+1.8%**	**-1.2%**
Gas	**-15%**	**+33%**	**+43%**	**-7.7%**
Electricity	**+4.6%**	**+54%**	**-12%**	**+4.6%**

Total energy production in the third quarter of 2024 was at a record low, down 4 per cent on the third quarter last year with oil at a record low and gas at a near record low. Energy production is 24 per cent below the pre-pandemic level recorded in the third quarter of 2019. Energy production from renewable assets (wind, solar and hydro) was stable on last year, although nuclear output improved due to fewer outages.

Renewable electricity generation grew 7 per cent on the same period last year. Total generation from wind, solar and hydro was flat, but bioenergy increased 23 per cent on the same period last year where output was down on typical levels.

Fossil fuel electricity generation decreased, down 29 per cent and another near record low because of stronger renewable generation and higher net imports from France reducing the need for domestic generation. The fossil fuel share of generation decreased 9.2 percentage points to 28.0 per cent, slightly up on last quarter's record low. **Low carbon generation maintained its near record high of 68.2 per cent of all generation**

Final energy consumption by households rose by 18 per cent on the last year's record quarterly low. Household demand last year was reduced by high energy prices and notably warm weather, and consumption this quarter is broadly in line with post-pandemic trends on a seasonal and temperature adjusted basis. **Transport demand was broadly flat on last year**, with a fall in diesel consumption being cancelled out by a rise in petrol and jet fuel consumption.

Fossil fuel dependency reached a record low in the third quarter of 2024, decreasing from 75.3 per cent last year to 71.8 per cent largely as a result of the record low from gas demand. **Net import dependency** increased from 37.5 per cent to 38.5 per cent, mainly due to rises in net imports of petroleum products, gas and electricity.

Section 1: UK total energy

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Key headlines

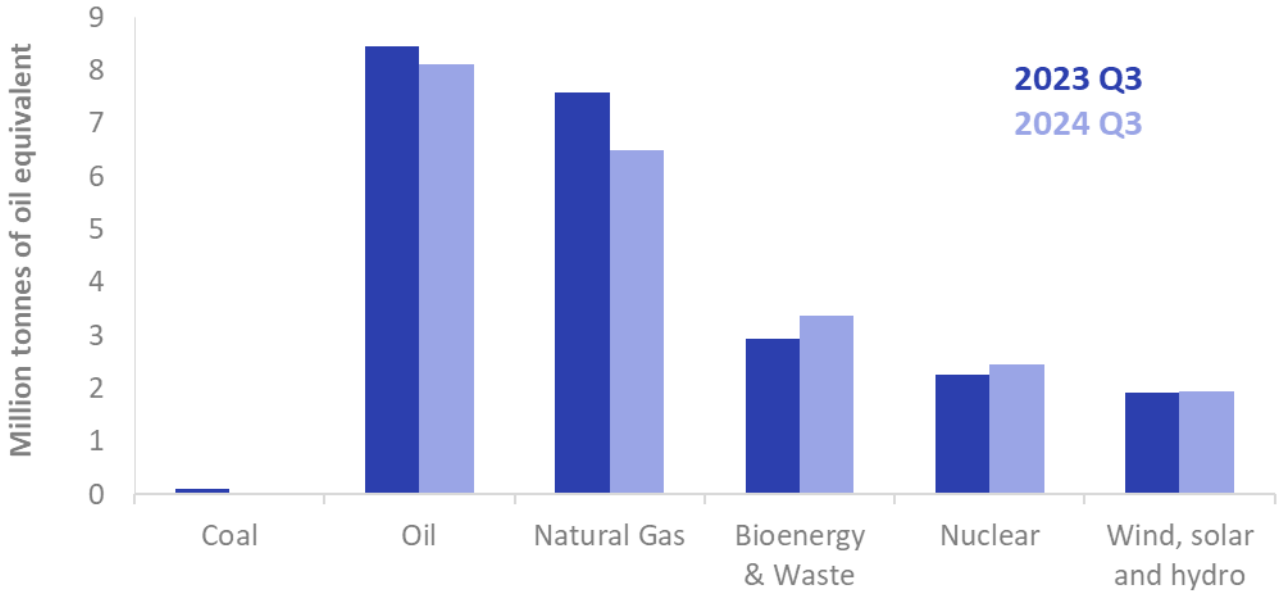
In the third quarter of 2024 **total production was 22.4 million tonnes of oil equivalent, 3.9 per cent lower** compared to the third quarter of 2023 and at the lowest quarterly total this century. Oil and gas production fell markedly on last year, and oil production is at a record quarterly low this century and notably below pre-pandemic levels. Low carbon output increased despite a fall in wind output on the same period last year.

Total primary energy consumption for energy uses fell by 0.6 per cent, with reduced demand from electricity generators and higher levels of net imports of electricity reducing gas consumption. When adjusted to take account of weather differences, primary energy consumption fell by 1.0 per cent on the same period last year.

Total final energy consumption (excluding non-energy use) was 1.7 per cent higher compared to the third quarter of 2023. Domestic consumption rose by 18 per cent with September 2024 notably cooler than a year earlier, services consumption rose by 0.6 per cent whilst transport consumption was broadly unchanged. Industry consumption fell by 4.4 per cent to the lowest quarterly total this century with recent closures of large industrial consumers contributing to this. On a seasonally and temperature adjusted basis, final energy consumption rose by 1.9 per cent, with rises in domestic and transport but falls in industry and services consumption.

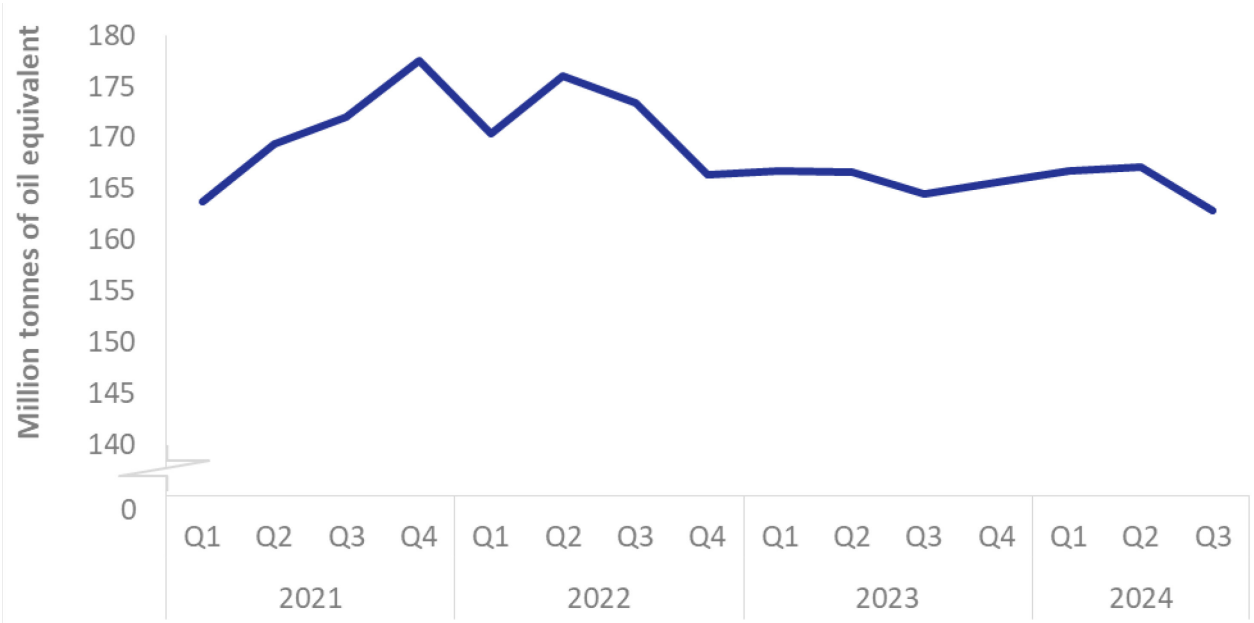
In the third quarter of 2024 **dependency on fossil fuels** was 71.8 per cent, down 3.5 percentage points on the same quarter of 2023 and at the lowest quarterly share this century due to reduced gas demand. The **low carbon share** was 24.6 per cent in the third quarter of 2024, up 2.4 percentage points on the same quarter of 2023 and at the highest quarterly share this century, as renewables displaced gas generation.

Chart 1.1 UK production (Energy Trends Tables 1.1 & 1.3)



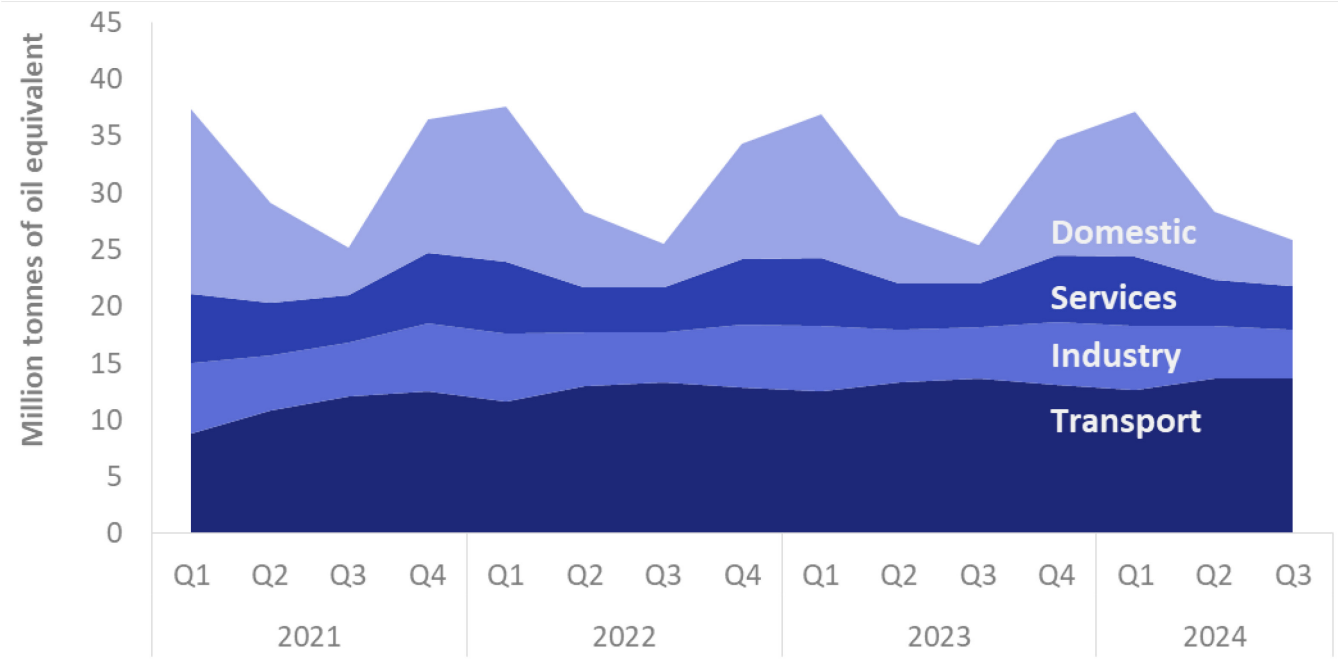
In the third quarter of 2024 **total production was 22.4 million tonnes of oil equivalent, 3.9 per cent lower** than in the third quarter of 2023 and at a record low. Oil production fell by 3.9 per cent to the lowest quarterly total this century due to maintenance and field closures, with output down nearly 40 per cent compared to pre-pandemic levels, whilst gas production fell by 14 per cent also due to maintenance. Nuclear production rose by 8.4 per cent due to fewer outages. Wind, solar and hydro output rose by 1.0 per cent due rises in onshore wind following outages in 2023, solar due to increased capacity and hydro, but a fall in offshore wind.

Chart 1.2 Total inland consumption (primary fuel input basis) (Energy Trends Table 1.2)



In the third quarter of 2024 total inland consumption over the last year (including not only fuel used by consumers, but for electricity generation and other transformation) was 162.8 million tonnes of oil equivalent, 1.0 per cent lower than in the third quarter of 2023. (Chart 1.2 is on a seasonally adjusted and annualised rate that removes the impact of temperature on demand.)

Chart 1.3 Final energy consumption by user (Energy Trends Table 1.3)



In the third quarter of 2024 **total final energy consumption (excluding non-energy use) was 1.7 per cent higher** than in the third quarter of 2023. Domestic consumption rose by 18 per cent with September 2024 notably cooler than a year earlier, services consumption rose by 0.6 per cent and transport consumption was broadly unchanged. Industry consumption fell by 4.4 per cent to the lowest quarterly total this century, with the closure of large industrial consumers contributing to the fall.

Section 2: Coal and derived gases

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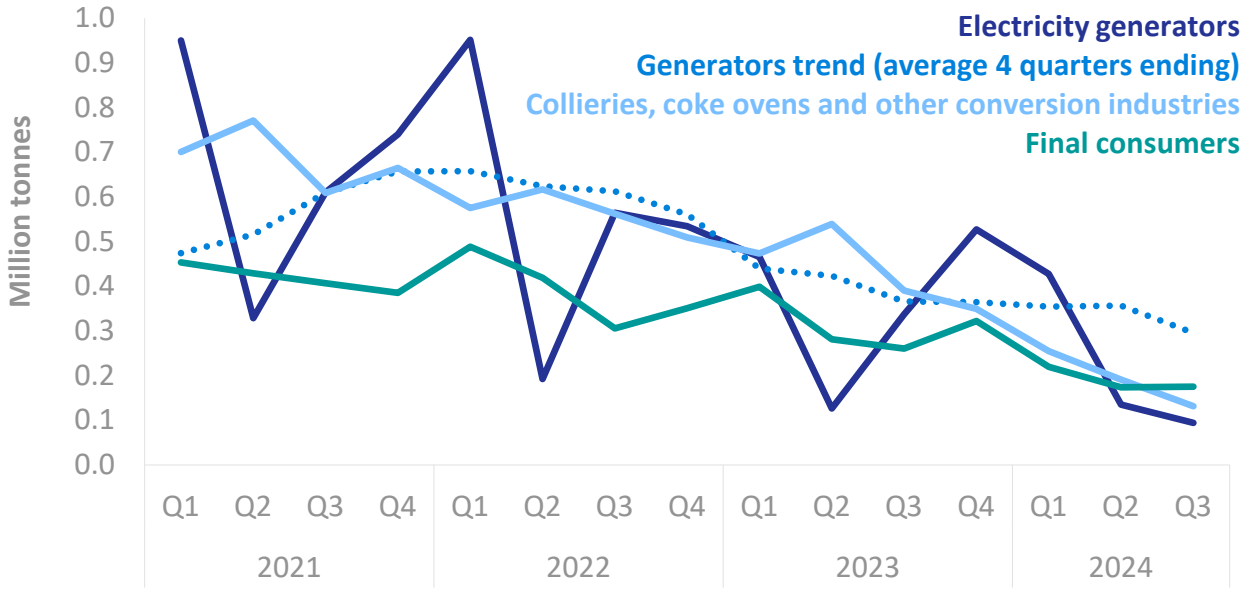
Key headlines

In the third quarter of 2024, UK coal demand fell 59 per cent to a record low of 0.4 million tonnes. Coal demand for electricity generation fell to 94 thousand tonnes (down 72 per cent compared to Quarter 3 2023) (Chart 2.1).

Overall coal production fell to 30 thousand tonnes, down 79 per cent on the third quarter of 2023. This was due to the last large surface mine Ffos-Y-Fran closing at the end of November 2023.

Coal imports rose to 641 thousand tonnes during the quarter, 13 per cent up on the same period last year. Colombia was the largest supplier of coal into the UK at 40 per cent of total imports. This was followed by the South Africa (23 per cent) and the European Union (20 per cent). (Chart 2.3)

Chart 2.1 Coal Consumption (Energy Trends Table 2.1)

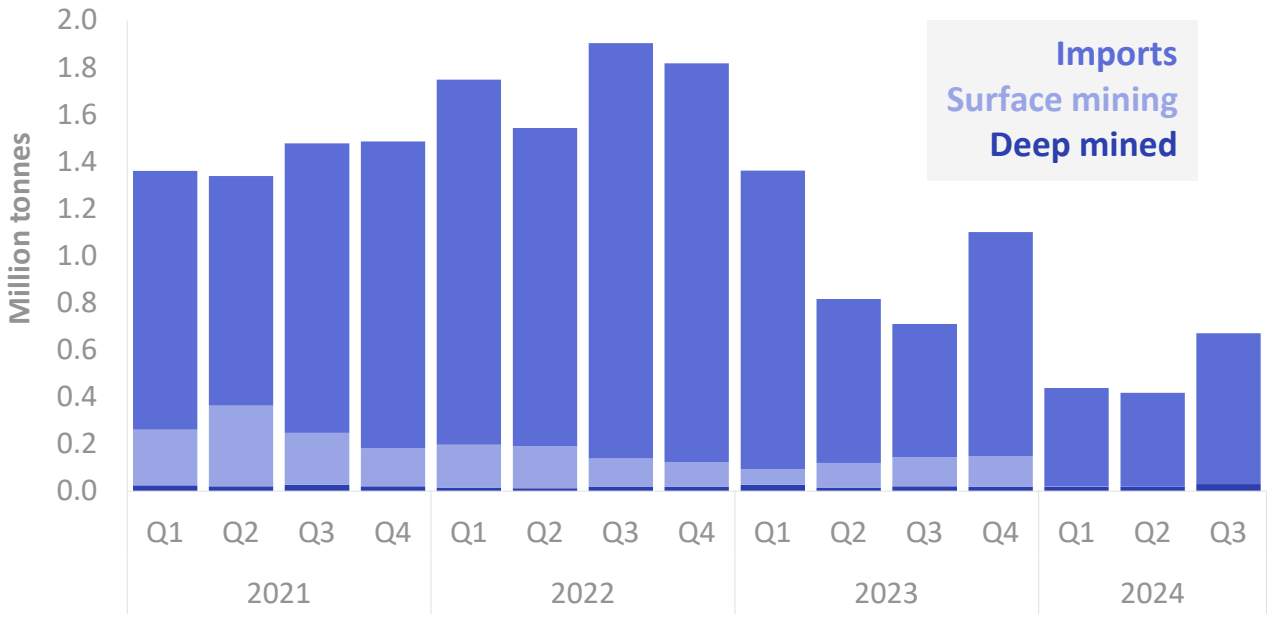


Demand for coal-fired generation is seasonal, peaking in winter when conditions are cold and dark. In recent years these peaks have declined as coal-fired generation became less competitive economically and gas and renewable sources displaced it.

Coal demand for coal-fired electricity generation fell from 337 thousand tonnes in Quarter 3 2023 to 94 thousand tonnes in Quarter 3 2024. Coal use is being phased out with electricity generation favouring gas, nuclear and renewables. During that period only one coal-fired power plant was operational in the UK, Ratcliffe-on-Soar, as Kilroot closed at the end of September 2023. Ratcliffe-on-Soar closed at the end of the third quarter on 30 September 2024 (see Energy Trends 5.4 for information on generation).

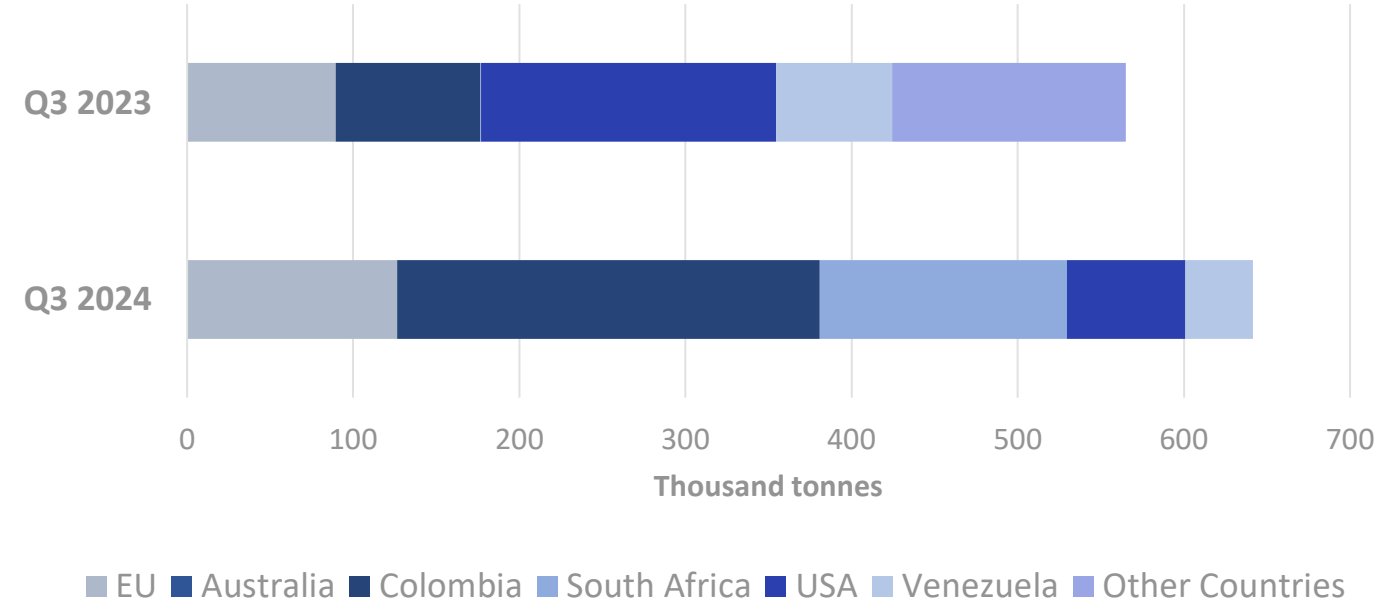
Coal demand for transformation into other fuels (including coke production and use in blast furnaces) fell in Quarter 3 2024. Demand from coke ovens fell to zero, down from 152 thousand tonnes in Quarter 3 2023 as the last coke oven closed in March 2024. Demand from blast furnaces fell 53 per cent in the same period. Port Talbot's blast furnaces closed at the end of September 2024.

Chart 2.2 Coal Supply (Energy Trends Table 2.1)



Domestic coal production has fallen steadily because of mine closures and reduced demand. At the end of 2023 the last of the large surface mines – Ffos-Y-Fran – ceased operation and coal production fell to 30 thousand tonnes in the third quarter of 2024. There is now no large-scale surface mining within the UK. Imports filled the gap but have gradually fallen from the peak of 13.4 million tonnes in the second quarter of 2013 as overall demand dropped. In the third quarter of 2023, imports of coal were 0.6 million tonnes.

Chart 2.3 Coal Imports (Energy Trends Table 2.4)



Imports this quarter comprised 541 thousand tonnes of steam coal (84 per cent of imports), 42 thousand tonnes of coking coal (7 per cent of imports) and 57 thousand tonnes of anthracite (9 per cent of imports). The largest provider was Colombia (40 per cent). This was followed by South Africa (23 per cent) and the European Union (20 per cent).

Section 3: Oil and oil products

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Key headlines

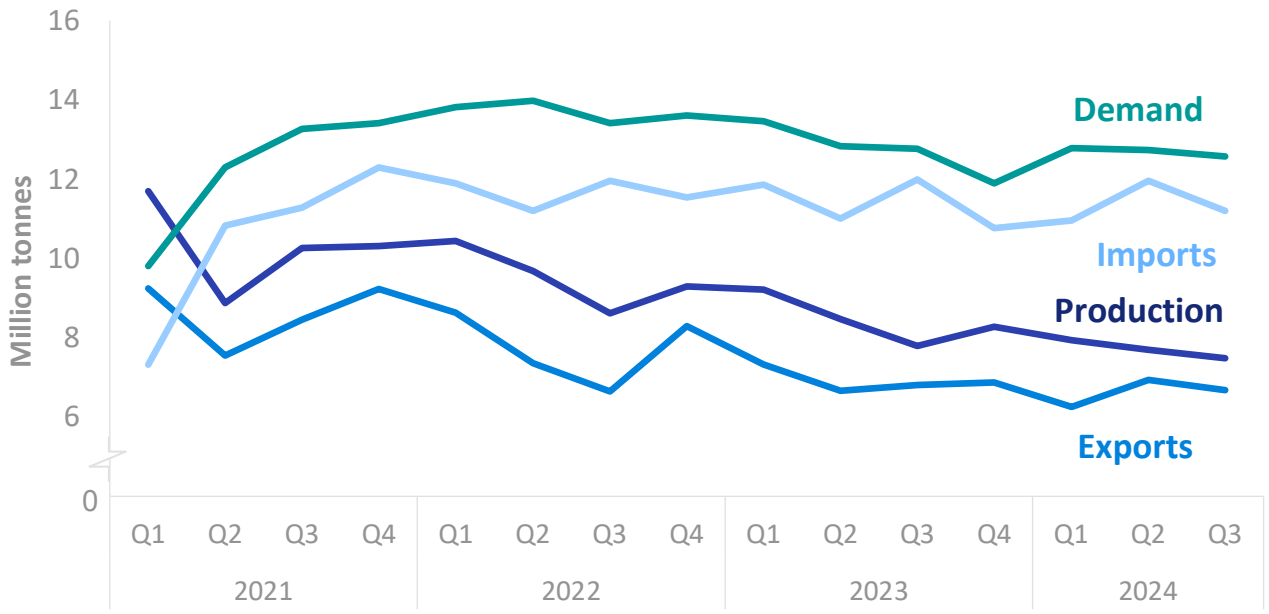
In Quarter 3 2024 production of primary oils fell to its lowest quarterly level, continuing with the downward trend since the most recent peak in 2019 from this mature basin. The third quarter of 2024 was also affected by the closure of two oil fields.

Refinery demand for primary oils was down resulting in a 13 per cent fall in net imports of primary oils and contributing to a 7.8 per cent drop in total net imports.

Production of petroleum products was down 1.8 per cent in Quarter 3 2024 compared to the same period the previous year. Overall demand also fell by 1.5 per cent and product trade figures remained broadly stable.

The drop in demand was because of warmer weather reducing demand in the domestic and public administration sectors, reduced demand in industry sectors, and stable transport demand.

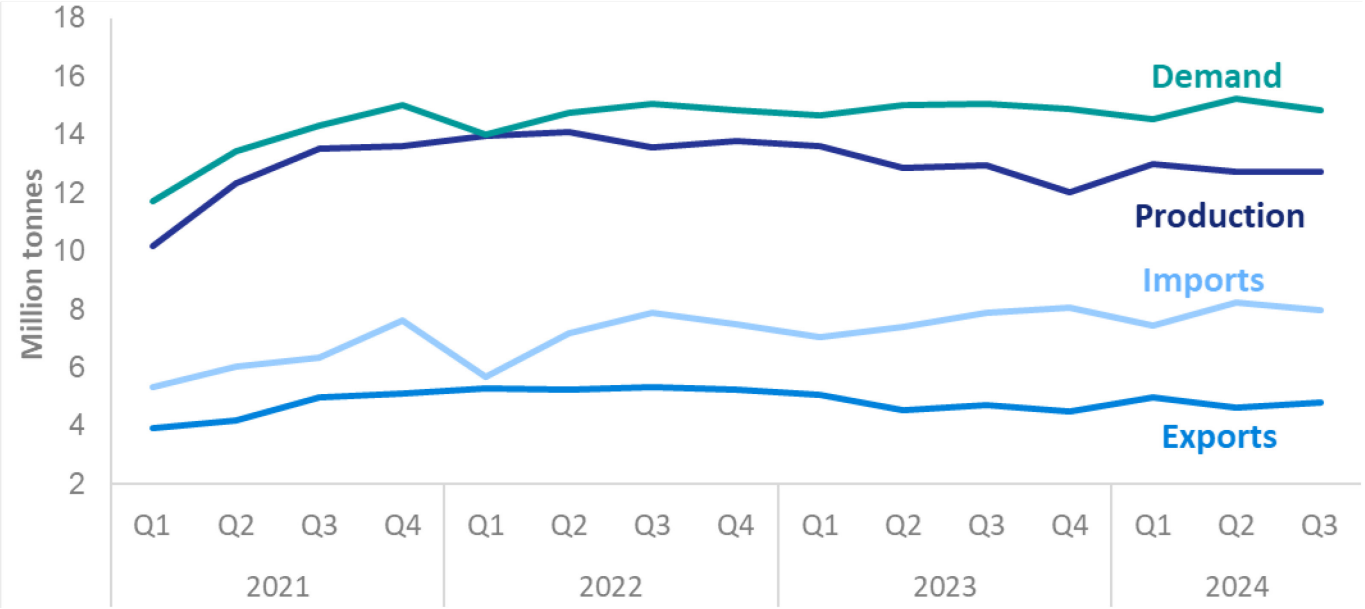
Chart 3.1 Production and trade of crude oil and NGLs (Energy Trends Table 3.1)



In Quarter 3 2024, indigenous production of primary oils fell to a record quarterly low of 7.5 million tonnes and was 3.9 per cent lower compared to the same period in the previous year. Production has been trending downwards in both the longer term and at an annual rate of nearly 8 per cent since 2019 from the mature North Sea basin. The fall in Quarter 3 2024 was also due to maintenance and the impact from the closure of two major oil fields in June 2024.

Although imports and exports of primary oils fell by 6.5 per cent and 1.8 per cent respectively in Quarter 3 2024 compared to the previous year, the UK remained a net importer of primary oils including feedstock by 4.5 million tonnes - down by 13 per cent on last year. Refinery demand was down 1.5 per cent on Quarter 3 2023.

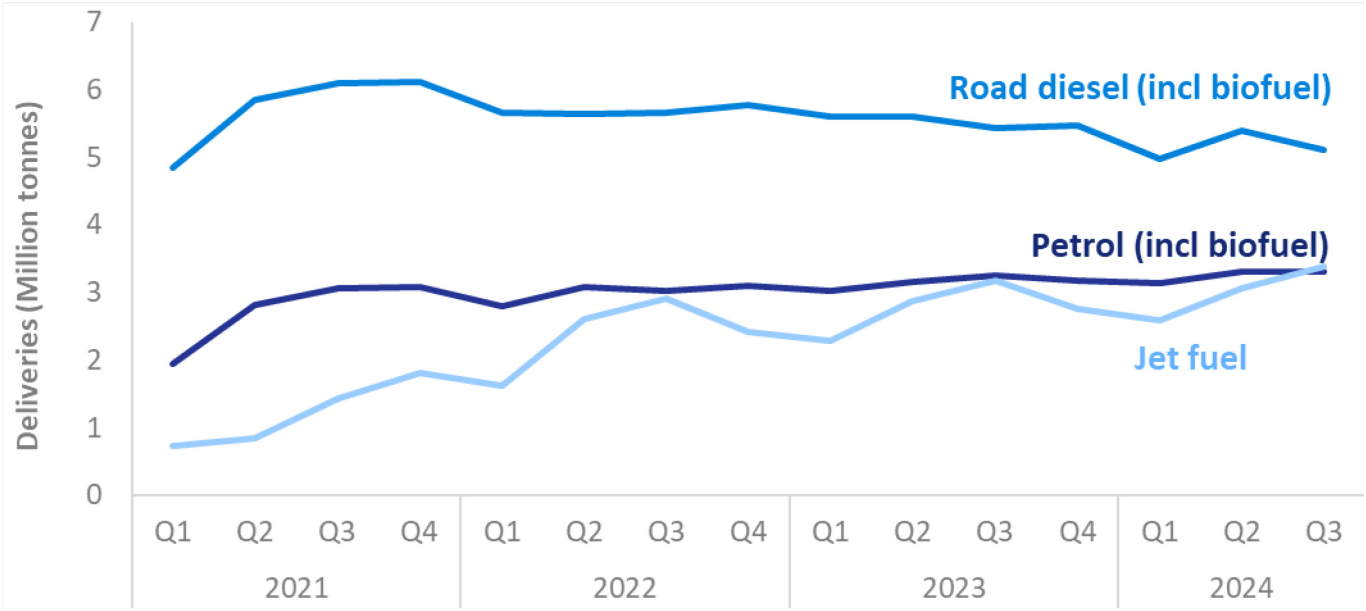
Chart 3.2 Production and trade of petroleum products (Energy Trends Table 3.2)



In Quarter 3 2024, production of petroleum products was down 1.8 per cent compared to the same period in the previous year and total demand was also down by 1.5 per cent. Imports and exports were each up marginally (by 1.1 and 1.7 per cent respectively) meaning the UK was a net importer of petroleum products by 3.2 million tonnes, stable on the year before. Demand remains 11 per cent below the same quarter in 2019 (pre-pandemic), with transport still 7.9 per cent lower than in Quarter 3 2019.

Imports of petroleum products originated from a large variety of countries, but the top three single origin sources in Quarter 3 2024 were the United States, Norway and the Netherlands. September marked a record high month for imports of jet fuel from Kuwait, at over half a million tonnes.

Chart 3.3 Demand for transport fuels (Energy Trends Table 3.5)



In Quarter 3 2024, demand for petroleum products decreased by 1.5 per cent compared to the same period in 2023. Overall transport demand remained flat, but within this were a 1.7 per cent growth in petrol and a 6.5 per cent growth in jet fuel sales. Petrol production was down by 7.5 per cent, meaning that demand was met by a 45 per cent increase in imports and a 3.9 per cent fall in exports.

Diesel, which dominates transport fuels and makes up nearly half of transport demand, was down in the third quarter of 2024 compared to last year. Sales of bioethanol dropped by 0.5 per cent and biodiesel by 1.9 per cent.

Demand for jet fuel increased by 6.5 per cent compared to the same period in 2023, but indigenous production fell by 2.1 percent. Demand was up by 1.1 per cent on the same period in 2019, and the summer of 2024 has seen monthly deliveries of jet fuel consistently above 1 million tonnes since May.

Final consumption of petroleum products was down by 1.3 per cent on Quarter 3 2023, with decreases in the domestic, public administration, industry and non-energy use sectors, partly due to warmer weather.

Section 4: Gas

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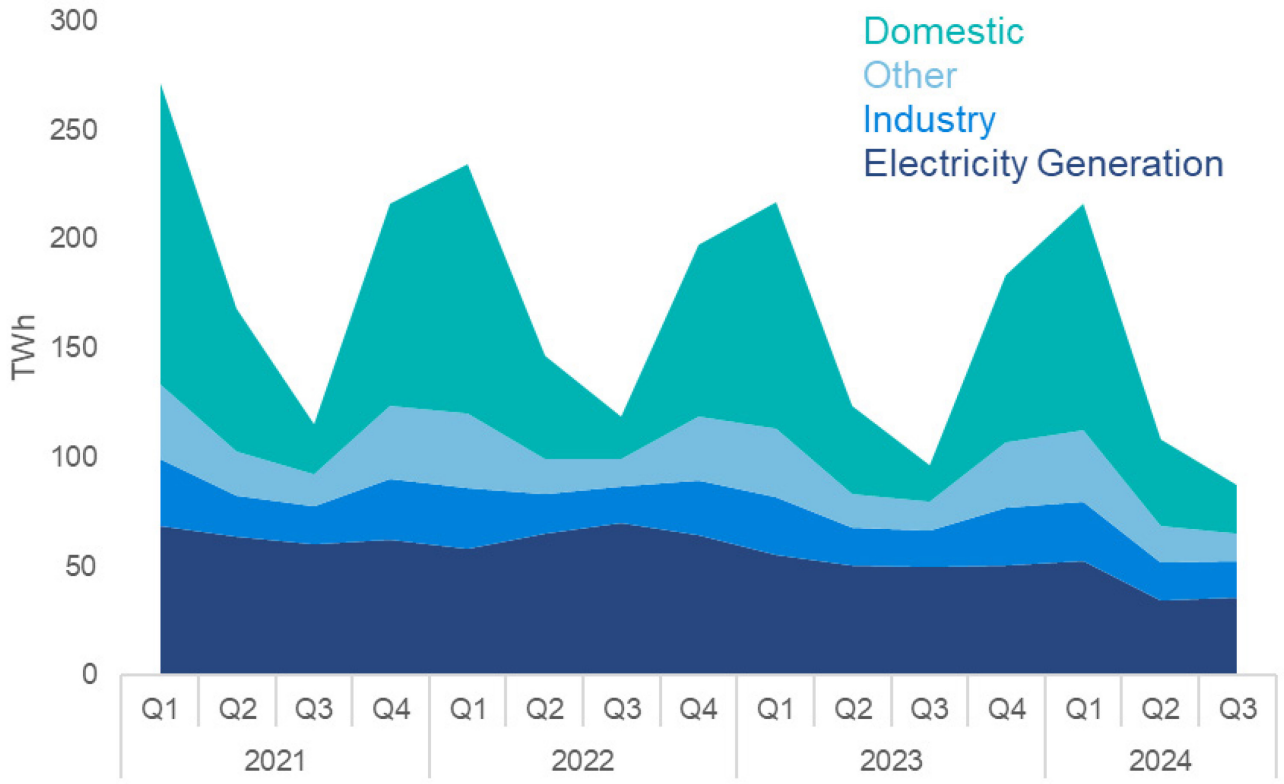
Key headlines

Demand for natural gas hit a record low in Quarter 3 2024, dropping to 104 TWh, a 7.5 per cent decrease compared to the same period in 2023. This was largely due to reduced demand for gas used in electricity generation, a result of low demand and high imports of electricity during the quarter. Gas used by final consumers increased by 11 per cent compared to Quarter 3 2023, driven by an increase in domestic consumption whilst most other sectors remained relatively stable.

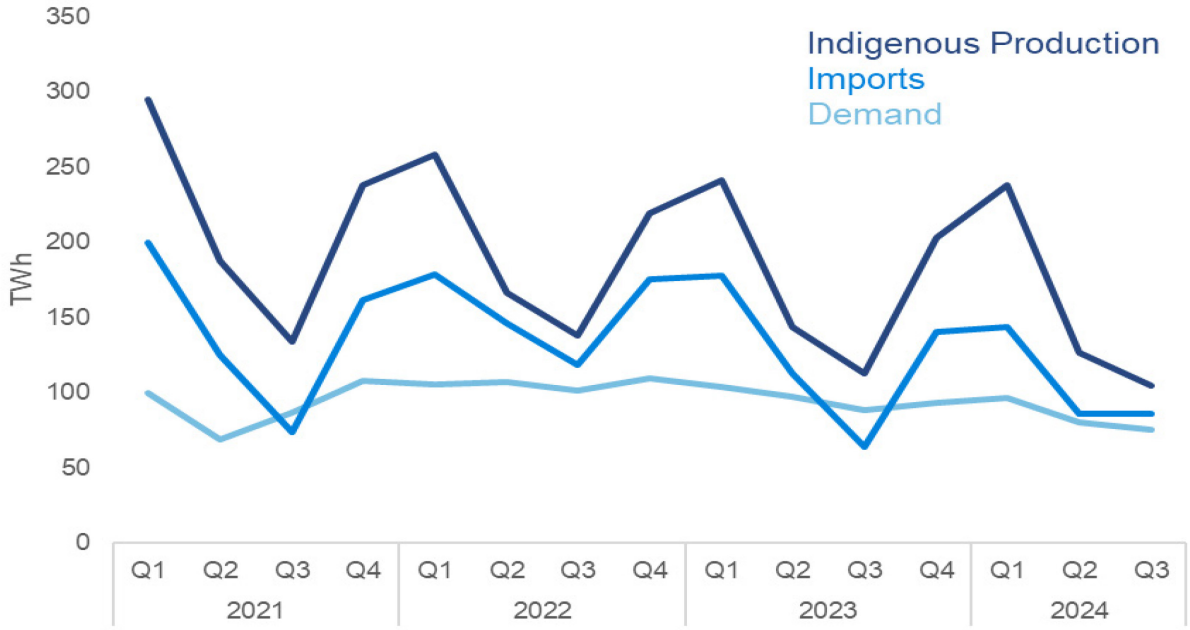
Import and exports increased in Quarter 3 2024, by 33 and 43 per cent respectively. The increase in pipeline imports, along with low demand, facilitated the rise in exports.

Chart 4.1 UK demand for natural gas (Energy Trends Table 4.1)



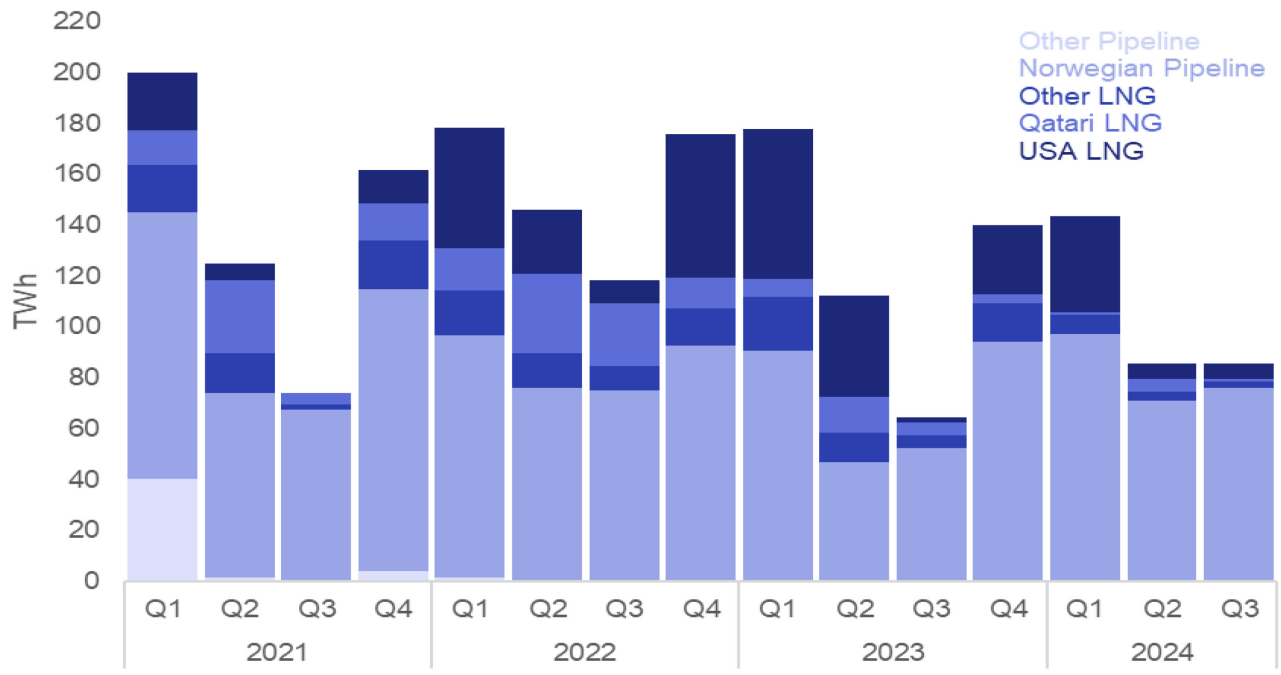
Demand for natural gas reached a record low of 104 TWh in Quarter 3 2024, down from 113 TWh in Quarter 3 2023. Gas demand for electricity generation fell by 28 per cent compared to the same quarter in 2023, a result of increased electricity imports and low demand. Gas used by final consumers was up by 11 per cent, as demand from domestic (household) consumers, increased by 35 per cent in the same period. This was partly due to lower temperatures during the quarter after 2023 which saw the warmest September on record. Gas demand by other final users, including commercial and public administration, dropped by 3.6 per cent compared to Quarter 3 2023. Industrial demand also saw a slight decrease, down by 2.4 per cent.

Chart 4.2 Production and trade of natural gas (Energy Trends Table 4.2)



Imports and exports of natural gas increased, up 33 and 43 per cent respectively compared to Quarter 3 2023. So far this year in 2024 exports have returned to pre 2022 (2017-2021) trading patterns, whereby exports to the continent fall in the winter then increase in the summer. Gas production fell again in Quarter 3 2024 to a near record low, down by 15 per cent compared to the same quarter in 2023 as North Sea production continues to decline.

Chart 4.3 Imports by origin (Energy Trends Table 4.3)



Pipeline imports were up by one third in Quarter 3 2024, primarily driven by pipeline imports to Norway which were up by 45 per cent in the period. Norway remained the largest imports source accounting for 90 per cent of total imports in Quarter 3 2024. Imports of liquified natural gas (LNG) decreased by one fifth compared to the same period last year, with an 83% drop in Qatari imports more than offsetting an almost threefold increase in imports from the US.

Section 5: Electricity

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Key headlines

Quarter 3 of 2024 saw net imports double from Quarter 3 of 2023, with UK generation falling to the lowest third quarter value on record. Net imports reached a record 8.1 TWh for the quarter, equivalent to 11 per cent of UK electricity demand. Higher imports reduced the amount of UK generation needed to meet demand and UK generation fell by 6.3 per cent.

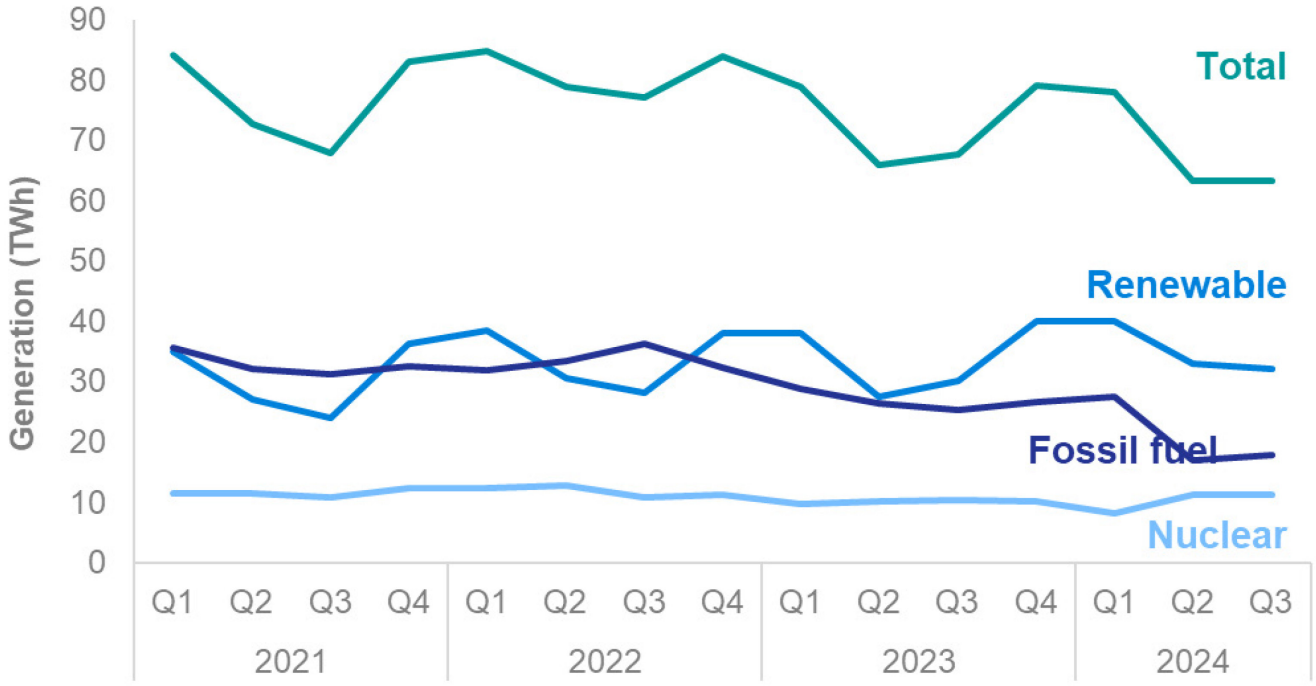
Fossil fuel generation remained low at 17.9 TWh, after falling to a record low value of 17.1 TWh in Quarter 2 of 2024. This is a 29 per cent decrease from Quarter 3 of 2023, driven by the fall in generation by gas due to displacement caused by higher imports. Meanwhile, generation by coal fell to a record low value of 0.3 TWh, as the last coal-fired power plant closed at the end of September.

The share of electricity generated from low carbon sources was 68.2 per cent, an increase of 8.5 percentage points from Quarter 3 2023. Similarly, renewables share of electricity generation increased by 6.1 percentage points, to 50.5 per cent. This can be attributed to increases in both nuclear generation and generation from bioenergy, due to key sites operating without outages during Quarter 3 of 2024.

Electricity consumption by end users rose slightly, by 1.4 per cent. Both domestic consumption and consumption by other users, including commercial users and transport, rose in line with this but industrial consumption fell.

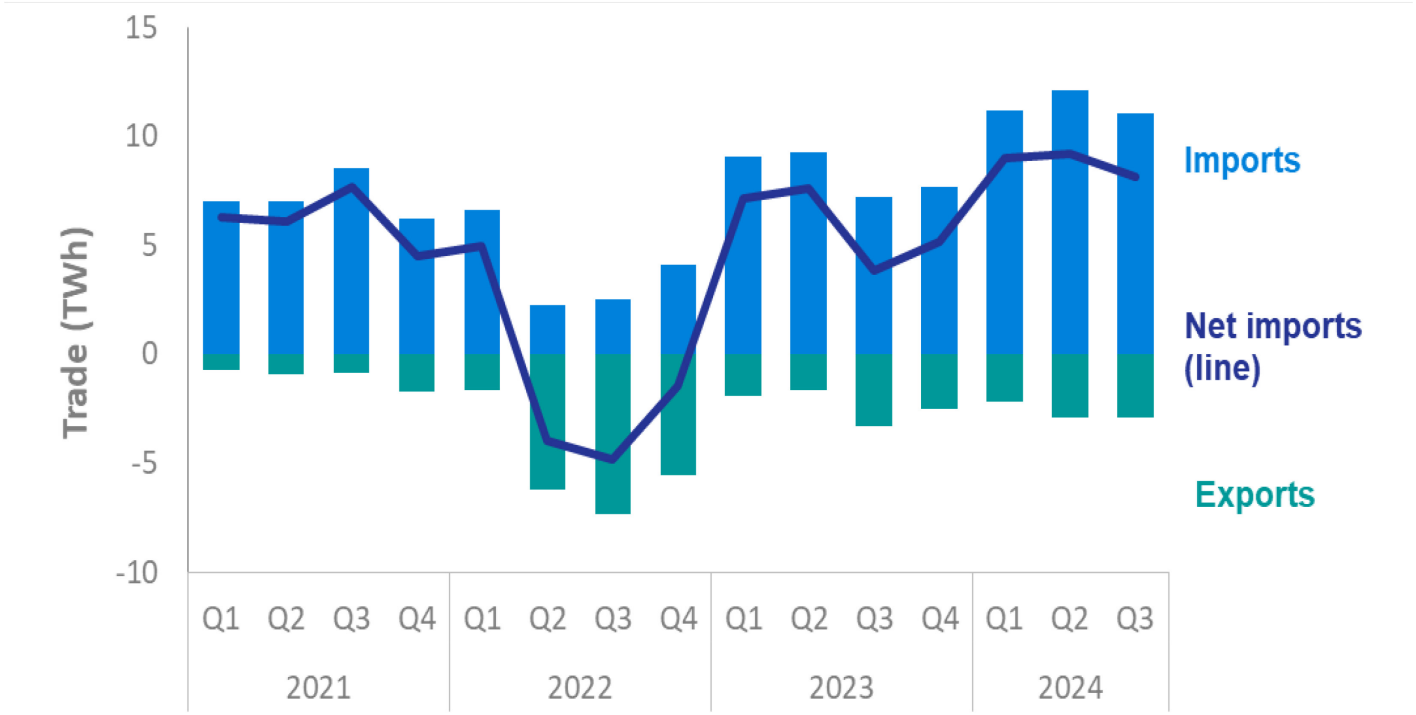
Low carbon's generation share was 68.2 per cent, 8.5 percentage points up on Quarter 3 2023, just below the record 69.4 per cent seen in Quarter 2 of 2024. Renewables' share rose 6.1 percentage points to 50.5 per cent. This is the fourth consecutive quarter where renewables comprised over half of UK generation, despite a small fall in offshore wind generation – see section 6 (renewables) for more detail. These increases can be attributed to both key nuclear and bioenergy sites operating without outages during Quarter 3 of 2024. Nuclear generation rose 8.0 per cent to 11.3 TWh, while generation from bioenergy increased 23 per cent to 9.7 TWh.

Chart 5.1 Electricity generated, by fuel type (Energy Trends Table 5.1)



Fossil fuel generation remained low at 17.9 TWh, after falling to a record low value of 17.1 TWh in Quarter 2 of 2024. This is a 29 per cent decrease from Quarter 3 of 2023, driven by a 29 per cent fall in generation by gas, to 17.3 TWh. Since gas is the marginal fuel for electricity generation, higher imports are likely to have displaced some generation by gas. Similarly, oil generation fell by 18 per cent to 0.4 TWh. Meanwhile, generation by coal fell by 64 per cent to a record low value of 0.3 TWh, as the last coal-fired power plant closed at the end of September.

Chart 5.2 Net imports (Energy Trends Table 5.2)



Quarter 3 of 2024 saw net imports double from Quarter 3 of 2023 with UK generation falling. Net imports have been high throughout the year and reached 8.1 TWh, the highest third quarter value on record and equivalent to 11 per cent of UK electricity demand. The increase in imports follows favourable interconnector prices which will have displaced UK generation over the quarter. Meanwhile, due to higher imports reducing the amount of UK generation needed to meet demand, UK generation fell 6.3 per cent to 63.7 TWh. This is the lowest third quarter value for UK generation on record.

Electricity consumption by all consumers rose by 1.4 per cent. Both domestic consumption and consumption by other users, including commercial users and transport, rose in line with this. Domestic consumption rose by 4.9 per cent to 19.8 TWh, likely due to cooler temperatures compared to last year. Similarly, consumption from other users (including transport) rose by 1.9 per cent, to 21.7 TWh. However, industrial consumption fell by 3.6 per cent, to 20.1 TWh. This is in line with changes in the Index of Production.

Section 6: Renewables

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Key headlines

Renewable electricity generation was 32.2 TWh in Quarter 3 2024, 6.5 per cent higher than 2023 and a record for the third quarter of a year. Most of the increase was in plant biomass which has recently recovered following outages at two major power plants in 2023. Wind speeds were marginally down on the same quarter in 2023 and although onshore wind generation saw a 2.1 per cent increase, offshore was 4.5 per cent lower. Solar PV generation was 9.2 per cent higher than in 2023; with no change in sun hours, the increase was due to additional capacity.

Over the last year, 2.7 GW of new renewable capacity has been added, 1.6 MW of which was solar PV, 0.4 GW was from offshore wind, and 0.6 GW was onshore wind, three quarters of which occurred during the most recent quarter.

Renewables' share of electricity generation was 50.5 per cent in Quarter 3 2024, up 6.1 percentage points on last year and just 1.1 percentage point lower than the record set in Quarter 2, 2024. The increase on last year is due to a combination of higher renewable generation and a fall in total generation, a result of near record levels of electricity imports during the quarter (see section 5).

Chart 6.1 Change in renewable generation and capacity between Q3 2023 and Q3 2024 (Energy Trends Table 6.1)

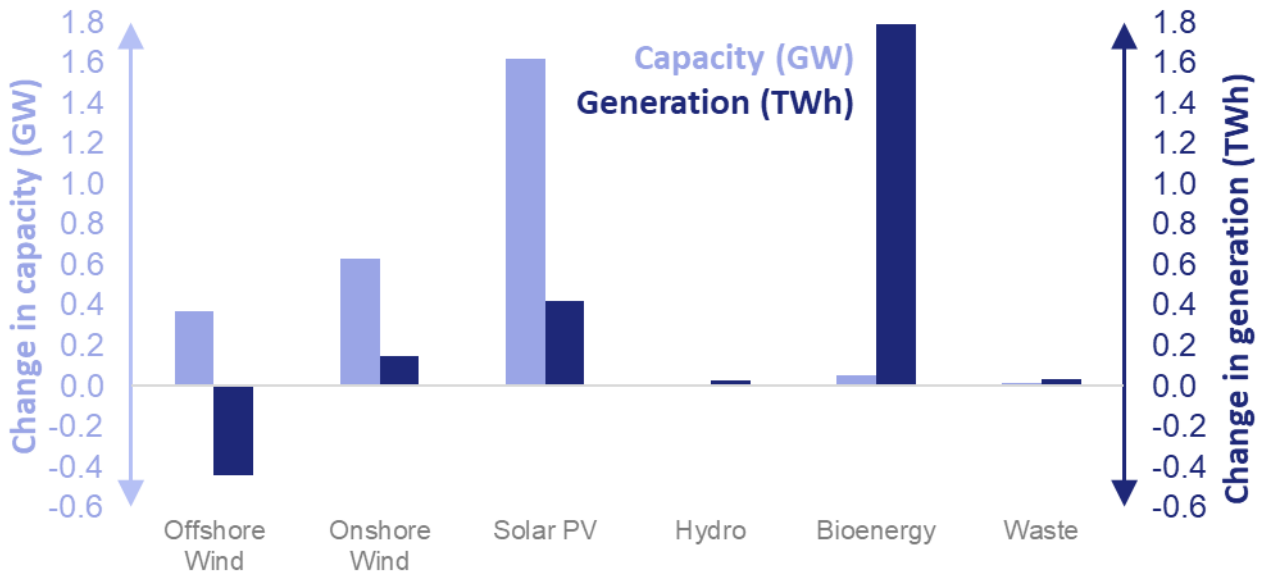


Chart 6.1 shows that although capacity increased for both onshore and offshore wind, only onshore experienced an increase in generation, compared to a 4.5 per cent decrease for offshore. Wind speeds were slightly down this year compared to last (7.9 knots and 8.0 knots respectively); the increase in onshore could be partly due to a higher level of new capacity, combined with regional variations in average wind speeds. Solar PV capacity increased by 10 per cent resulting in a 9.2 per cent increase in generation; sun hours were the same compared to the same quarter last year.

The largest increase in generation (at 36 per cent) was from plant biomass, though the same quarter in 2023 was unusually low due to outages at two large power plants; compared to Quarter 2 2024, it showed a more modest increase at 1.0 per cent.

Chart 6.2 Added capacity during the year for the leading technologies (Energy Trends Table 6.1)

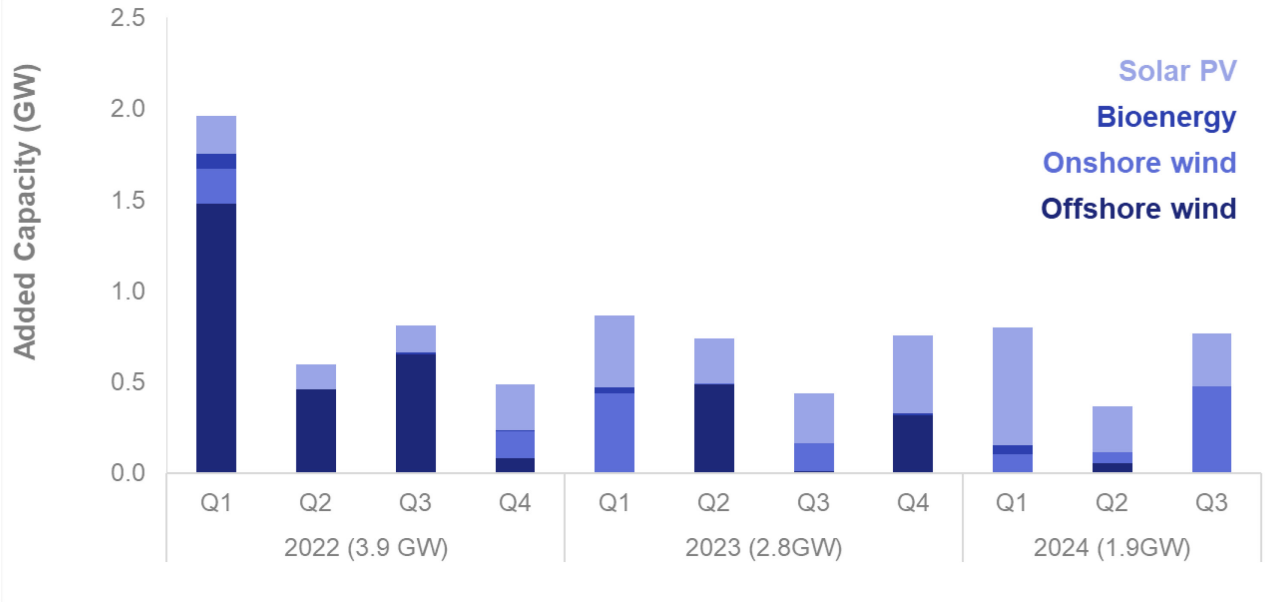
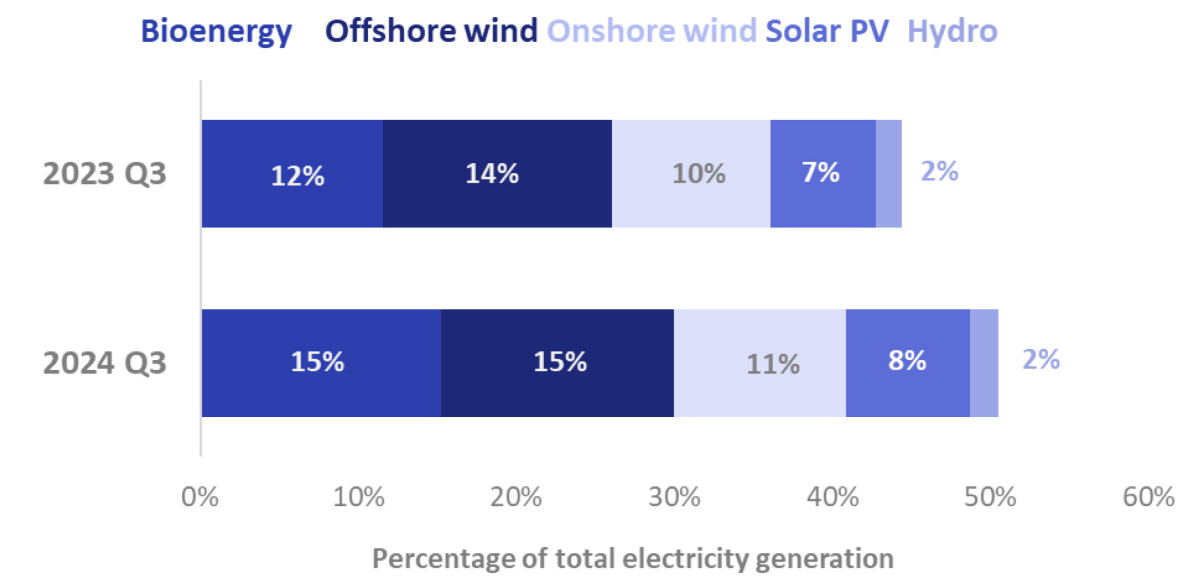


Chart 6.2 displays quarterly capacity added by the leading technologies. New capacity for the first three quarters of 2024 has averaged 0.6 GW per quarter, compared to 0.7 GW for calendar year 2023, though the technology split differs. Almost two thirds of new capacity so far in 2024 was in solar PV compared to just less than half in 2023 when a much larger share was accounted for by offshore wind.

Of the 1.6 GW of new solar PV capacity (since Quarter 3 2023), there were several large-scale installations including Whirlbush Farm (36 MW), Larport (45 MW), Pentlow Hill (24 MW) and Northfield House (26 MW) in England, and Hopkins (28 MW) in Wales. The remainder is accounted for by a large number of small scale (50 kW or less) installations (for more details see the solar deployment tables). Onshore wind saw the next largest contribution to capacity growth with 0.6 GW added, including the single largest plant at Viking (443 MW) in Scotland.

Chart 6.3 Renewables' share of electricity generation Q3 2023 and 2024 (Energy Trends Table 6.1)



Since Quarter 3 2023, the most notable shift has been in the share of bioenergy which has increased by 3 percentage points due to the resumption of operations by two large power stations which had experienced outages during 2023. With the exception of hydro, (which has remained stable), the remaining technologies saw an increase of one percentage point during the last year.

Data tables and special articles

Data in this release

Data are collected by DESNZ through surveys of energy suppliers. This publication highlights key stories in energy in the UK for the specified period. Additional data are available in the quarterly and monthly statistical tables for each fuel and total energy. The tables are generally in commodity balance format, showing the flow from the sources of supply through to final use.

Special articles

Special articles that explore current topics of interest are available alongside this summary report. Included in this publication are:

Diversity of supply of natural gas in Europe, 2023

Electricity generation and supply in Scotland, Wales, Northern Ireland and England, 2019 to 2023

Feed-in Tariff load factor analysis: 2023/24

Land utilised by solar PV – September 2024

Statistical tables*

Data tables available as part of the Energy Trends series:

Total energy

Solid fuels and derived gases

Oil and oil products

Gas

Electricity

Renewables

The full range of special articles is available here: https://www.gov.uk/government/collections/energy-trends-articles

Additional sources of information

Index of Production, published by the Office for National Statistics:
https://www.ons.gov.uk/economy/economicoutputandproductivity/output/bulletins/indexofproduction/previousReleases

Index of Services, published by the Office for National Statistics:
https://www.ons.gov.uk/economy/economicoutputandproductivity/output/bulletins/indexofservices/previousReleases

Detailed annual Digest of UK Energy Statistics:
https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

Tables showing foreign trade flows of energy:
https://www.gov.uk/government/statistics/dukes-foreign-trade-statistics

Weather tables produced by DESNZ using Met Office data:
https://www.gov.uk/government/collections/weather-statistics

Information on Energy Prices:
https://www.gov.uk/government/collections/quarterly-energy-prices

*Hyperlinks will open the most recently published table. If you require a previously published version of a table, please contact DESNZ at: energy.stats@energysecurity.gov.uk

Technical information

Methodology and revisions

More detailed notes on the methodology used to compile the figures and data sources are available on the collection pages for each fuel. The figures have not been adjusted for temperature or seasonal factors except where noted.

Percentage changes relate to the corresponding period a year ago. They are calculated from unrounded figures. They are shown as (+) or (-) when the percentage change is very large. Quarterly figures relate to calendar quarters. All figures relate to the United Kingdom unless otherwise indicated. Further information on Oil and Gas is available from the North Sea Transition Authority at https://www.nstauthority.co.uk/

Table of conversion factors

To	ktoe	TJ	GWh	million therms	To	toe	GJ	kWh	therms
From	Multiply by				**From**	Multiply by			
ktoe	1	41.868	11.63	0.39683	**toe**	1	41.868	11,630	396.83
TJ	0.023885	1	0.27778	0.0094778	**GJ**	0.023885	1	277.78	9.4778
GWh	0.085985	3.6	1	0.034121	**kWh**	0.000085985	0.0036	1	0.034121
million therms	2.52	105.51	29.307	1	**therms**	0.00252	0.105510	29.307	1

ktoe = thousand tonne of oil equivalent toe = tonne of oil equivalent

Sector breakdowns

Categories for final users are defined by Standard Industrial Classification 2007:

Fuel producers	05-07, 09, 19, 24.46, 35
Final consumers	
Iron and steel	24 (excluding 24.4, 24.53 and 24.54)
Other industry	08, 10-18, 20-23, 24.4 (excluding 24.46), 24.53, 24.54, 25-33, 36-39, 41-43
Transport	49-51 (part*)
Other final users	
Agriculture	01-03
Commercial	45-47, 49-51 (part*), 52-53, 55-56, 58-66, 68-75, 77-82
Public administration	84-88
Other services	90-99
Domestic	Not covered

* Note – transport sector includes only energy used for motion/traction purposes. Other energy used by transport companies is classified to the commercial sector.

Revisions policy

Figures for the latest periods are provisional and are liable to subsequent revision. The DESNZ statistical revisions policy sets out the revisions policy for these statistics, which has been developed in accordance with the UK Statistics Authority Code of Practice for Statistics.

Glossary

Tonne of Oil Equivalent

A common unit of measurement which enables different fuels to be compared and aggregated, and equal to 41.868 gigajoules. Usually expressed in Trends as ktoe (Thousand tonnes of oil equivalent) or Mtoe (Million tonnes of oil equivalent).

Indigenous production

The extraction or capture of primary fuels: for oil this includes production from the UK Continental Shelf, both onshore and offshore. Production by fuel is shown in Table 1.1. As with all data in Tables 1.1 to 1.3, these data are presented in either Million tonnes of oil equivalent or Thousand tonnes of oil equivalent. Various conventions are involved in the presentation of these data (e.g. for nuclear production the energy input is the heat content of the steam leaving the reactor) and these conventions are detailed in the Table notes and methodology documents (see link at end of glossary).

Primary supply

Primary supply is the sum of production, other sources, imports (+), exports (-), stock change, marine bunkers and transfers. A breakdown of supply by fuel is shown in Table 1.3.

Primary demand

Primary demand is the sum of the transformation, energy industry use, losses and final energy consumption by the industry sectors including non-energy use. A breakdown of demand by fuel is shown in Table 1.3.

Primary inland energy consumption

The sum of primary supply less non-energy use (Table 1.2).

Final energy consumption

Energy consumption by final user, i.e., which is not being used for transformation into other forms of energy. Final energy consumption is shown by sector and for individual fuels in Table 1.3.

Non-energy use

Includes fuel used for chemical feedstock, solvents, lubricants, and road making material, see Table 3.2.

Imports

Goods entering the UK, e.g. via pipeline from Norway or LNG cargoes from Qatar and the US for gas (Table 4.3) and interconnectors for electricity from The Netherlands (Table 5.6).

Exports

Goods leaving the UK, e.g. via LNG regassification cargoes to Europe for gas (Table 4.4) and interconnectors for electricity to France (Table 5.6).

Transformation

Transformation covers those activities that transform fuels into a form which is better suited for specific uses. Most of the transformation activities correspond to particular energy industries whose main business is to manufacture the product associated with them. Certain activities involve transformation to make products that are only partly used for energy needs (e.g. coke and oven coke) or are by-products of other manufacturing processes (e.g. coke oven and blast furnace gases). A breakdown of transformation by fuel is shown in Table 1.3.

Seasonally and temperature adjustment

The temperature corrected series of total inland fuel consumption, Table 1.2 indicates what annual consumption might have been if the average temperature during the year had been the same as the average for the years 1991 to 2020. Table 1.3 shows seasonal and temperature adjusted final consumption.

Primary oil

Crude oil, natural gas liquids and feedstocks. (Table 3.1)

Petroleum products

Motor spirit, diesel, gas oil, aviation turbine fuel, fuel oils, petroleum gases, burning oil and other products. (Table 3.4)

Transport fuels

Motor spirit and diesel for road and aviation turbine fuel for aviation. (Table 3.4)

Electricity generation

Electricity generation represents the quantities of fuels burned for the generation of electricity. The activity is divided into two parts, covering the Major Power Producers such as those generating electricity for sale, as their main business activity, and autogenerators such as those generating electricity for their own needs but who may also sell surplus quantities (Table 5.1).

Fossil fuels

Coal, oil and natural gas. The percentage share of electricity generation by fossil fuels is shown in Table 5.1.

Renewables

Renewable energy includes solar power, wind, wave, tidal, hydroelectricity, and bioenergy. Solid biomass includes wood and wood pellets, straw, short rotation coppice, and the biodegradable component of wastes (the non-biodegradable component is shown as a memo item in Table 6.1). Liquid biofuels include bio diesel and bioethanol, along with new and emerging fuels such as bio LPG (liquified petroleum gas). Biogases include landfill gas, sewage gas, and anaerobic digestion. The percentage share of electricity generation by renewables is shown in Table 5.1.

Low carbon

Nuclear and renewables. The percentage share of electricity generation by low carbon sources is shown in Table 5.1.

Additional information

A more detailed glossary is available in The Digest of United Kingdom Energy Statistics (DUKES), Annex B, whilst the energy balance methodology note provides background detail on the compilation of an energy balance, as well as an explanation of each of the key energy balance flows. Notes in individual Energy Trends tables and individual fuel methodology notes (see links below) provide further detail.

Coal methodology note

Oil methodology note

Gas methodology note

Electricity methodology note

Renewables methodology note

Related publications

Recent publications of interest

Energy Consumption in the United Kingdom (ECUK)
Detailed data on end use estimates of energy in the UK: www.gov.uk/government/collections/energy-consumption-in-the-uk

Sub-national total final energy consumption
Findings of the sub–national energy consumption analysis in the UK for all fuels, for the period covering 1 January to 31 December, with gas consumption covering the annual period from mid-May: www.gov.uk/government/collections/total-final-energy-consumption-at-sub-national-level

Sub-national electricity consumption
Electricity consumption by consuming sector for Great Britain and devolved administration areas. Data are based on the aggregation of Meter Point Administration Number readings as part of DESNZ's annual meter point electricity data exercise: www.gov.uk/government/collections/sub-national-electricity-consumption-data.

Sub-national gas consumption
Gas consumption by consuming sector for Great Britain, and devolved administration areas. Data are based on the aggregation of Meter Point Reference Number readings throughout Great Britain as part of DESNZ's annual meter point gas data exercise. Data are subject to a weather correction factor to enable comparison of gas use over time: www.gov.uk/government/collections/sub-national-gas-consumption-data.

Sub-national road transport consumption
Road transport fuels consumption in the UK at regional and local authority level. Data is modelled and provided to DESNZ by Ricardo Energy & Environment, with estimates based on where the fuel is consumed, rather than where it is purchased.
www.gov.uk/government/collections/road-transport-consumption-at-regional-and-local-level

Sub-national consumption of residual fuels
Non-gas, non-electricity and non-road transport fuels consumption in the UK. Includes coal, petroleum, solid fuels, and bioenergy not for generation or road use: www.gov.uk/government/collections/sub-national-consumption-of-other-fuels

Further information

Accredited official statistics

These statistics are accredited official statistics. Accredited official statistics are called National Statistics in the Statistics and Registration Service Act 2007.

These accredited official statistics were independently reviewed by the Office for Statistics Regulation (OSR) in June 2014. They comply with the standards of trustworthiness, quality and value in the Code of Practice for Statistics.

Our statistical practice is regulated by the Office for Statistics Regulation.

OSR sets the standards of trustworthiness, quality and value in the Code of Practice for Statistics that all producers of official statistics should adhere to.

You are welcome to contact us by emailing energy.stats@energysecurity.gov.uk with any comments about how we meet these standards.

Alternatively, you can contact OSR by emailing regulation@statistics.gov.uk or via the OSR website.

Pre-release

Some ministers and officials receive access to these statistics up to 24 hours before release. Details of the arrangements for doing this and a list of the ministers and officials that receive pre-release access to these statistics can be found in the DESNZ statement of compliance with the Pre-Release Access to Official Statistics Order 2008.

User engagement

Users are encouraged to provide comments and feedback on how these statistics are used and how well they meet user needs. Comments on any issues relating to this statistical release are welcomed.

This publication is available from: https://www.gov.uk/government/collections/energy-trends

If you need a version of this document in a more accessible format, please email energy.stats@energysecurity.gov.uk

Please tell us what format you need. It will help us if you say what assistive technology you use.

Diversity of supply of natural gas in Europe, 2023

Ellie Slee-Lamb **0751 188 0196** Ellie.SleeLamb@energysecurity.gov.uk

Key headlines

The Russia-Ukraine conflict caused shifts in European gas supply and demand which continued into 2023.

Like 2022, liquified natural gas (LNG) continued to play a role as many countries moved away from Russian gas. LNG imports to Europe increased a further 7 per cent in 2023 on 2022 highs. Relatedly, European demand continued to fall, down 8 per cent in part due to policies designed to reduce consumption as well as the effects of warm temperatures and high prices.

UK exports of gas to Europe fell but remained substantial, imports returned to typical levels with exports facilitated by low UK demand rather than increased imports like 2022. This resulted in fewer import sources for the UK in 2023 and subsequently lower diversity and supply indexes. However whilst production continued to fall, down 10 per cent in 2023 compared with 2022, lower demand meant self-sufficiency remained stable.

Background

Europe, including the UK, use natural gas for electricity generation, domestic (or household) heating and cooking, and other purposes such as industrial processes. This article sets out how countries in Europe meet their natural gas demand via production and imports.

This article uses Energy Trends and International Energy Agency (IEA) data. European IEA member states reflect the majority of Europe but excludes Andorra, Kosovo, Liechtenstein, Monaco, San Marino, and Vatican City which are not included in the article. Cyprus, Iceland, and Montenegro did not produce or consume natural gas so are also not included in the article.

Methods

Three indicators have been used to undertake this analysis.

Self-sufficiency

Production is the process of extracting natural gas from the earth. Self-sufficiency is a measure of a country's ability to meet its demand through production. This is calculated as production divided by demand where:

- Self-sufficiency equals 0, there was no natural gas production.
- Self-sufficiency is between 0 and 1, production met some demand.
- Self-sufficiency equals 1, production equalled demand.
- Self-sufficiency greater than 1, production exceeded demand.

Generally higher self-sufficiency means more secure natural gas supply.

Diversity index

The diversity index is a measure of the number of import sources, weighted by the country of origin's political stability[1]. This means that a country with many import sources of high political stability will have a high diversity index. Conversely, a country with few import sources of low political stability will have a low diversity

[1] Data sourced from World Bank governance indicators. See Appendix 1 for underlying data and Appendix 2 for method.

index. In general, a diverse source of imports means gas supply is more secure. This is further improved if the source countries are politically stable.

Supply index

The supply index is the sum of self-sufficiency and diversity index. A higher supply index can be indicative of higher security in terms of a country's sources of gas. A supply index of 0 indicates that a country has no production and only one import source.

Chart 1: Self-sufficiency and diversity index for European countries, 2023

Norway has been excluded from the graph because its self-sufficiency is substantially larger than other countries (25). See Appendix 1 for underlying data.

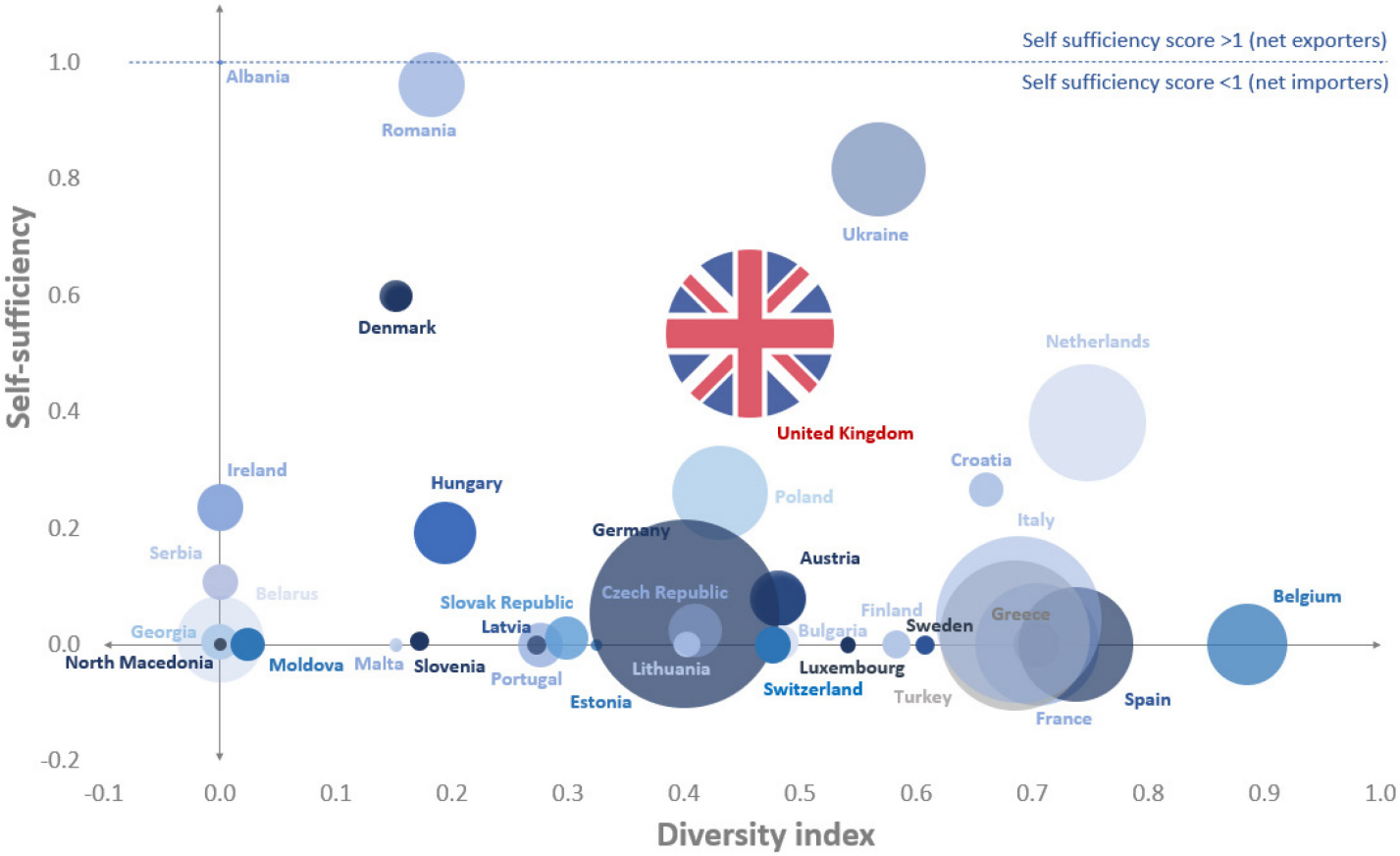


Chart 1 shows the relationship between self-sufficiency and diversity index. The size of each bubble represents natural gas demand in each country.

Self-sufficiency

Norway met their demand for natural gas with production alone, making them self-sufficient. Norway is the largest producer of natural gas in Europe, and in the top 10 globally; in 2023, Norway produced more than 25 times the natural gas it consumed, accounting for 57 per cent of total European natural gas production. Other European countries are not large producers of natural gas which is reflected by an average self-sufficiency score of 0.15 for European countries (excluding Norway). This means on average 15 per cent of gas demand could be met by production.

Albania also continued to be self-sufficient in 2023, producing the same amount of gas that it used. Of the European countries who use natural gas, Albania's demand is the smallest.

The UK had a self-sufficiency score of 0.54 meaning more than half of gas demand could have been met by production in 2023. In the UK, production has been equivalent to around half of demand for over a decade reaching 54 per cent in 2023 due to notably low demand. UK production of natural gas fell in 2023, down 10 per cent compared to 2022 as North Sea output declines. Production remained just above the 2021 record low caused by extensive maintenance.

Of the 39 countries included in this analysis, 12 had a self-sufficiency score of 0 meaning they didn't produce any gas and were reliant on imports to meet supply.

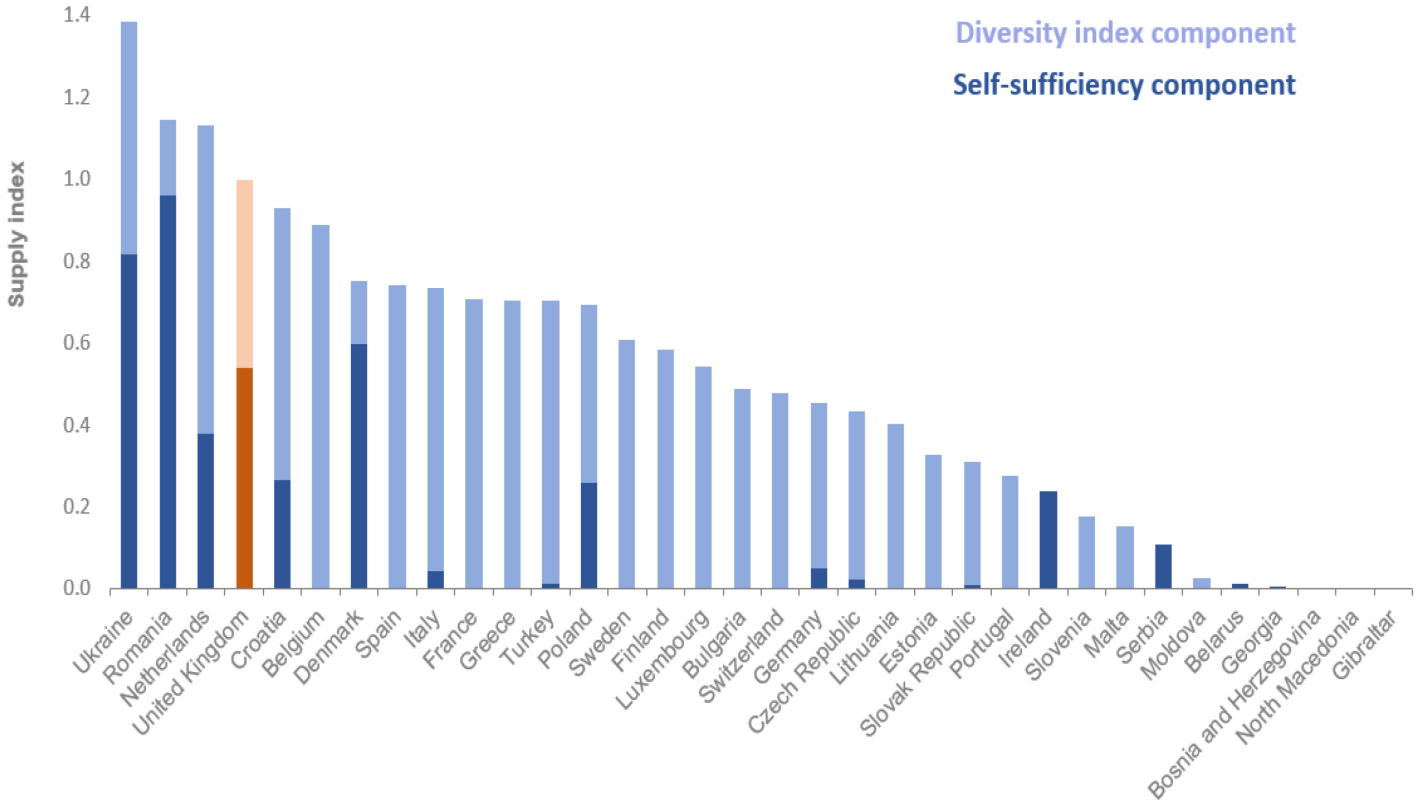
Diversity

Most countries use imports to meet demand. In 2023, the average diversity index of European countries was 0.37. The proximity of Western European countries to the sea facilitates shipments of liquified natural gas (LNG) from a wider range of countries than would be possible with pipelines alone, which contributes to their tendency to have higher diversity indexes. In 2023, the UK's diversity score was 0.46, above the European average, reflecting a large number of import sources, some of which were rated as very politically stable.

Demand

Germany remained the largest natural gas consumer in Europe (80 bcm), followed by the UK, Italy and Turkey; these four countries accounted for over half of total European natural gas demand in 2023. Overall European demand for natural gas continued to decline, down 8 per cent on 2022. Declines were seen in the majority of European countries as a result of warmer temperatures and higher gas and other prices. Additionally, EU countries saw ongoing effects of policies designed to reduce gas consumption in light of the Russia-Ukraine conflict. UK gas demand decreased by 11 per cent in 2023 compared with 2022, due to a substantial decline in gas demand for electricity generation and reduced demand from final consumers due to warm temperatures and high costs.

Chart 2: Supply index for European countries, 2023



Norway has been excluded from the graph because its self-sufficiency is substantially larger than other countries (25), see Appendix 1 for underlying data.

Chart 2 shows the supply index for European countries in 2023. The self-sufficiency score and diversity index have been stacked, indicating the relative contribution of these components to the index.

Ukraine

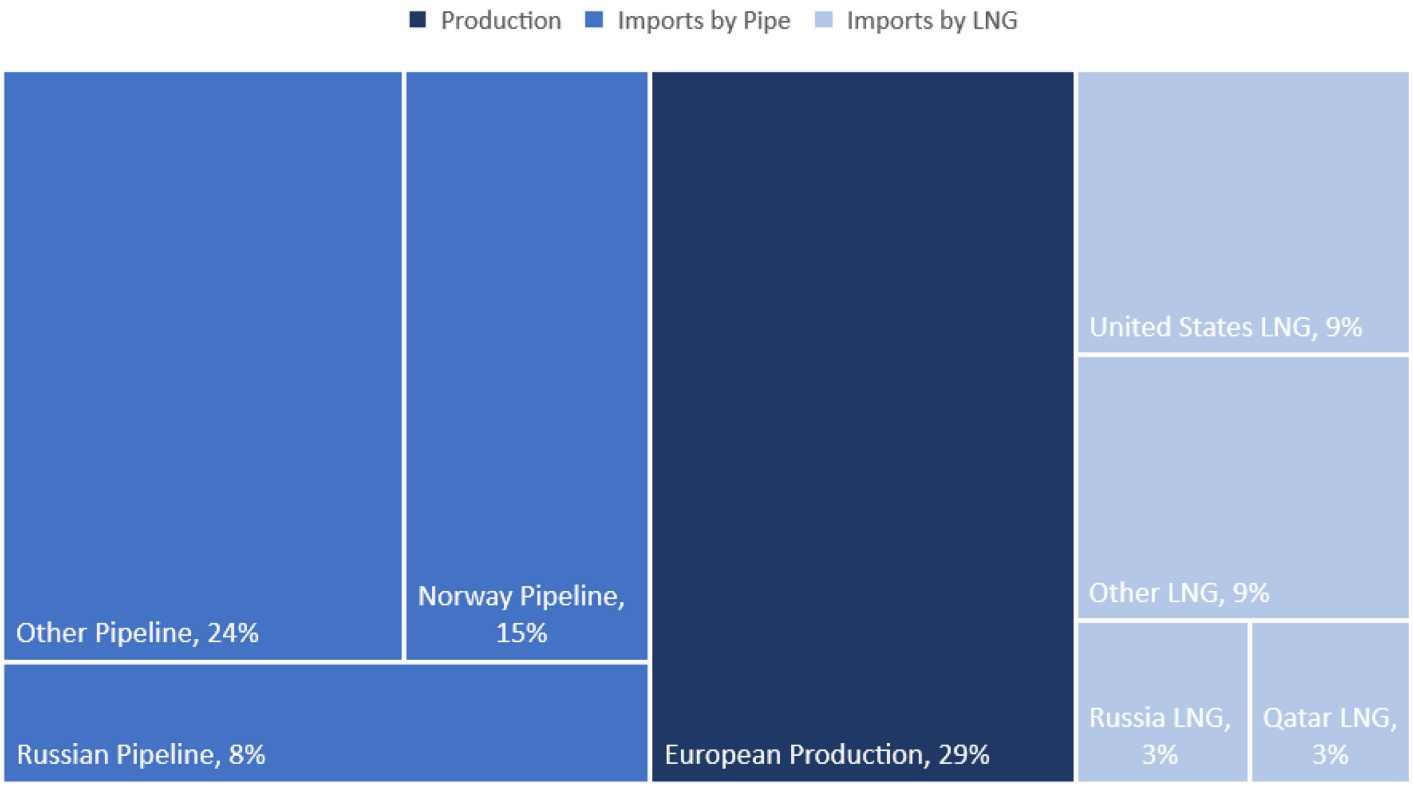
In 2023, the self-sufficiency and diversity index of Ukraine increased substantially resulting in the second highest supply index. Ukraine's self-sufficiency increased due to a notable drop in demand (meaning less production met a greater proportion of demand). Ukraine's diversity index increased due to a larger number of import sources compared to previous years. This analysis does not consider other factors which could be considered when evaluating supply.

Supply index

In 2023, Norway had the highest supply index of European countries at 25.8. This is significantly higher than the median score of 0.49 due to substantial production. The average European supply index was 1.16 which falls to 0.51 when excluding Norway, reflecting most countries' reliance on imports to meet demand. Twelve countries produced no natural gas, so their supply index equalled their diversity index. Of these countries, Bosnia and Herzegovina, Gibraltar, and North Macedonia had only one import source, resulting in a supply index of zero.

With a supply index of 1.00, the UK had the sixth highest European supply index, behind Norway, Ukraine, Romania, the Netherlands, and Albania. This was down from 1.15 in 2022. The UK is Europe's second largest producer of natural gas; however it is substantially smaller than Norway, producing 72 per cent less gas than Norway in 2023.

Chart 3: Sources of European gross gas supply, 2023

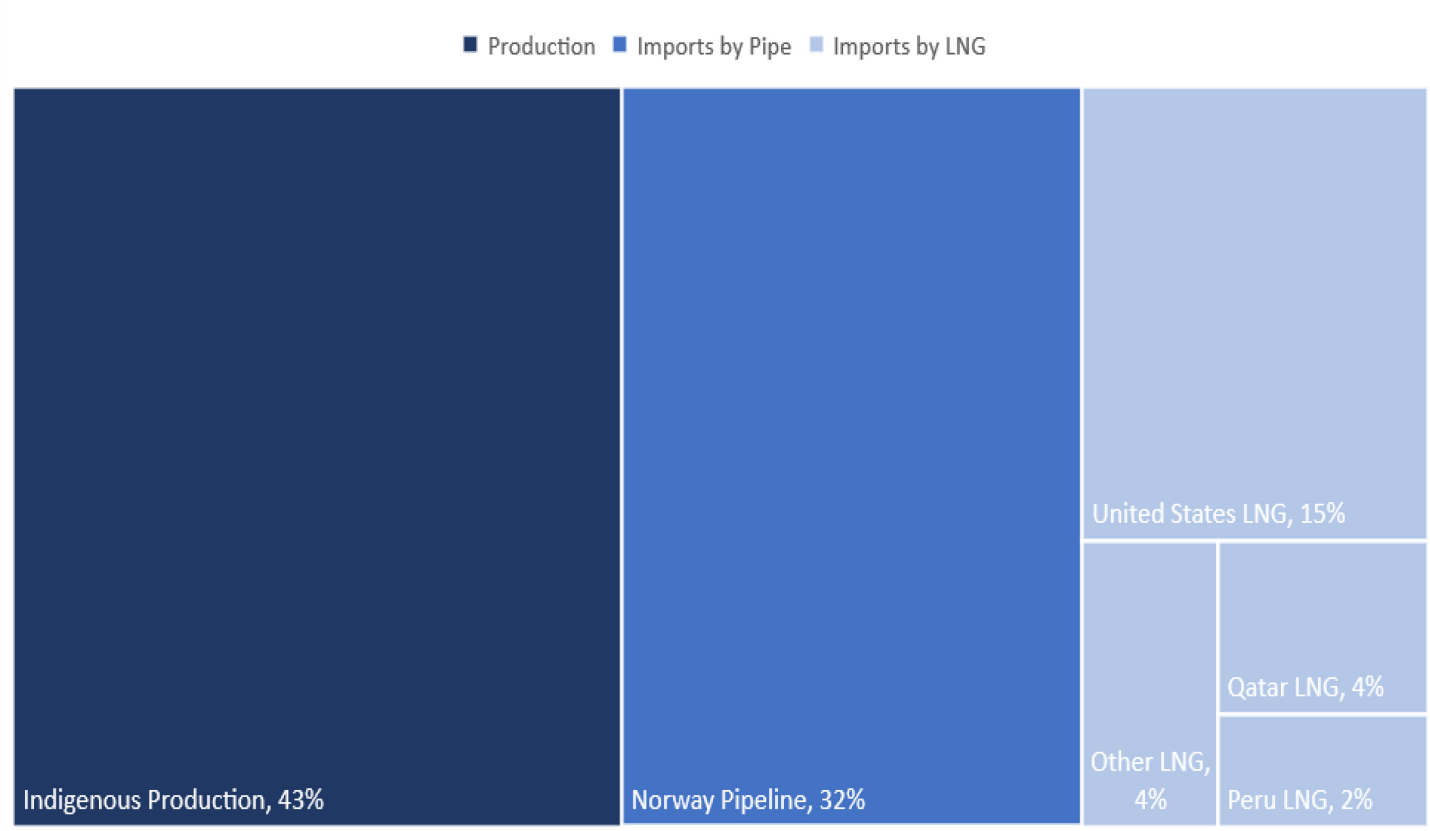


The majority of European natural gas imports arrive via pipeline for which infrastructure is well-established. In 2023, imports by pipeline made up 66 and 57 per cent of total imports to Europe and the UK respectively. Pipeline infrastructure means it is often convenient to import gas from neighbouring countries. Countries can also import natural gas as shipments of LNG which is gas that has been cooled to a liquefied state, making it easier to store and transport. It can then be regasified at import terminals, before being transferred to the

pipeline system. The UK has the second largest LNG regasification infrastructure in Europe, behind Spain, with three import terminals - Dragon, the Isle of Grain and South Hook.

Chart 3 shows European gas supply sources in 2023, see Appendix 1 for a breakdown of other. The top import sources for European countries have remained relatively unchanged since 2021, with 13 countries ranking within the top 15 sources each year from 2021 to 2023. Of these, Norway, Russia, Algeria, and the United States have consistently ranked within the top five sources of European imports although the proportion of European supply met by Russian gas has fallen sharply since 2021 when Russian imports comprised 24 per cent of gross supply. European pipeline imports from Russia[2] fell by almost 50 per cent in 2023 compared to 2022 as many European countries moved away from Russian gas following the invasion of Ukraine. Despite this Russia remained the second largest pipeline import source to Europe behind Norway, down from the largest in 2022 and accounting for 8 per cent of gross supply. Imports of Russian LNG increased slightly in the same period. Unlike 2022, the shortfall was met with reduced demand and increased LNG imports rather than pipeline imports. LNG imports increased by 7 per cent in 2023 compared to 2022, with imports of LNG from the US making up 9 per cent of gross supply. Imports of gas to Europe from the UK decreased by 14 per cent in 2023 compared to record highs in 2022 but remained higher than pre-conflict averages.

Chart 4: Sources of UK gross gas supply, 2023



Similar to Chart 3, Chart 4 shows gas supply sources for the UK in 2023. In 2022 UK trade patterns shifted following Russia's invasion of Ukraine reaching record highs for both imports and exports as the UK facilitated gas trade into mainland Europe. Following this, in 2023, imports and exports were down compared to those record highs. Imports returned to more typical levels and higher than normal exports were facilitated by low UK demand. Norway remained the UK's largest import source, accounting for 32 per cent of gross supply. Norway accounted for almost 100 per cent of all pipeline imports to the UK in 2023 as Belgian and Dutch interconnectors were mainly used for exports.

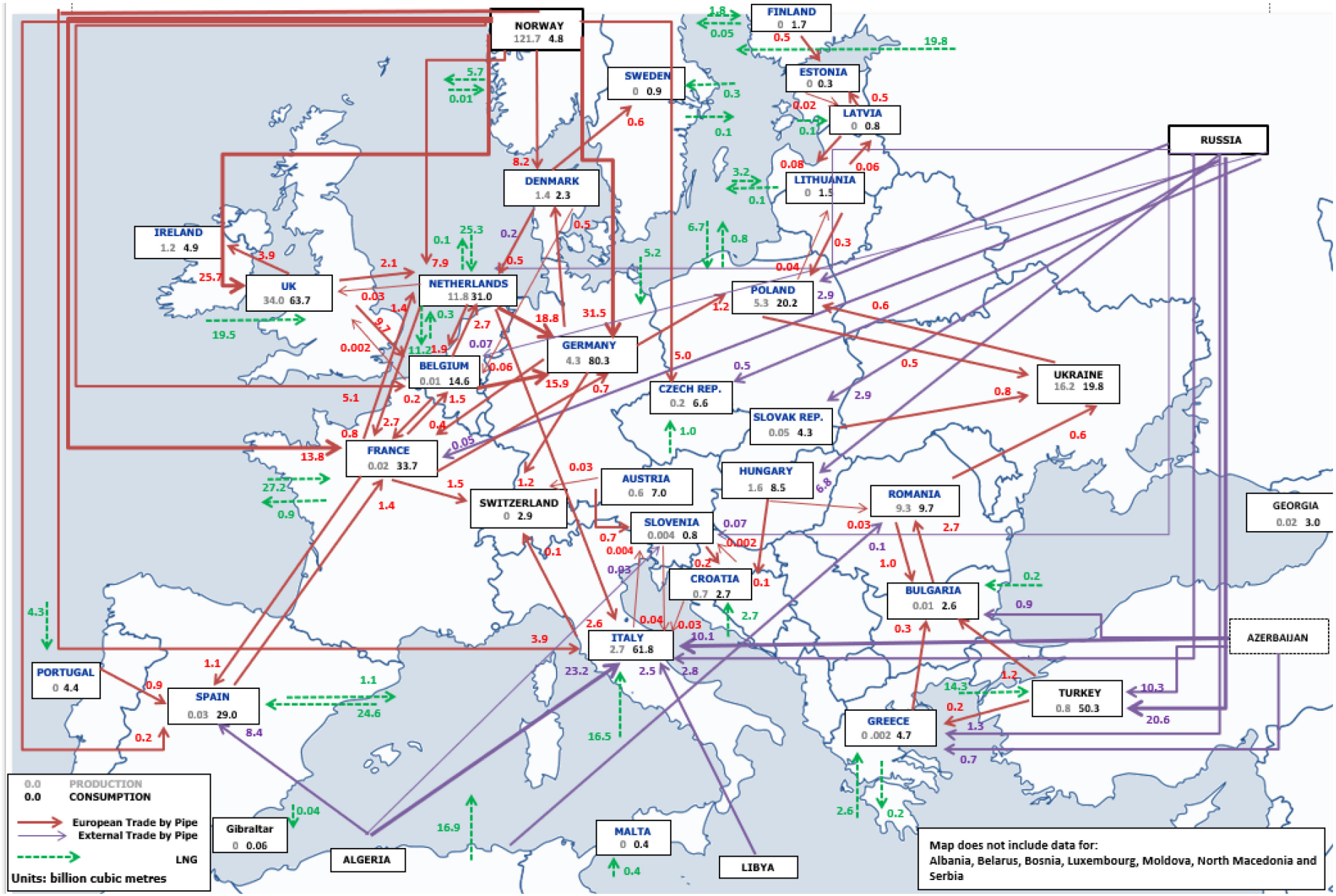
[2] Russia acts as a transit country for gas from Kazakhstan and Turkmenistan, so it should be noted that the origin of this gas is not necessarily all Russian.

Imports of LNG from the US accounted for 61 per cent of total UK LNG imports in 2023, up from 50 per cent in 2022 and 26 per cent in 2021. It remained the largest source of LNG to the UK, having overtaken Qatar in 2022. LNG from the US has increased considerably; recent provisional data up to October 2024 indicates that so far in 2024, US LNG imports have accounted for almost 70 per cent of total LNG imports (see Energy Trends Table 4.3 for further information). Qatari LNG imports accounted for 14 per cent of total LNG imports and despite being the second largest source, this was the lowest proportion seen in over a decade. LNG imports from Qatar fell by 64 per cent in 2023 compared to 2022. In total, the UK sourced LNG from 10 different countries in 2022, down from 13 in 2022.

Following sanction announcements and industry self-sanctioning, the last cargo of Russian LNG imported to the UK was received in March 2022.

Map 1:

Map 1 illustrates the diversity of import supply, as well as the complexities of inter-EU gas trade.



Appendix 1: Underlying data for charts

Table 1: Underlying data for Chart 1 and Chart 2

Country	Self-sufficiency	Diversity index	Supply index	Demand (mcm)
Albania	1.00	0.00	1.00	48
Austria	0.08	0.48	0.56	7,004
Belarus	0.01	0.00	0.01	16,532
Belgium	0.00	0.89	0.89	14,619
Bosnia and Herzegovina	0.00	0.00	0.00	247
Bulgaria	0.00	0.48	0.49	2,552
Croatia	0.27	0.66	0.93	2,719
Czech Republic	0.02	0.41	0.43	6,568
Denmark	0.60	0.15	0.75	2,336
Estonia	0.00	0.32	0.32	336
Finland	0.00	0.58	0.58	1,719
France	0.00	0.70	0.70	33,691
Georgia	0.01	0.00	0.01	3,017
Germany	0.05	0.40	0.45	80,305
Gibraltar	0.00	0.00	0.00	60
Greece	0.00	0.70	0.70	4,658
Hungary	0.19	0.19	0.39	8,519
Ireland	0.24	0.00	0.24	4,874
Italy	0.04	0.69	0.73	61,842
Latvia	0.00	0.27	0.27	801
Lithuania	0.00	0.40	0.40	1,487
Luxembourg	0.00	0.54	0.54	556
Malta	0.00	0.15	0.15	401
Netherlands	0.38	0.75	1.13	30,983
Norway	25.29	0.55	25.84	4,811
Poland	0.26	0.43	0.69	20,194
Portugal	0.00	0.28	0.28	4,437
Republic of Moldova	0.00	0.02	0.02	2,503
Republic of North Macedonia	0.00	0.00	0.00	350
Turkey	0.02	0.69	0.70	50,291
Romania	0.96	0.18	1.14	9,686
Serbia	0.11	0.00	0.11	2,906
Slovak Republic	0.01	0.30	0.31	4,274
Slovenia	0.01	0.17	0.18	810
Spain	0.00	0.74	0.74	29,015
Sweden	0.00	0.61	0.61	856
Switzerland	0.00	0.48	0.48	2,910
Ukraine	0.82	0.57	1.38	19,799
United Kingdom	0.54	0.46	1.00	63,731
Average	**0.79**	**0.37**	**1.16**	**12,883**

Source: IEA (http://data.iea.org/)

Countries included in 'Other Pipeline' in Chart 3: Algeria, Azerbaijan, Netherlands, Belgium, Germany, Slovak Republic, United Kingdom, Iran, France, Libya, Ukraine, Bulgaria, Spain, Denmark, Czech Republic, Italy, Lithuania, Switzerland, Austria, Greece, Estonia, Hungary, Portugal, Slovenia, Latvia, Turkey, Croatia, Moldova, Finland, Romania.

Countries included in 'Other LNG' in Chart 3: Algeria, Nigeria, Egypt, Angola, Trinidad and Tobago, Norway, Peru, Equatorial Guinea, Cameroon, Oman, Spain, France, Australia, Indonesia, Lithuania, China, Chile, Mozambique, Netherlands, Gibraltar, Belgium, South Korea, Jamaica, Finland, Malaysia, Sweden, Estonia, Germany, Hungary, Italy.

Countries included in 'Other LNG' in Chart 4: Angola, Algeria, Nigeria, Russia, Norway, Trinidad and Tobago, Egypt, Spain, Chile, Oman.

Appendix 2: Methodology

Self-sufficiency

Data for natural gas was extracted from the IEA database. Self-sufficiency was determined from data on production and demand (production (mcm) ÷ demand (mcm)).

Diversity index

The diversity index used here is a product of a standard diversity index and an index for political stability. As a basic index for measuring diversity, we used the Shannon-Wiener diversity index:

$$\sum_{i=1}^{n} -x_i ln(x_i)$$

Where x is the proportion of total natural gas supply represented by the i^{th} source country and n represents the final source country. A value below 1 signifies a country that is dependent on a small range of import sources, a value above 1 represents a country with a wider range of import sources. The minimum value of zero denotes a country that has one imported fuel source or relies entirely on production (or a country with no imports). The Shannon-Wiener was chosen here because it places weight on the diversity of contributions from smaller countries and reduces the impact of larger nations.

Political stability was determined using data from the World Bank worldwide governance indicators. Specifically, the index reflects perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism. These data were standardised between 0 and 1.

Source: World Bank http://info.worldbank.org/governance/wgi/index.aspx#home

Shannon-Wiener and political stability indices were multiplied and summed:

$$\sum_{i=1}^{n} -x_i ln(x_i) b_i$$

Where b is an index of political stability of producing country. This is called the SWNI (Shannon-Weiner-Neumann index), in line with previous work. Each SWNI index was normalised between 0 and 1, in order to have a standardised index. This was done by working out a maximum diversity score, by assuming maximum diversity was equivalent to importing products in line with proportional contributions of exporting countries (e.g. if a single country were responsible for exporting 50 per cent of all natural gas, and five other countries were responsible for 10 per cent each, we assumed maximum import diversity at a ratio of 5:1:1:1:1:1). This maximum diversity score then acted as our upper score of 1, with all other scores divided by this maximum to standardise the data.

Other sources of gas

Sometimes, due to a variety of reasons, countries may report an import of natural gas from a “Non-Specified/ Other” source country. Border Point Data was used to reallocate imports for Austria, Hungary, Poland, Republic of Moldova, Slovak Republic, and Ukraine, which is available at https://www.iea.org/data-and-statistics/data-product/gas-trade-flows#gas-trade-flows. This data is collected by the IEA and shows monthly gas flows in Europe.

This publication is available from: https://www.gov.uk/government/collections/energy-trends

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Electricity generation and supply in Scotland, Wales, Northern Ireland, and England, 2019 to 2023

Emmanuel Abebe 075 616 01157 Emmanuel.abebe@energysecurity.gov.uk

Introduction

This article examines the variation of electricity generation and consumption in the four nations of the United Kingdom. It updates and extends the previous version, published in December 2023. The UK data in this article is taken from chapters 5 and 6 of the Digest of United Kingdom Energy Statistics (DUKES) 2024 and the definitions match those in DUKES. The main text covers the latest five years of data and the corresponding timeseries (including the latest revisions) for 2004 to 2023 can be found in the accompanying Excel spreadsheet.

Key headlines

- UK total electricity generation in 2023 was 293 TWh, a decrease of 9.9 per cent compared to 2022. This is the lowest electricity generation on the published data series.
- Generation from fossil fuel fell in all four nations of the UK compared to 2022. Scotland -36 per cent, Wales -27 per cent, Northern Ireland -19 per cent, England -18 per cent.
- Renewable generation trends were mixed across the nations with decreased renewable generation in Scotland and Northern Ireland but increases for England and Wales. Overall, there were record levels of total UK renewable generation.
- UK nuclear generation decreased by 14 per cent compared to 2022, to the lowest value on the published data series. Nuclear generation increased by 14 per cent in Scotland and decreased by 20 per cent in England where maintenance and refuelling outages took place.
- The low carbon shares (renewables + nuclear) of electricity generation were 89.6 per cent in Scotland, 57.2 per cent in England, 50.9 per cent in Northern Ireland and 34 per cent in Wales. Total UK low carbon generation share stood at its second highest value on the time series at 60.3 per cent.
- Generation patterns were influenced by record imports from Europe. Net imports totalled 23.8 TWh, this was due to favourable price differentials from interconnectors.

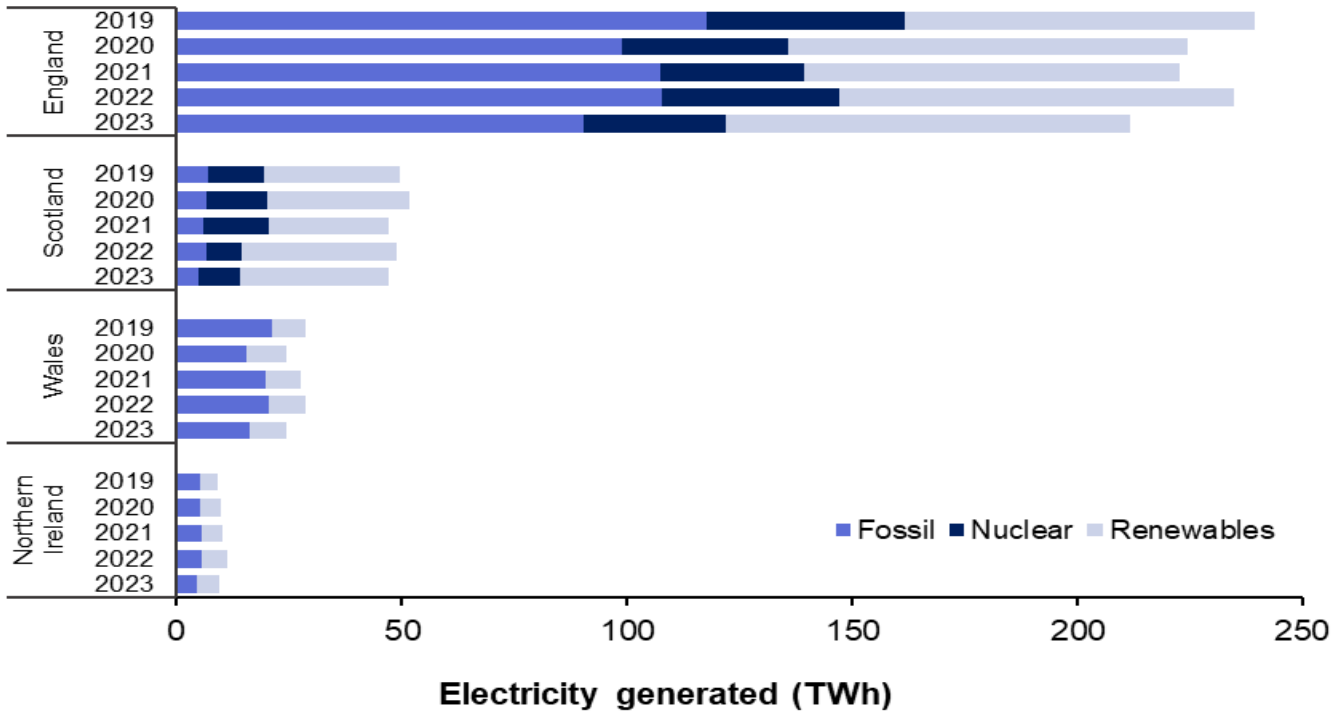
Generation, consumption, and trade

During 2023, the UK generated 293 TWh of electricity. This was a decrease of 9.9 per cent compared to 2022 and was the lowest UK generation figure on the published data series. This was due to lower UK demand, increased electricity imports and lower demand for exports to Europe. Generation has been on a downward trend since 2016, though there was a year-on-year increase in 2022 when nuclear outages in France led to increased UK generation for exports.

From 2022 to 2023, all four UK regions saw a decrease in generation. Scotland decreased by 3.9 per cent while Wales decreased by 19 per cent. Northern Ireland decreased by 15 per cent and England decreased by 10 per cent from 2022's figure. Chart 1 shows total electricity generation by country, between 2019 and 2023, with generation divided by fossil fuel, nuclear and renewable technologies.

The reduction in generation was in line with reduced demand for electricity, shown in the regional tables by reduced consumption of electricity. This fell 1.2 per cent to 269 TWh, another record low figure in the published data series. This was a smaller decrease than the decrease in generation, with increased electricity imports making up the difference.

Chart 1: Total electricity generation by country (all generating companies), 2019 to 2023.



Shares of electricity generated by nation remained similar to the previous year, with England having the largest share of electricity generation at 72.3 per cent, increasing by 0.1 percentage points relative to 2022. Scotland accounted for the second largest share, at 16.1 per cent, increasing by 1.0 percentage points. Wales's share decreased to 8.3 per cent, by 0.9 percentage points. Northern Ireland's share decreased by 0.2 percentage points to 3.3 per cent.

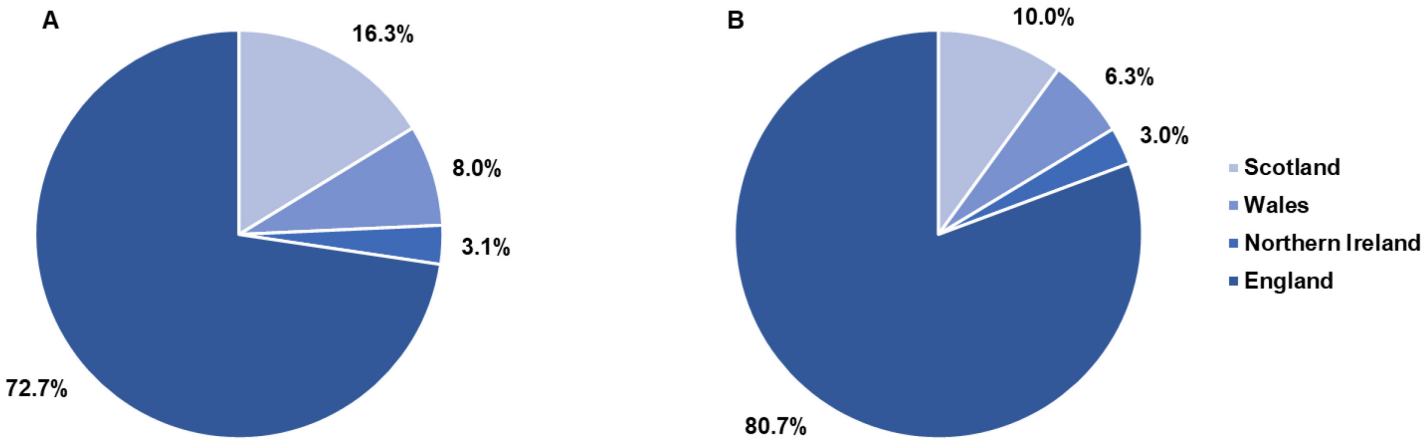
UK fossil fuel generation decreased by 20 per cent from 2022 to 2023, to 107 TWh. This was the lowest figure on the published data series. In line with the low generation, the share of generation from fossil fuel fell to 36.7 per cent, a decrease of 4.5 percentage points. This year-on-year decrease in fossil fuel use reflects lower overall generation numbers due to high net imports. Scotland had the largest year-on-year decrease in fossil fuel generation, down by 36 per cent. Wales saw a decrease of 27 per cent from 2022, down to 14.4 TWh. Coal generation continued in England and Northern Ireland in 2023, but their fossil fuel generation still decreased by similar rates. Fossil fuel generation in England was down 18 per cent and Northern Ireland down 19 per cent, with larger decreases in coal generation in both nations. This resulted in coal's overall share of UK generation being 1.3 per cent, down by 0.5 percentage points from 2022, with the last coal plants closing during 2024.

UK nuclear generation was down by 14 per cent to 40.6 TWh from 2022. This resulted in a 13.9 per cent share of overall UK generation, a decrease of 0.7 percentage points. Scotland and England are the only nations with nuclear generation, as has been no nuclear generation within Wales or Northern Ireland since the closure of Wylfa in Wales in 2015. Although overall nuclear generation fell, Scotland's increased by 14 per cent to 9.1 TWh but England's share fell as a result of outages. There was a 20 per cent decrease in England's nuclear generation from 2022, down to 32 TWh.

UK renewable generation was similar in 2022 and 2023, but with a small increase to a new record figure of 136 TWh in 2023. The renewable share of UK generation also increased to 46.4 per cent, an increase of 4.7 percentage points, with lower generation overall and lower fossil fuel generation. Increased capacity saw higher wind and solar generation despite slightly lower average wind speeds and lower average daily sun hours, while hydro and bioenergy generation both fell.

Shares of annual electricity consumption of the respective UK nations did not vary much from 2022 and have been relatively consistent across the reported data series. The majority of consumption came from England (80.7 per cent), 10.0 per cent from Scotland, 6.3 per cent from Wales and 3.0 per cent from Northern Ireland. This shows that Scotland and Wales supply more than they consume, whereas the reverse is true for England and the shares for Northern Ireland are similar for supply and consumption. Chart 2 shows shares of electricity supply and consumption in the UK by country in 2023.

Chart 2: Shares of electricity supply (A) and consumption (B) in the UK by country in 2023



International exports and transfers

The UK returned to being a net importer of electricity in 2023 after the atypical net exports in 2022. This was primarily due to electricity price differentials between interconnected countries making interconnectors a cheaper source of electricity compared to the more expensive types of UK based generation. The UK transfers electricity to Europe via interconnectors with France, Netherlands, Belgium, the Republic of Ireland, and Norway and a new interconnector with Denmark called Viking Link (commissioned in December 2023). England was the largest importer of electricity from Europe, with 27 TWh of net imports compared to last year where net exports totalled 5.1 TWh. Although the UK as a whole was a net importer from Europe, Wales and Northern Ireland were still net exporters as they host interconnectors with the Republic of Ireland. Wales transferred 1.7 TWh and Northern Ireland transferred 1.6 TWh of electricity to Europe. Scotland transferred 14 TWh of electricity to England as well as 2.0 TWh to Northern Ireland.

Transfers and trade between countries is complex as it will depend on the generation mix at any given time and the price differentials in operation. Transfers and trading patterns are ascribed to the country or nation where the interconnector is located, but this cannot reflect the full complexity of how electricity flows between countries. A flow chart illustrating electricity generation, consumption and trade in the UK nations is provided in Appendix A.

Electricity generation by fuel

In recent years the closure of coal and gas fired power stations and an increase in the capacity of renewable generators has shifted the UK's mix of generation from fossil fuels to renewables. This is the second year in a row that renewable generation had a greater share than fossil fuels across electricity generation for the UK as a whole. The difference between the shares was much larger in 2023 with a difference of 9.7 percentage points this year, compared to only 0.5 percentage points in 2022. Fossil fuel share fell from 43.4 per cent in 2019 to 36.7 per cent in 2023. This contrasts in relation to the renewable share increasing from 36.6 per cent in 2019 to 46.4 per cent in 2023. These decreases can mostly be attributed to the majority of fossil fuel generation coming from gas-fired stations and their overall decrease in generation. UK gas generation fell by 24 per cent from 2019 to 2023, compared to the biggest renewable fuel, wind, which increased by 29 per cent

through the same period. No nations sustained an increase of fossil fuel generation from 2019, indicating a shift to renewable energy sources.

Coal-fired generation's share of UK electricity was only 1.3 per cent in 2023, a record low. This was a steep decline from 2012 when coal accounted for 39.2 per cent of the UK mix and followed a range of policies including the introduction of the Carbon Price Floor (CPF) in April 2013. By the end of 2023, only one coal plant remained in the UK, Ratcliffe-on-Soar, which closed in late 2024. This came as West Burton and Kilroot closed during 2023 along with the closure of the two remaining coal units at Drax. Coal generation was down 33 per cent in England year-on-year as well as being down 54 per cent in Northern Ireland. Scotland and Wales no longer have any coal-fired stations.

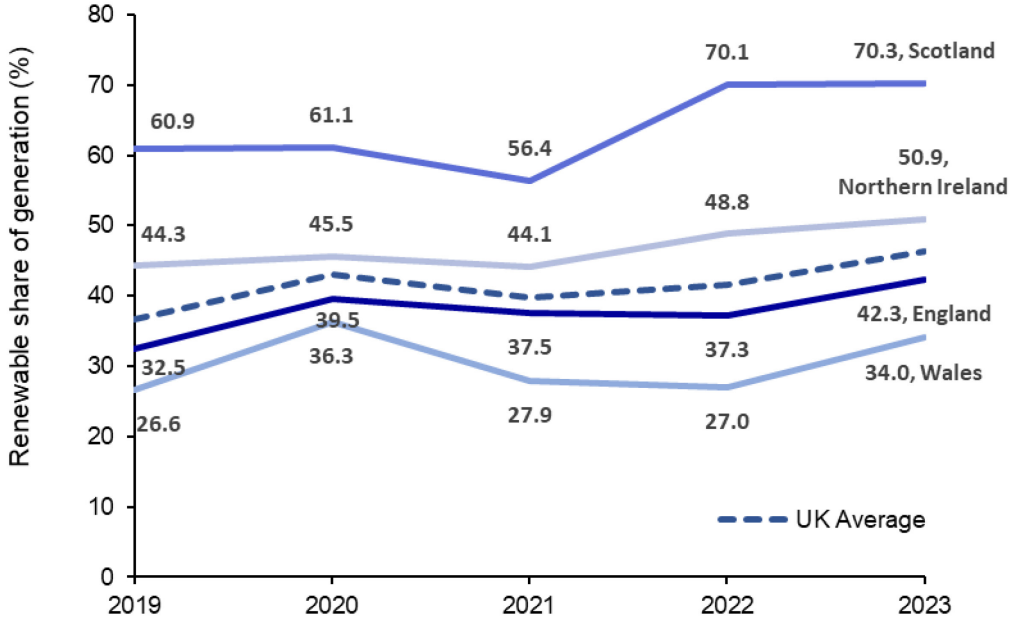
Gas had largely replaced coal in the generation mix since the introduction of the CPF. UK gas generation decreased to 102 TWh in 2023, though remained the fuel with the highest generation figure. This consistent decline can be seen as gas generation has decreased by 24 per cent compared to 2019. England had the highest level of gas generation with 80 TWh in 2023, a decrease of 16 per cent from 2022.

The UK's overall nuclear generation has been on a downward trend since 2019, although increased by a small amount in 2022. Nuclear generation decreased by 14 per cent to 41 TWh in 2023, with ongoing outages as a result of aging infrastructure. There were fewer outages for Scottish plants compared to 2022, which meant their nuclear generation increased by 14 per cent to 9.1 TWh year-on-year. However, England saw a decrease of 20 per cent compared to 2022's figure. Since the closure of Wylfa in 2015 there has been no nuclear generation in Wales.

UK low carbon generation decreased 3.5 per cent compared to 2022, from 183 TWh to 176 TWh. This is due to similar levels of renewable generation while nuclear generation decreased particularly in England. However, lower total UK-based generation meant that the low carbon's share of UK generation increased to 60.3 per cent, up by 4.0 percentage points, mostly due to fossil fuel decline. The share of low carbon generation varied across the 4 nations with Scotland having 89.6 per cent, England with 57.2 per cent, Northern Ireland with 50.9 per cent and Wales with 34.0 per cent. All 4 regions also increased their share of low carbon generation from 2022 but was particularly large for Wales with an increase of 7.1 percentage points.

Renewable generators saw their share of generation increase to 46.4 per cent, up by 4.7 percentage points compared to 2022. This occurred due to the emphasis on renewable fuels for generation compared to fossil fuel use as well as lower overall generation. The share of generation for most renewable technologies was similar in 2022 and 2023 due to minor differences in weather conditions and similar capacity levels. Chart 3 shows the renewable share of total electricity generation in each UK country from 2019 to 2023, in comparison to the UK average.

Chart 3: Renewable share of electricity generation by country, 2019 to 2023

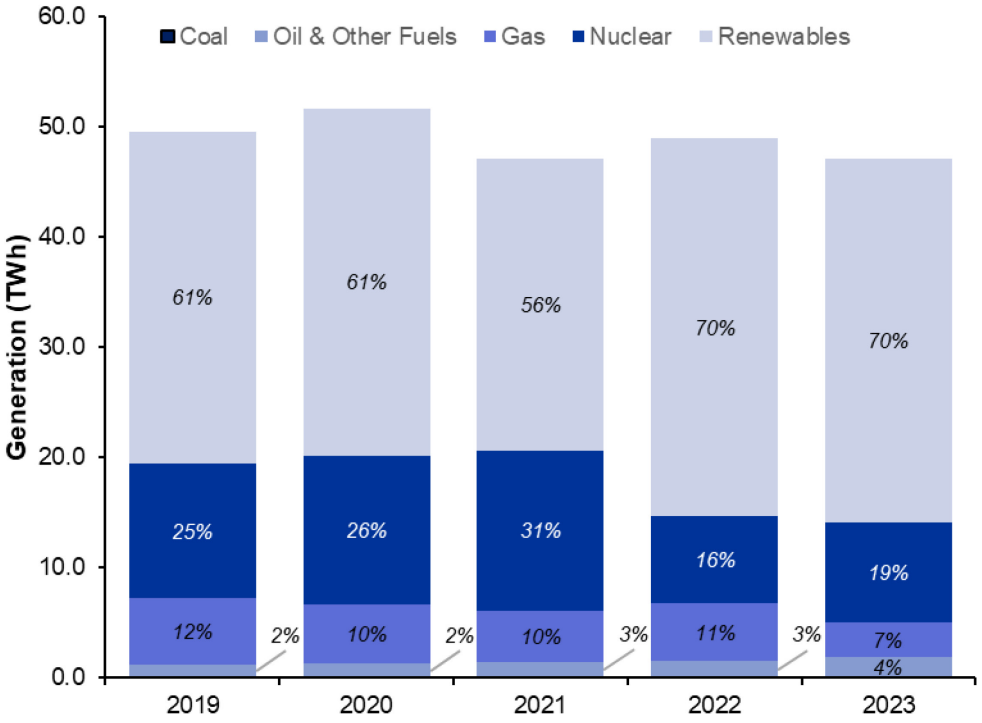


A map illustrating the distribution of Major Power Producers in Scotland, Wales, Northern Ireland and England is provided in Appendix B.

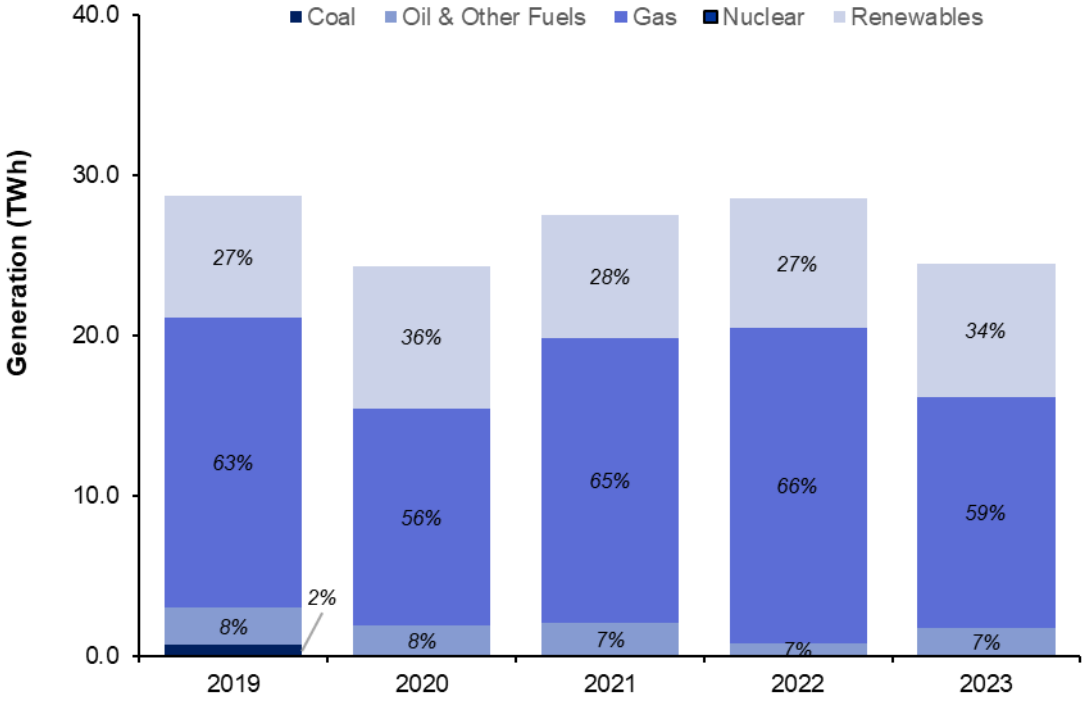
Chart 4 shows electricity generation by fuel (in all generating companies) in each UK country for the period 2018 to 2022. To illustrate the generation mix in each country, shares of electricity generated by fuel are shown as data labels.

Chart 4: Electricity generation by fuel (with shares of electricity generated) in all generating companies, in Scotland (A), Wales (B), Northern Ireland (C) and England (D), 2019 to 2023.

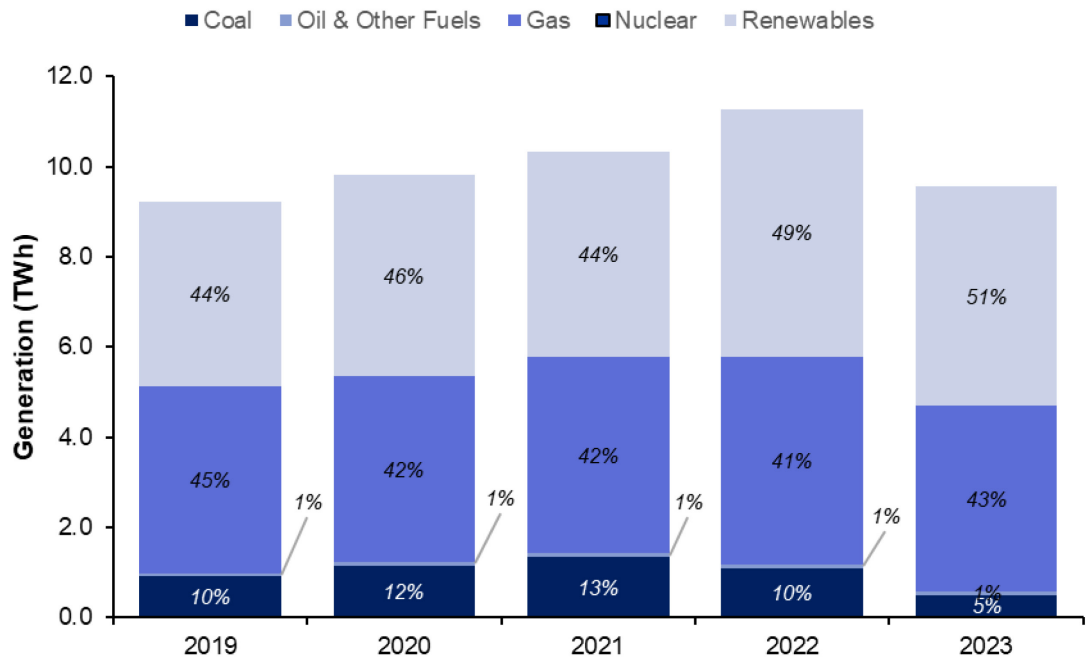
A - Scotland



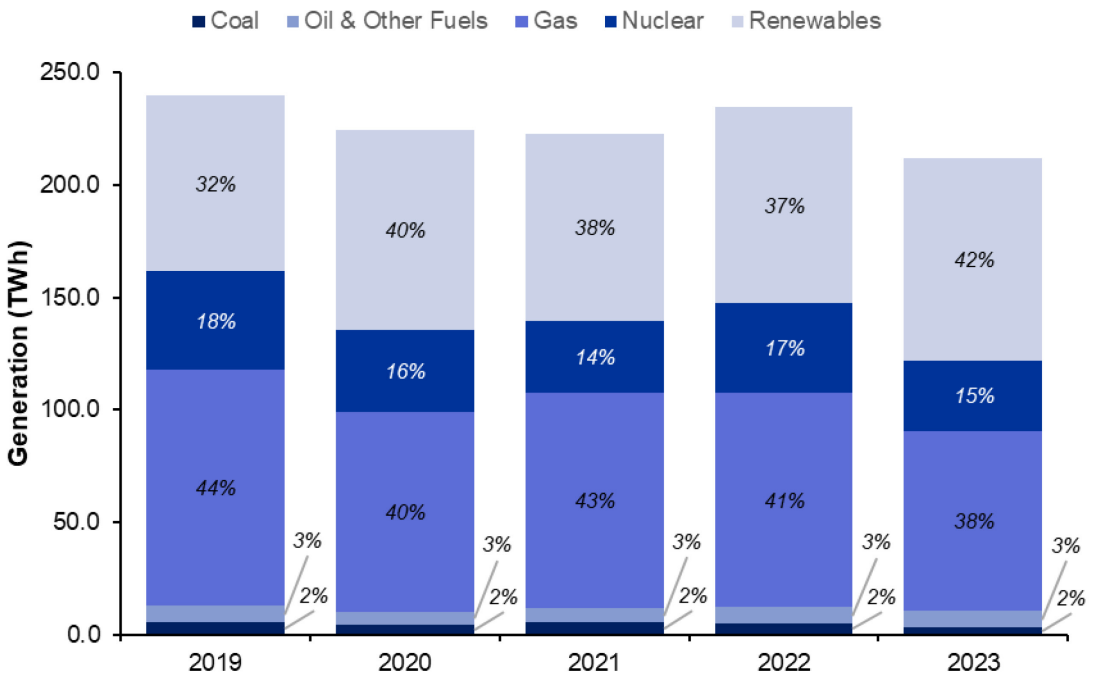
B – Wales



C – Northern Ireland



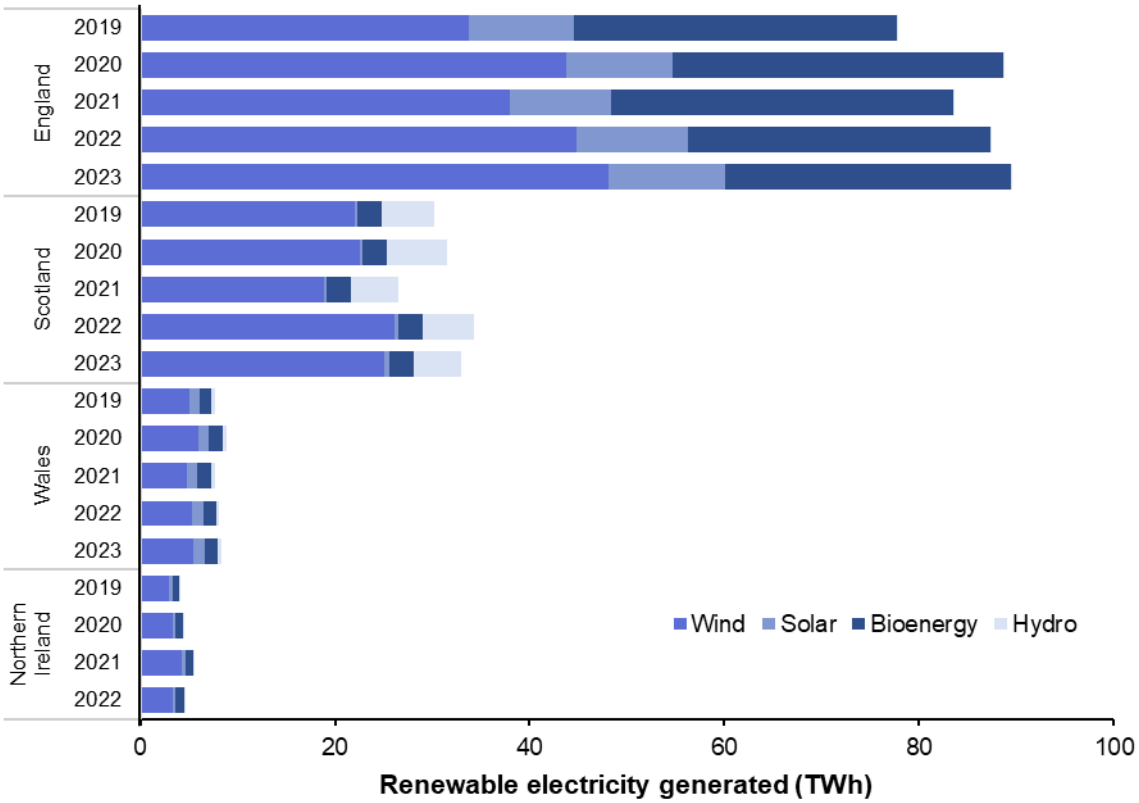
D – England



Low carbon and renewable electricity

Renewable electricity generation and capacity has increased dramatically in recent years, as the UK strives towards a cleaner future, working towards its goal to achieve net zero carbon emissions by 2050. Chart 5 shows electricity generation by renewable technology in each UK nation between 2019 and 2023.

Chart 5: Renewable electricity generation by technology, in each UK nation between 2019 and 2023



Wind had the largest generation of the renewable technologies at 82.3 TWh in 2023, with generation increasing by 2.2 per cent compared to 2022. Wind power accounted for 53.4 per cent of Scotland's generation in 2023, the highest wind share for any nation and more than double the proportion of English and Welsh wind generation (22.7 per cent and 22.5 per cent respectively). Wind generation increased in Wales and England but decreased in Scotland and Northern Ireland.

Bioenergy was the second largest category of renewable generation in 2023, at 11.7 per cent of total generation. Since the conversion of coal units at Lynemouth and Drax to biomass in 2018, most bioenergy generation by major power producers takes place at these two sites, which are both in England. Bioenergy generation decreased 5.9 per cent in 2023 across the UK, with outages at key sites reducing the generation. These trends were similar for England (down 5.3 per cent) and Wales (down 7.3 per cent) with generation remaining consistent in Northern Ireland and Scotland.

Solar generation increased in 2023 by 4.1 per cent, compared to a 9.0 per cent increase in capacity. Average daily sun hours were lower than in 2022, and slightly below the 20-year mean. All nations apart from Northern Ireland saw an increase in solar generation. Scotland increased the most by 14 per cent, Wales by 5.6 per cent and England by 3.9 per cent, compared to a 6.9 per cent decrease in Northern Ireland.

The vast majority of the UK's **hydro** generation assets are in Scotland. There were no changes in capacity but lower average monthly rainfall in some months of 2023 meant hydro generation decreased by 2.2 per cent across the UK as a whole, with a decrease of 4.8 per cent in Scotland.

Further Details

For further detailed renewable statistics on a sub-national and regional basis, please refer to the special feature article published in the September 2024 issue of Energy Trends. For weather data, weighted by location of renewable resources, refer to Energy Trends section 7: weather.

Note that previous versions of this article included reference to renewable generation under the Renewables Obligation (RO). This is no longer included since the RO closed to new generating capacity in March 2017, with a grace period ending in 2018. Since this date, the expansion of renewable capacity renders renewable generation under the RO less significant.

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Revisions

Previous versions of the data in this article remain available online for comparison at:

www.gov.uk/government/collections/energy-trends-articles

References

Digest of UK Energy Statistics 2024 (DUKES) – Electricity (Chapter 5):

https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes

Electricity Statistics: data sources and methodologies

https://www.gov.uk/government/publications/electricity-statistics-data-sources-and-methodologies

Electricity generation and supply article and accompanying data for Scotland, Wales, Northern Ireland and England, 2019 to 2023:

https://www.gov.uk/government/publications/energy-trends-december-2024-special-feature-articles

UK electricity generation and consumption (Energy Trends 5.1 to 5.6):

https://www.gov.uk/government/statistics/electricity-section-5-energy-trends

Renewable electricity generation and capacity (Energy Trends 6.1):

https://www.gov.uk/government/statistics/energy-trends-section-6-renewables

Renewable electricity in Scotland, Wales, Northern Ireland and the regions of England in 2023:

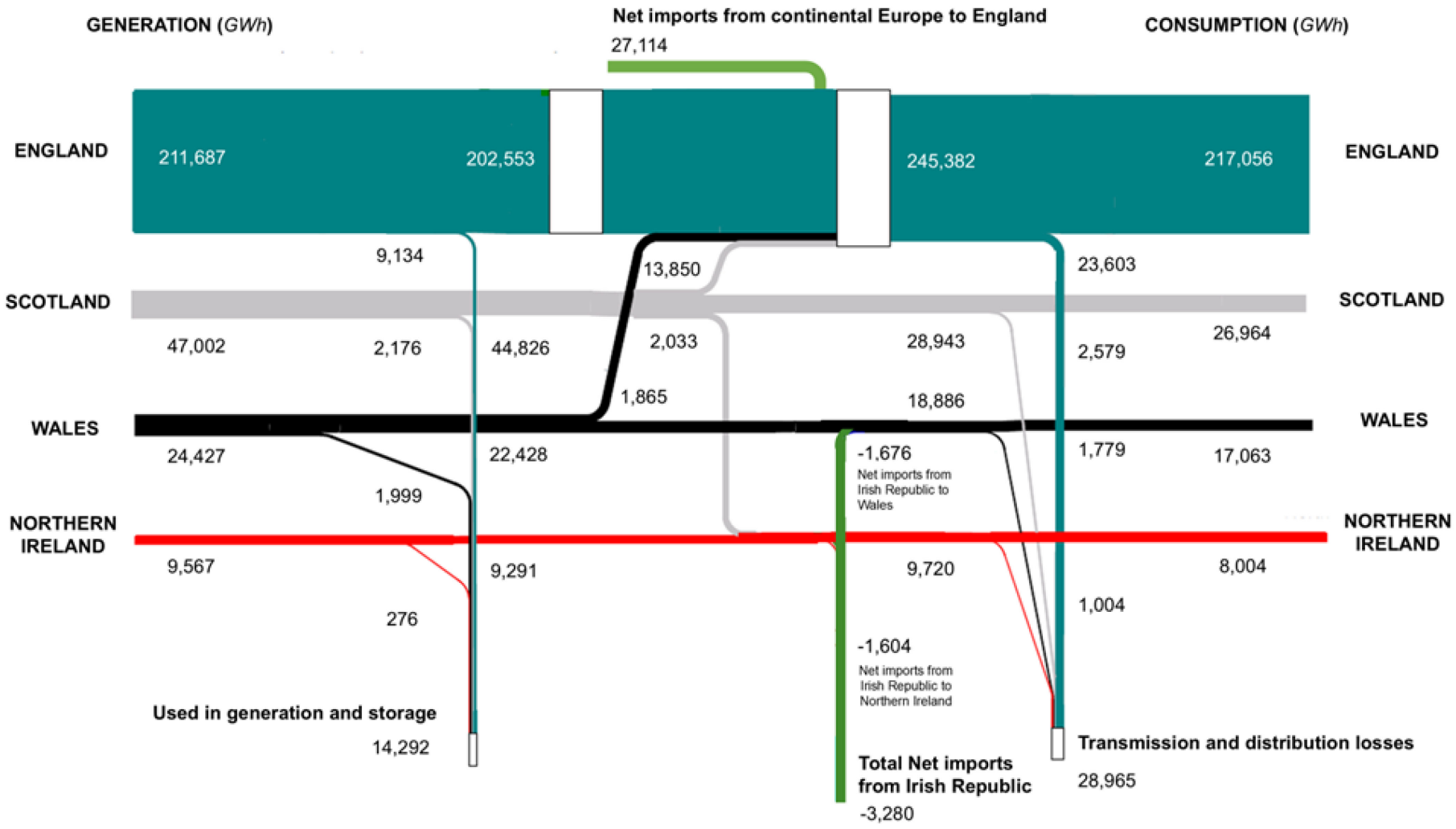
https://www.gov.uk/government/statistics/regional-renewable-statistics

Energy Trends: weather

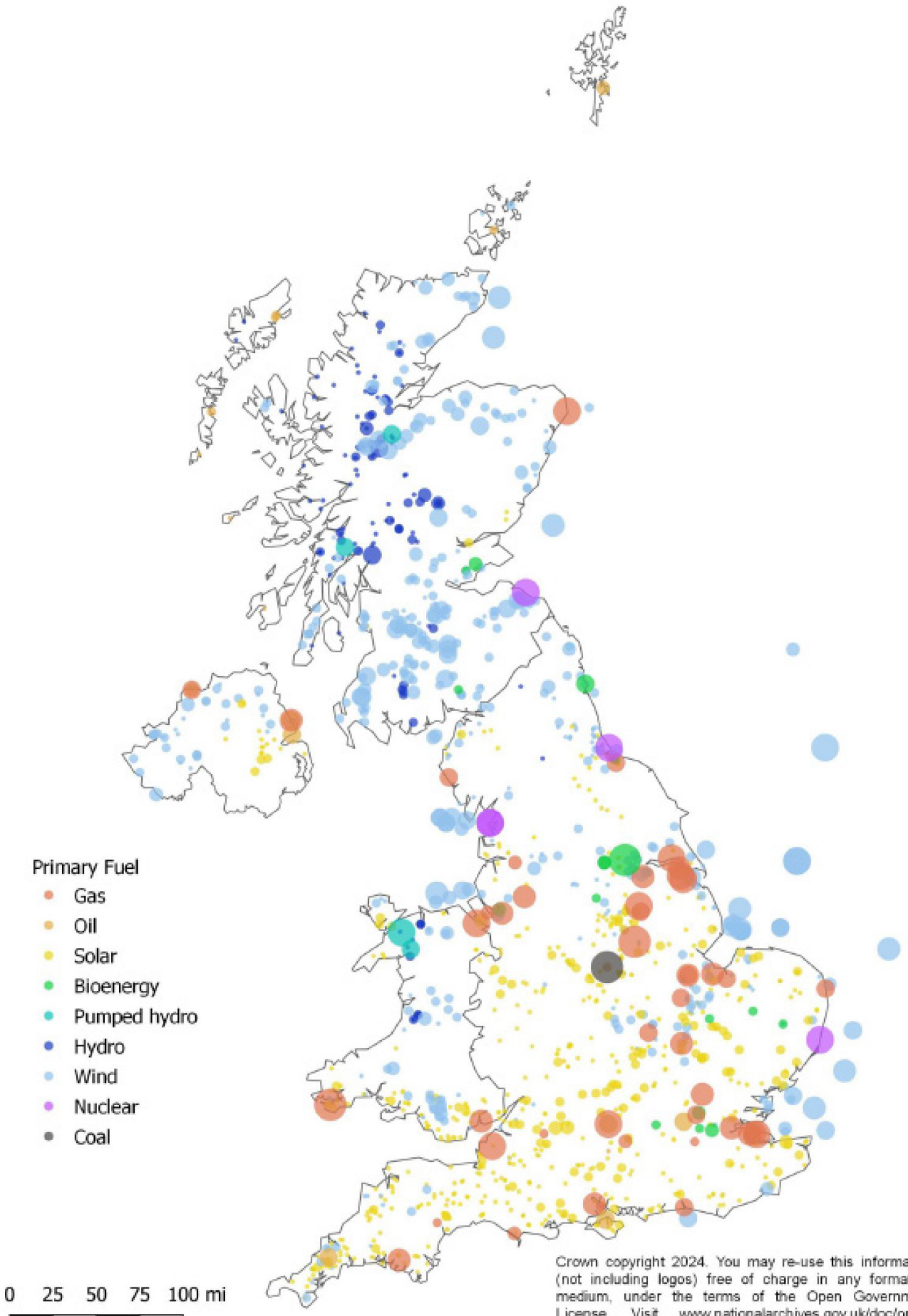
www.gov.uk/government/statistics/energy-trends-section-7-weather

Appendices

Appendix A: Electricity generation and consumption in Scotland, Wales, Northern Ireland and England



Appendix B: Distribution of Major Power Producers (MPPs) in the United Kingdom (as of May 2024)



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Feed-in Tariff load factor analysis

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Key headlines

Median load factors for solar photovoltaic (PV) decreased to 9.4 per cent in 2023/24. This is the lowest recorded median in the time series. Average sun hours in 2023/24 were down on the previous year and were at their lowest since 2017/18.

The median load factor for wind was 20.2 per cent in 2023/24, a 2.9 percentage points increase with respect to 2022/23 despite a very small rise in average wind speed. However, the weighted mean load factor saw a more modest increase.

Like last year, **South West and East of England had the highest median load factor for solar PV,** while **Scotland had the highest wind load factor**. Wind load factors exhibit greater regional variability than solar load factors.

This article analyses load factors from a sample of small-scale renewable installations accredited under the Feed-in Tariff (FiT) scheme[1]. For each financial year since 2011/12 (the second year of the FiT scheme), we provide an update on national load factors for all technologies, as well as regional load factors for solar PV and Wind installations, and quarterly national load factors for solar PV, Wind and Hydro schemes. Detailed tables are available as an Excel workbook, at: https://www.gov.uk/government/publications/quarterly-and-annual-load-factors

Background

Load factors are a measure of the efficiency of electricity generation. A load factor is the amount of electricity generated by a system over a certain period expressed as a proportion of its maximum possible output.

The Feed-in Tariff scheme was launched in April 2010[2]. It is managed by Ofgem. It is a financial support scheme for eligible low-carbon electricity technologies, aimed at small-scale installations. The following technologies are supported:

- Solar photovoltaic (up to 5 MW capacity)
- Anaerobic digestion (AD, up to 5 MW capacity)
- Hydro (up to 5 MW capacity)
- Wind (up to 5 MW capacity)
- Micro Combined Heat & Power (Micro CHP, up to 2 kW capacity)

Some generators receive financial support for generating electricity and some for exporting electricity, depending on the tariff which they are on. The generation tariff is based on the number of Kilowatt hours (kWh) generated whereas the export tariff is based on electricity that is generated on site, not used, and exported back to the grid. The FIT scheme closed to new entrants at the end of March 2019, though a grace period has been allowed to a small number of installations since then. Accredited generators continue to receive support for 20 years from the date they were commissioned (10 years for micro-CHP, 25 years for solar PV commissioned prior to August 2012). At the end of 2023/24, there was more than 5,100 MW of solar PV capacity supported by FiTs (around 30 per cent of total solar PV capacity). In addition, there was around 770

[1] The article published in December 2022 can be found at the following link (opens in a new window)
[2] More details here: www.ofgem.gov.uk/environmental-and-social-schemes/feed-tariffs-fit

MW of wind (5 per cent of total onshore wind capacity), nearly 200 MW of hydro (10 per cent of total hydro capacity) and nearly 300 MW of AD capacity (around 46 per cent of total AD capacity) accredited on FITs.

Data cleansing

Table 1 shows how many installations were registered on the Central Feed-in Tariff Register at the start of FIT Year 14 and how many installations had valid meter readings; to be included in the analysis, each installation was required to have meter reading taken sufficiently close to April 1st, 2023, and a corresponding reading approximately one year later.

Of the 869,446 schemes registered for FiTs at the start of the financial year[3], 23 per cent were found to have sufficient meter readings for the annual analysis. Extreme load factor values were then excluded (as in previous years' analysis), accounting for around 2,300 (0.3 per cent) of installations. The column 'Valid load factor' in Table 1 indicates how many installations were included in the final annual analysis for each technology. Micro CHP statistics are no longer included in this release as there are few installations remaining which are still in support of FIT support (see Introduction).

The headline coverage is always lower in the most recent survey wave, due to the absence of a final meter reading for many installations. In the 2022 publication, we introduced a new method whereby closing readings for the previous year's analysis are added to the data set which increases the sample size for that year, making the results more robust. See the methodology annex in the December 2022 edition of this article[1] (link in note 1). Therefore, we have revised the results for 2022/23 by supplementing the data with this year's data. This has added nearly 130,000 more installations with valid readings to the analysis. This means that the load factors published for the latest FiTs year (2023/24) are subject to revision next year when more data will be available but typically, this method does not have a substantive effect on the reported load factors.

Table 1: Installations included in analysis by technology – FIT Year 14

Technology	Commissioned by 31st March 2021	Generation Data Reported*	Valid load factor	% remaining in analysis
Anaerobic digestion	427	237	209	49%
Hydro	1,206	395	352	29%
Photovoltaic	860,252	199,365	197,395	23%
Wind	7,561	2,614	2,358	31%
All Technologies	**869,446**	**202,611**	**200,314**	**23%**

For this year's edition, we have revised the data for FiT year 13 (2022/23). This is because more data is available by using meter readings from the latest survey which were taken on or around March 31st 2023. As with all sample data, there is a degree of uncertainty surrounding the results and any generalisation to the population should be treated with caution not least because these sites are not randomly selected but are an artefact of those sites who have provided data at the start and end of the financial year.

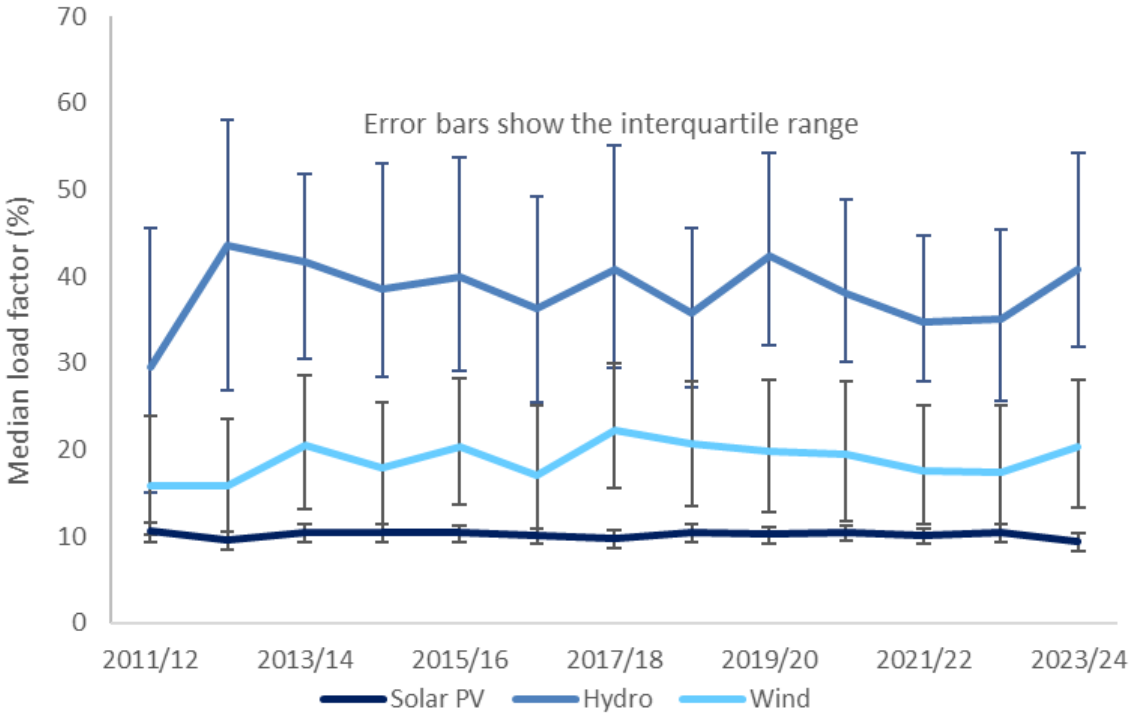
Results

Chart 1 below shows the annual load factors for the leading technologies (hydro, wind, and solar PV) over the FiT years. We present load factors on a line plot for each technology and year, displaying their median value and the interquartile ranges as a measure of dispersion around it. The plot highlights the differences between the technologies: although primary renewables are all dependent on weather conditions, the distribution of load factors around their median repeats across the years and has a different spread for each technology.

[3] Excluding Micro CHP and subject to further revision.

While load factors for solar PV are more concentrated, hydro and wind load factors exhibit a wider spread and a wider range of values can be observed. Fluctuating sample sizes may also influence the distribution year on year; solar PV has the largest sample size each year.

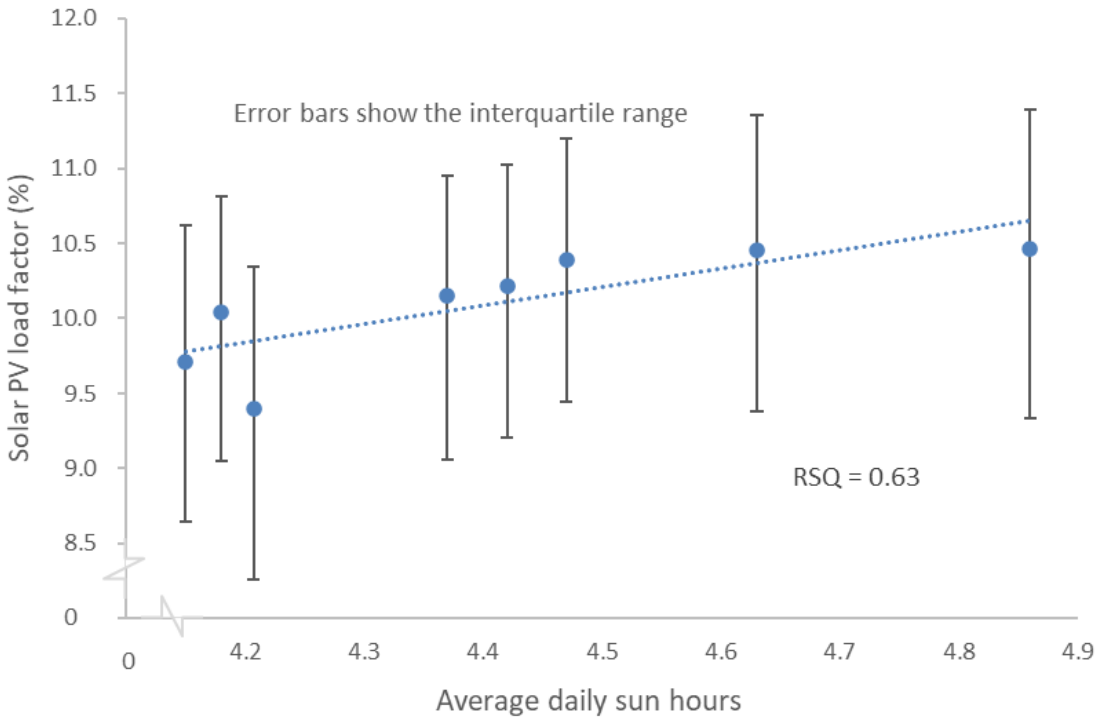
Chart 1: Hydro, Wind and Solar PV load factors, 2011/12-2023/24



The median load factor for solar PV in 2022/23 was 9.4 per cent, 1.4 percentage points lower than in 2022/23; this was due to shorter average sun hours which were down by around 9 per cent over the course of the year. The weighted mean was 8.6 per cent, also down on last year. The weighted mean is typically lower than the median, but the difference is small in relative terms; this suggests that the efficiency of solar PV installations is less dependent on their size than other technologies, although small scale installations (less than 50 kW) account for around two thirds of accredited capacity and may skew mean load factors towards the lower end.

The load factors for solar PV show a close relationship with average sunlight hours, with patterns repeating in the two series (see Chart 2 below). The load factor for the latest year is lower than expected given the average sun hours but the expected value is well within the interquartile range.

Chart 2: Solar PV load factors and average sun hours, 2016/17-2023/24



In 2023/24, the median load factor for Wind was 20.2 per cent, increasing by 2.9 percentage points since 2022/23, even though average wind speeds over the financial year only saw a marginal increase. However, the median load factor had been especially low last year, the lowest since 2016/17 and one of the lowest on record. As in previous years, the weighted mean of the load factor for wind is notably higher than the median and tends to be more closely related to the average wind speeds. In 2023/34 the weighted mean was 25.3, a small increase on 25.2 in 2022/23. The difference between the median and weighted mean generally reflects that larger wind farms are more efficient, and therefore skew the mean load factor towards higher values.

There is a relationship between annual wind speed and wind load factors, but it is weaker than the relationship between solar PV and sun hours. Load factors for wind vary more than those for solar PV throughout the year, with percentiles spreading further away from the median. It is also worth noting that wind speeds can vary considerably by location and by height above the ground, making an accurate nationwide analysis more difficult to achieve.

The median load factor for hydro in 2023/24 was 40.8 per cent, an increase of 5.7 percentage points on the previous year, despite a small increase in average rainfall. Load factors for hydro tend to vary a lot within the sample. As reported last year, the load factor for 2022/23 was particularly low, the latest load factor is more in line with previous years, for example, average rainfall in 2023/24 was around 18 per cent up on 2021/22, in line with the increase in the median load factor.

The median load factor for anaerobic digestion was 82.3 per cent in 2023/24, which is consistent with the values observed in recent years.

Quarterly load factors

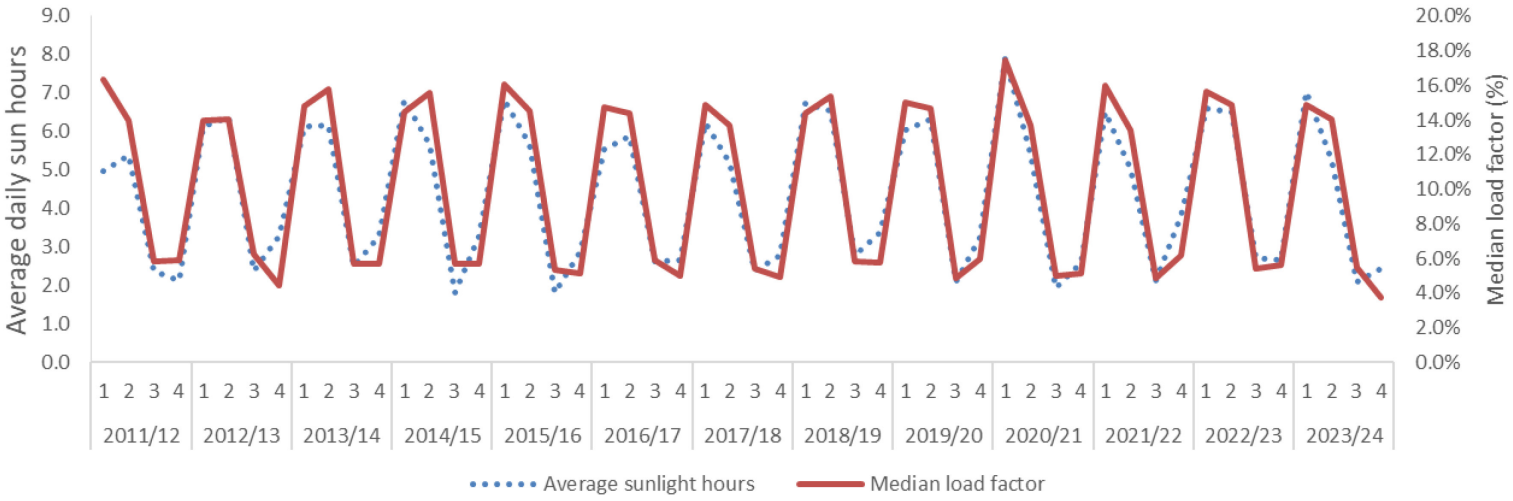
The load factors for solar PV, wind and hydro follow a seasonal pattern due to weather conditions, with high load factors for hydro and wind being associated with wetter, windier autumn and winter months, and solar PV load factors being higher in spring and summer months.

Chart 3 below shows quarterly load factors for Solar PV compared to average sunlight hours. As expected, there is a strong association between sunnier seasons and higher load factors. Solar PV generation is boosted when the sun shines for longer and is weaker in winter months.

In 2023/24, the spring quarter (April-June) had the highest load factor of the year (14.9 per cent), which has often been the case over the previous ten years. The sun's irradiance is at its highest in June. The lowest load factor of 3.8 per cent was observed between October and December; this is the lowest quarterly load factor

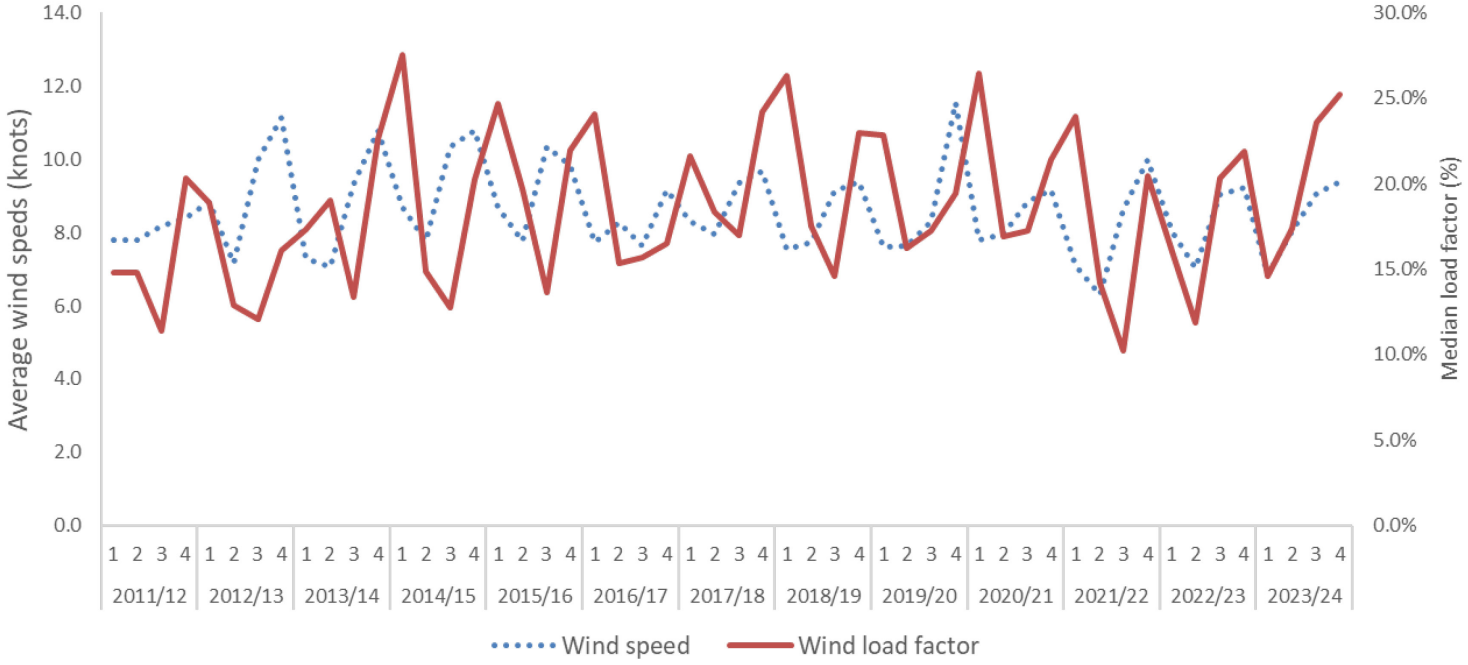
recorded in our time series. However, the sample size is relatively small in this quarter so this figure is subject to revision next year when more data will be available.

Chart 3: Quarterly Solar PV load factors by FIT year



Wind load factors also follow a regular quarterly pattern. Chart 4 displays a line plot of wind load factors across the quarters since 2011 against average wind speed. Except for some discrepancies in the early years, load factors have mirrored wind speed quite closely, reaching their maximum during the winter months in most years. The load factor for the final quarter in this series is high compared to average wind speed but again, the sample size is relatively small and this figure is subject to revision next year.

Chart 4: Average wind load factors and wind speeds by quarter

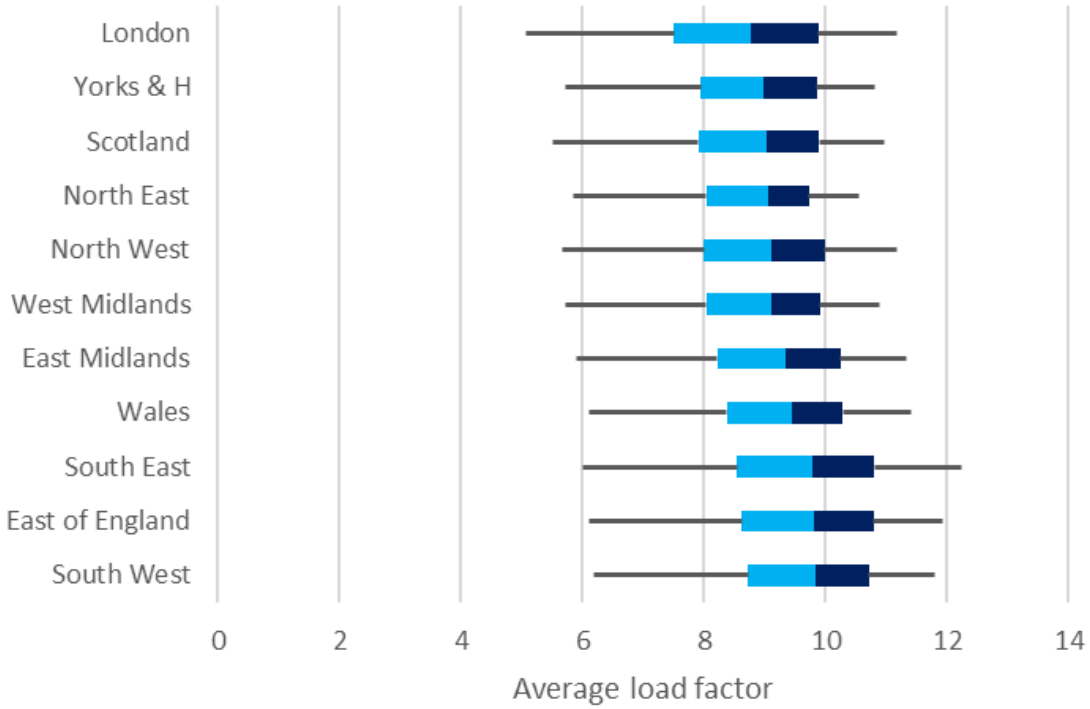


For hydro, wetter seasons are associated with higher load factors, though the relationship between weather and load factors is less strong than it is for wind or solar PV.

Regional Solar PV load factors

Chart 5 below displays the solar PV load factor for Scotland, Wales, and each region of England in Year 14. The median load factor varies across regions, but the distributions are similar from region to region.

Chart 5: Solar PV regional load factors for FiT Year 14 (2023/24).



In 2023/24, South West England **had the highest load factor**, closely followed by the East of England and South East England, all at around 9.8 per cent. The same regions typically have the highest average load factors. London had the lowest median load factor in 2023/24, followed by Yorkshire and the Humber and Scotland. London typically has one of the lowest regional load factors; this may be due to pollution particles settling on the panels, or because panels are shaded by tall buildings nearby. Every region showed a decrease in median load factors when compared to the previous year.

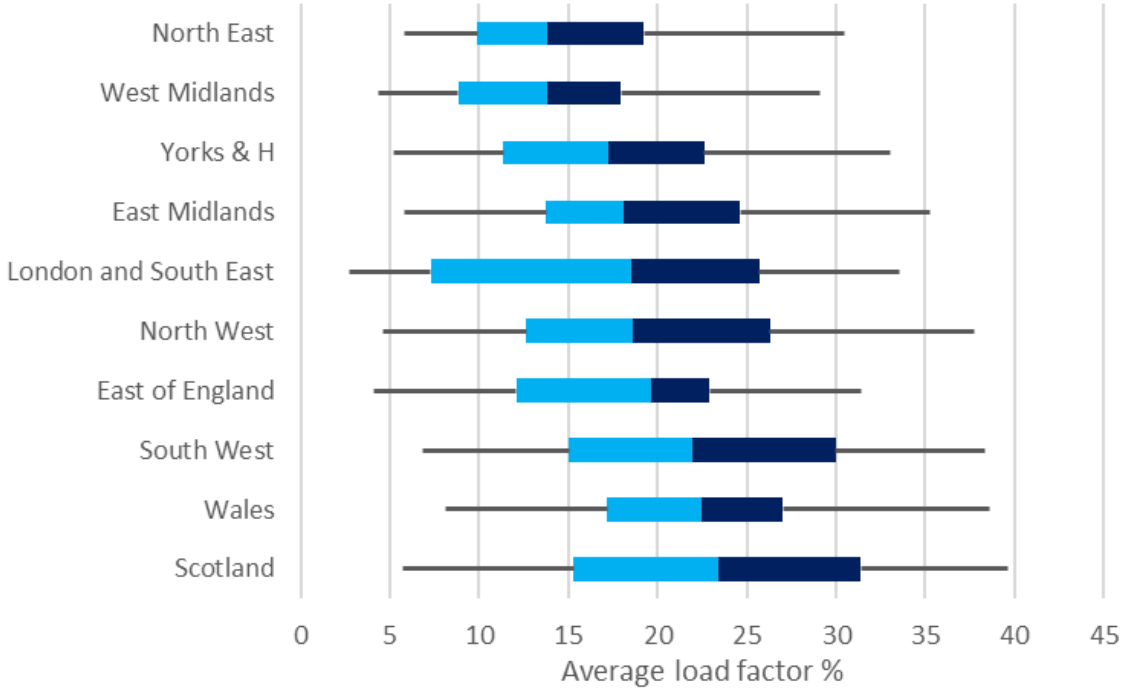
Regional Wind load factors

Chart 6 below shows wind load factors in a box-and-whiskers plot for each region. Data from London and the South East are aggregated due to the low number of installations with a valid load factor in these regions.

In the latest year, **Scotland had the highest Wind median load factor at 23.4 per cent**, followed by Wales and South West. Scotland remained the highest median load factor despite a small decrease compared to last year. Every other region showed an increase in median load factor with the exception of North East England.

Unlike solar PV, load factors for wind appear to follow different distributions across different regions, although the overall spreads are comparable. West-facing coastal regions tend to report higher load factors more frequently than central and easterly regions. Moreover, regions with a lower median load factor are less likely to report extreme load factors. This suggests that wind load factors have a stronger geographic dependence than solar PV load factors.

Chart 6: Wind regional load factors for FITs year 14 (2023/24)



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Land utilised by solar PV – September 2024

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Key headlines

At the end of September 2024, ground-mount solar PV panels covered an estimated **21,200 hectares** (52,000 acres), which is around **0.1 per cent** of the total land area of the UK.

Background

This article publishes the Department's first estimate of the amount of land covered by solar PV panels in the UK. This estimate does not include rooftop solar panels which are placed on buildings. These figures are estimated, more details of how they have been calculated are given below.

Methodology

The estimates are based on:

1. An estimate for the total capacity of ground-mount solar PV
2. The median area covered by solar installations per MW of capacity
3. The total land area of the UK

1. Total capacity of ground-mount solar PV

The total capacity of ground-mount solar is based on the data published in Table 2 of the Department's Solar Deployment report. This is published at:
https://www.gov.uk/government/statistics/solar-photovoltaics-deployment

Table 2 shows that at the end of September 2024, there was a minimum of 7,700 MW of confirmed ground-mount capacity, accounting for 45 per cent of total UK solar PV capacity. This is comprised of the 'FiTs standalone', 'RO ground mounted' and 'CfD ground mounted' lines. FiTs standalone refers to ground-mounted installations smaller than 5 MW capacity which are supported by the Feed-in-Tariff (FiTs) scheme. RO ground-mounted refers to larger projects supported by the Renewables Obligation (RO). Both RO and FiTs are now closed to new entrants. CfD ground-mounted refers to Charity and Triangle installations which are supported by Contracts for Difference (CfD).

In addition, there is around 4,700 MW of capacity from installations that are not supported by FiTs, RO or CfD. These schemes include both ground-mount and rooftop installations and are summarised under 'unaccredited' within Table 2. These installations are registered under the MCS (microgeneration certification scheme), Renewable Energy Planning Database (REPD) and the Department's own survey of major power producers (MPP).

To estimate the ground-mount portion of the installations, we assume that nearly all the MCS installations are rooftop as they are all 50 kW or less. In total they contribute nearly 3,000 MW to the unaccredited figure. For the REPD and MPP installations, a conservative approach has been used here which assumes all of the remaining unaccredited capacity (from the REPD and MPP) is ground-mounted. This means that the estimated total ground-mount capacity is:

$$7{,}700\ \text{MW}\ (\text{ground} - \text{mount in Table 2}) + 4{,}700\ \text{MW}\ (\text{unaccredited}) - 3{,}000\ \text{MW}\ (\text{of which MCS}) = 9{,}400\ MW$$

This equates to 55 per cent of total UK solar PV capacity.

2. The average area covered by projects per MW of capacity

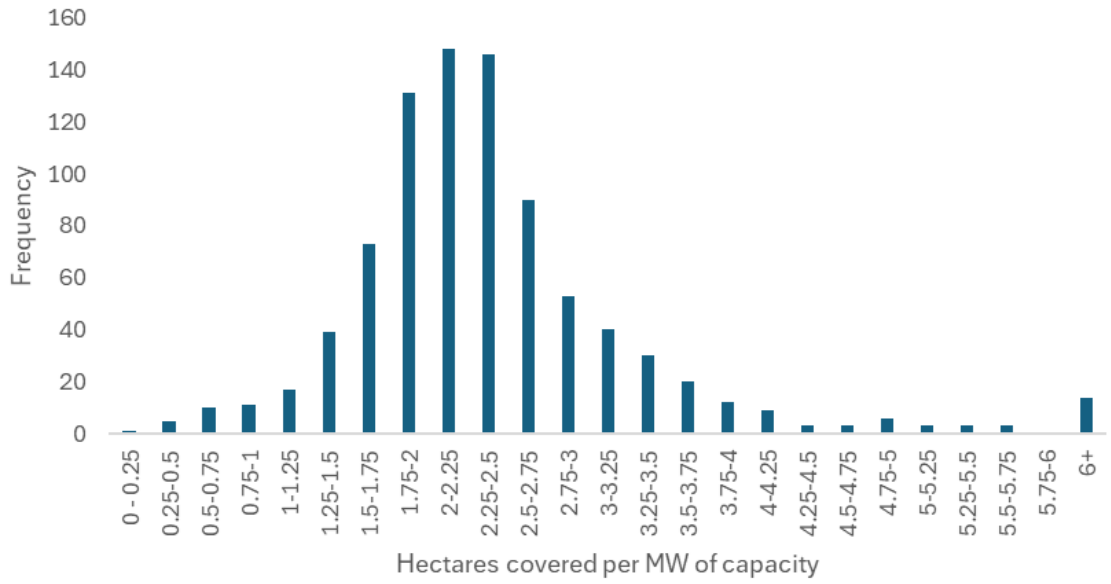
The exact area of many solar plants is not centrally recorded. Therefore, an average land area per MW of capacity has been estimated. The average is based on data from the Renewable Energy Planning Database. This is published at: https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract

The REPD tracks the progress of UK renewable electricity projects over 150kW through the planning system and is sourced mostly from planning authority databases and through direct contact with developers. The minimum threshold for installed capacity was 1MW until 2021, at which point it was lowered to 150kW. This means that projects below 1MW that were going through planning system before 2021 may not be represented in the REPD.

The REPD included 1,187 operational ground-mount solar PV installations at the end of September 2024. Of these, 315 did not have a recorded land use. For each of the remaining 872 sites, the land used per mega-watt of capacity was calculated. For example, if a 10 MW installation covered 25 hectares, it would have a value of 2.5 hectares per MW.

The median footprint of these projects was then taken. This was calculated to be 2.25 hectare (5.6 acres) per MW of capacity. The median was close to the weighted mean of 2.2 hectares per MW, using the mean instead of the median would not have had a material effect on the total land use estimate. The median was chosen as there are some outliers in the data as shown in Chart 1. Just under 60 per cent of the installations fell within 0.5 hectares of the median estimate and 83 per cent fell within 1 hectare:

Chart 1 – Distribution of solar installations – hectares covered per MW of capacity



It should be noted that this estimate captures existing ground-mount installations. Older installations typically have lower efficiency panels generating less power per area. Therefore, this estimate will be higher than our estimate of future installations - 1.6 - 2 hectares (4-5 acres) per MW based on current technology.

3. Total land area of the UK

The total land area of the UK is 24,438,000 hectares. This is published by the ONS[1] in 'Standard Area Measurements for Administrative Areas (December 2023)'. This is published at: https://geoportal.statistics.gov.uk/datasets/c1aca9d405094d90b63e64b29e6c00b7/about

4. Final calculation

$$Total\ land\ area\ utilised = Median\ area\ per\ MW \times Total\ ground\ mount\ capacity$$

$$Total\ land\ area\ covered = 2.25 \times 9400\ MW = 21{,}200\ hectares$$

$$Percentage\ land\ utilised = \frac{Total\ land\ utilised}{Total\ area\ of\ UK} \times 100 = \frac{21{,}200}{24{,}438{,}000} = 0.1\%\ (1\ dp)$$

5. Limitations and sensitivity analysis

There is a degree of uncertainly in this analysis, particularly around the amount of land covered per solar installation and, to a lesser extent, the total number of installations which we have derived from the available administrative data.

These limitations are set out in more detail in the attached Annex.

As ever, we welcome comments and methodological suggestions as to how these estimates might be improved.

[1] Area to mean high water

Annex: Limitations and sensitivity analysis

The figures published here are estimates which come with a degree of uncertainty. The precise size is not known for every solar installation. Furthermore, there is some uncertainty around the total amount of ground-mount capacity. Several checks were carried out to test the robustness of this estimate.

The lower quartile in the data analysed was 1.88 hectares per MW. The upper quartile was 2.7 hectare per MW.

As mentioned in section 1, the ground-mount capacity was calculated as all known ground-mount FiTs, RO and CfD capacity + any unaccredited capacity which is not registered with the MCS.

An upper bound for the total amount of known ground-mount capacity would assume that only the MCS installations recorded as "domestic" are rooftop and all other unaccredited capacity is ground-mount. Upper bound:

$$7{,}700\ \text{MW}\ (\text{ground} - \text{mount in Table 2}) + 4{,}700\ \text{MW}\ (\text{unaccredited}) - 1{,}900\ \text{MW}\ (\text{of which MCS domestic})$$
$$= 10{,}500\ \text{MW} = 61\ \text{per cent of total capacity}$$

A lower bound would assume that only the unaccredited installations that are greater than 5 MW are ground-mount and that all other installations are rooftop. Lower bound:

$$7{,}700\ \text{MW}\ (\text{ground} - \text{mount in Table 2}) + 1{,}600\ \text{MW}\ (\text{unaccredited over 5 MW}) = 9{,}300\ \text{MW}$$
$$= 54\ \text{per cent of total capacity}$$

Using the lower quartile for hectares per MW and the lower bound for ground-mount capacity results in a lower bound of:

$$Total\ land\ area\ covered = 1.88 \times 9{,}300\ MW = 17{,}500\ hectares\ (43{,}000\ acres)$$

The corresponding upper bound is:

$$Total\ land\ area\ covered = 2.70 \times 10{,}500\ MW = 28{,}400\ hectares\ (70{,}000\ acres)$$

Both of these calculations still round to 0.1% of total UK land use.

The total capacity used here includes all known capacity as published in our Solar Deployment report. This includes solar installations reported in our own survey of Major Power Producers (MPP), the Renewable Energy Planning Database (REPD), the Microgeneration Certification Scheme database (MCS) and those subsidised by the Renewables Obligation, Feed-in Tariff, and Contracts for Difference. In addition, several plants from Distribution Network Operators (DNO) embedded capacity registers are included. However, the statistics do not currently include all unsubsidised solar installations below 150 kW capacity that are not recorded in these data sources. We are reviewing data sources to improve coverage and intend to make use of data from other sources when available.

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