Department for Energy Security & Net Zero

Energy Trends

UK, October to December 2024 and 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 annual change from 2023, primary energy basis

(Mtoe basis)	Production	Imports	Exports	Demand
Total energy	**-5.5%**	**-1.6%**	**-8.4%**	**-0.5%**
Coal	**-79%**	**-51%**	**+52%**	**-55%**
Primary oil	**-9.0%**	**+0.7%**	**-4.6%**	**-0.4%**
Petroleum products	**+1.0%**	**+2.7%**	**+1.2%**	**-0.01%**
Gas	**-11%**	**-7.9%**	**-33%**	**-2.8%**
Electricity	**+1.4%**	**+31%**	**+8.9%**	**+1.4%**

Production from renewable technologies in 2024 increased 7 per cent to a record 144.7 TWh, and a record share of 50.8 per cent of electricity generation, passing half of generation for the first time ever in the annual data. Wind generation increased by 2 per cent to a new record high. Bioenergy and solar output also increased to new record highs. With nuclear output stable, **low carbon generation was a record 65.0 per cent for the year.**

Generation from fossil fuels dropped to levels last seen in the 1950s, down 16 per cent and a share of 31.5 per cent due to 15 per cent fall in gas generation and the cessation of coal generation in the latter part of the year.

UK energy production in 2024 dropped 5 per cent to a consecutive record low. Oil and gas production reached a record low as output continues to decline from what is now a mature basin. Nuclear output was stable on last year but production from wind, solar and hydro increased by 3 per cent.

Household energy consumption increased in 2024 on last year's record low, up 4 per cent, potentially due to some easing from the higher energy prices in 2023. **Industrial energy consumption** saw a 2 per cent decrease on last year's record low and consumption is at a fifty-year low. **Transport demand** was level on 2023, with falls in diesel but increases in petrol and jet.

Despite relatively low energy demand, reduced energy production meant **that net import dependency increased to 43.0 per cent in 2024 from 40.8 per cent in 2023** with electricity imports increasing significantly on 2023. Norway and the US were the principal sources of UK's imported energy in 2024.

Data for the final quarter of 2024 broadly mirror trends in the annual data, bar a fall in renewable generation due mainly to low wind speeds in the final quarter of the year. Energy production decreased across nearly all fuels, but energy consumption levels increased slightly, again likely due to lower prices in the final quarter of 2024 compared with 2023.

Section 1: UK total energy

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Key headlines

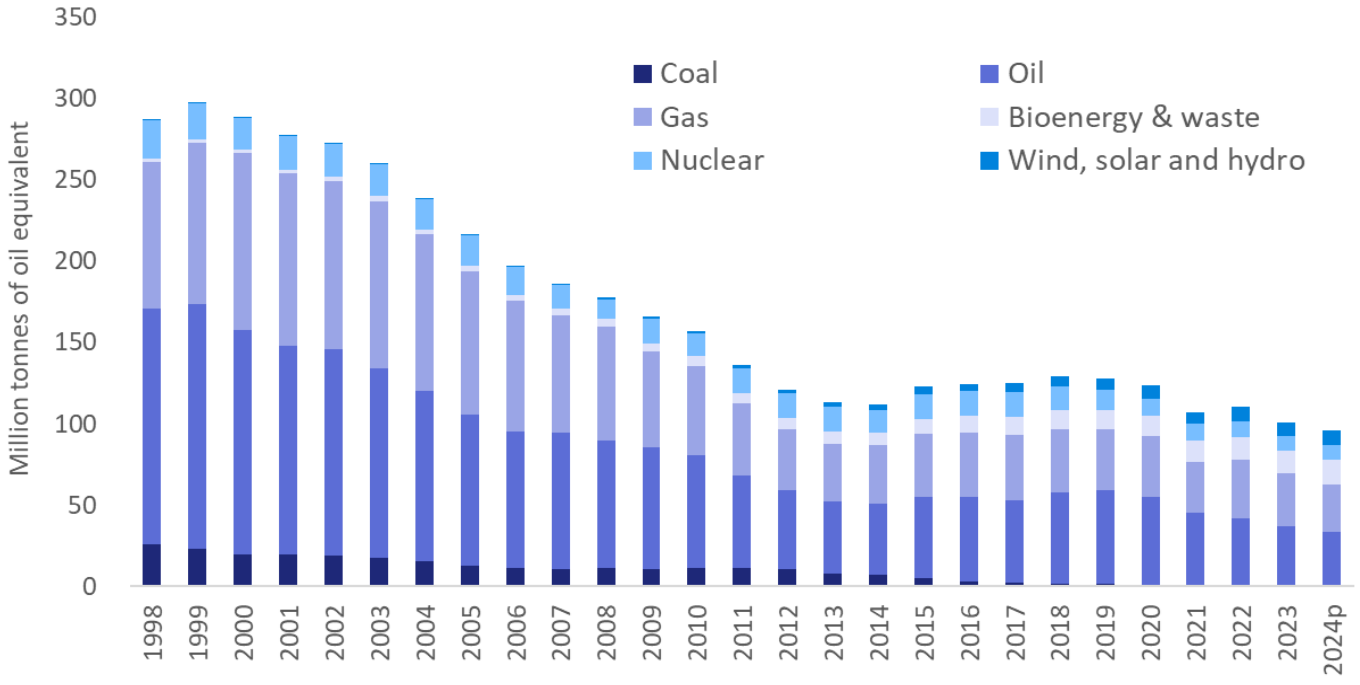
In 2024 total production was 95.7 million tonnes of oil equivalent**, 5.5 per cent lower than in 2023 and at a record low level in the published series,** and 68 per cent lower than in 1999 when UK production peaked**.** Production levels for all fuels except bioenergy & waste, nuclear and wind, solar and hydro are down on 2023, with coal, oil and gas output at record low levels. Production in the fourth quarter of 2024 was 3.3 per cent lower than the same period in 2023; production of all primary fuels fell except for bioenergy & waste.

Energy consumption in 2024 was 1.2 per cent higher than in 2023. Domestic consumption rose by 3.6 per cent, transport consumption rose by 0.9 per cent, with jet fuel demand returning to near pre-pandemic levels. Consumption by other final users also rose by 0.9 per cent but industrial consumption fell by 1.6 per cent to a consecutive record low. On a seasonally and temperature adjusted basis, final energy consumption rose by 1.2 per cent

Energy consumption in the domestic, other final users and transport sectors all rose in the fourth quarter of 2024. Domestic consumption rose by 5.3 per cent, other final users' consumption rose by 1.8 per cent, and transport consumption rose by 1.6 per cent. Industrial consumption fell by 1.4 per cent. On a seasonally and temperature adjusted basis, final energy consumption rose by 2.0 per cent.

In 2024 **dependency on fossil fuels** was 75.0 per cent, down 1.9 percentage points on 2023 and at a record low share in these published data. In contrast **low carbon dependency** was 22.0 per cent in 2024, up 1.3 percentage points on 2023 and at a record high share in these published data.

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

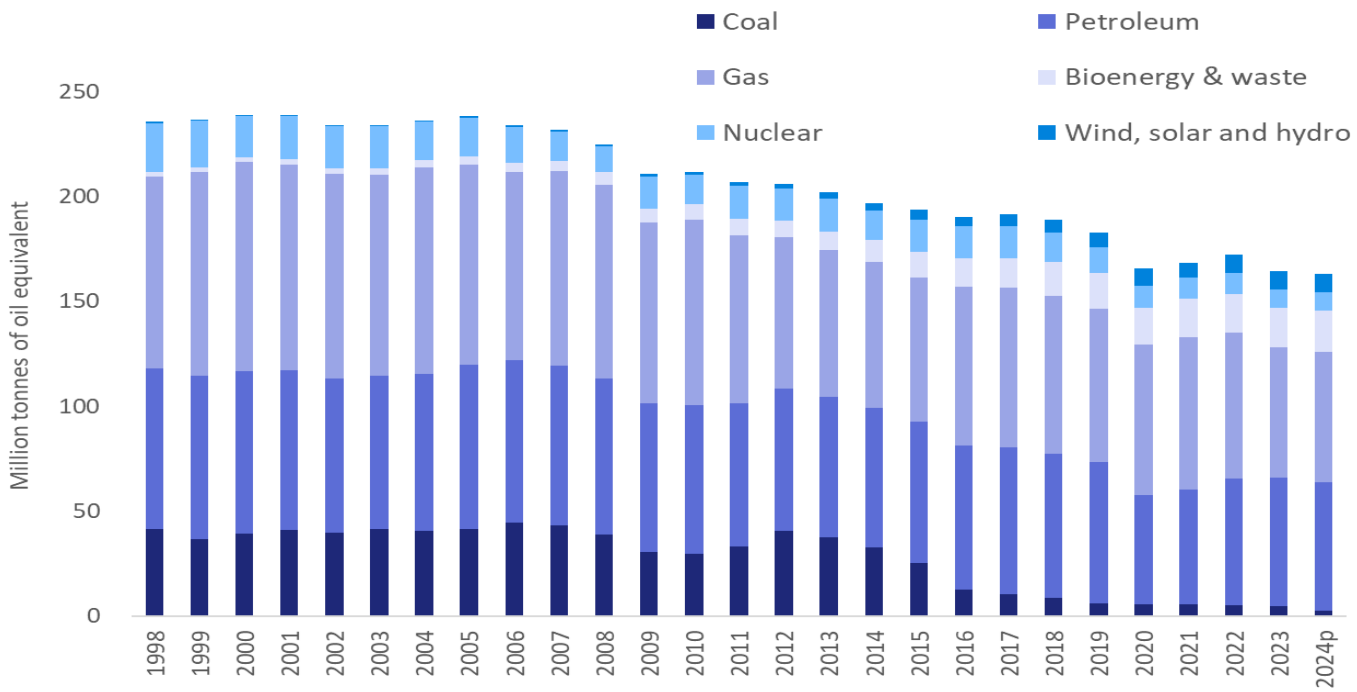


In 2024 total production was 95.7 million tonnes of oil equivalent, 5.5 per cent lower than in 2023 and at a record low level in the published series, and 68 per cent lower than in 1999 when UK production peaked**.** Production levels for all fuels except bioenergy & waste, nuclear and wind, solar and hydro are down on 2023,

with coal, oil and gas output at record low levels. Production of oil fell by 9.1 per cent to a record low level, whilst natural gas fell by 11 per cent also to a record low level. Electricity produced from nuclear rose very slightly due to fewer outages than in 2023. Electricity produced from wind, solar and hydro rose by 2.9 per cent to a record high level, with output from all three technologies up on 2023 levels.

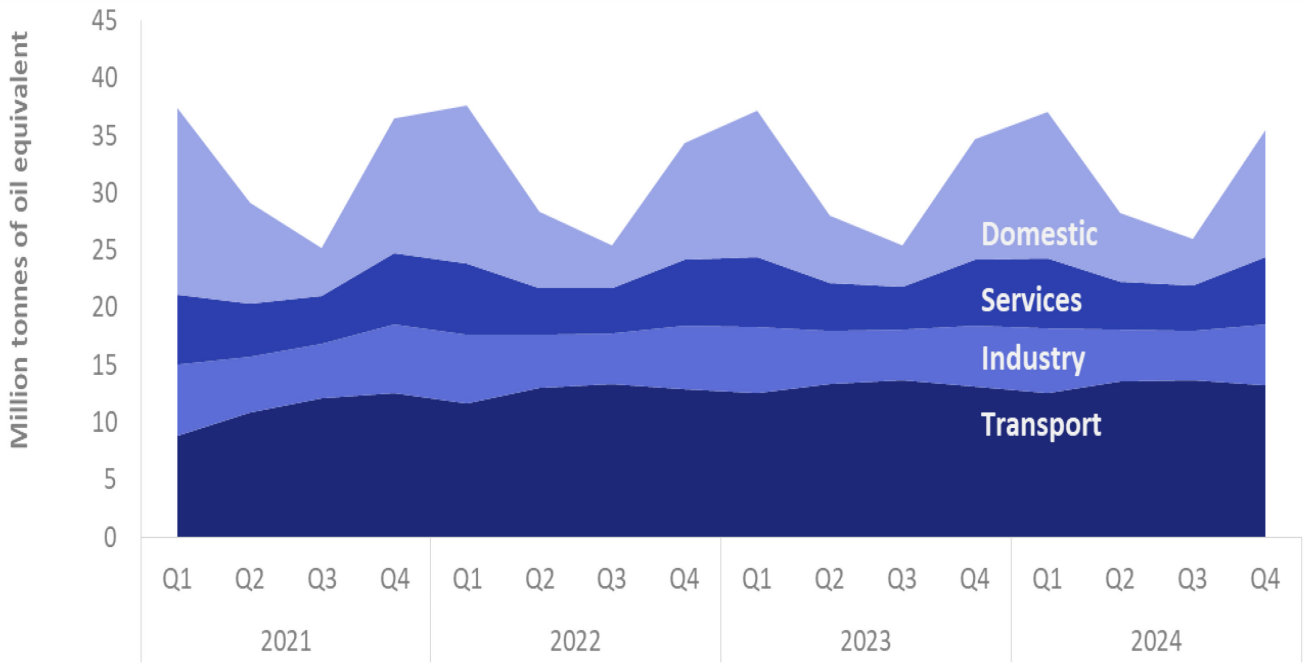
In the fourth quarter of 2024 total production was 24.9 million tonnes of oil equivalent, 3.3 per cent lower than in the fourth quarter of 2023. Production of all primary fuels fell except for bioenergy & waste.

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



In 2024 total inland consumption (this includes not only fuel use by consumers, but fuel used for electricity generation and other transformation) was 166.1 million tonnes of oil equivalent, down marginally on 2023, and down 10 per cent on pre-pandemic (2019) levels (on a seasonally adjusted and annualised rate that removes the impact of temperature on demand). **In the fourth quarter of 2024** consumption rose by 1.0 per cent (on an unadjusted basis) on the fourth quarter of 2023, with gas consumption up 7.5 per cent due to increased demand from electricity generators as a result of reduced low carbon output, as well as increased demand in the domestic, industrial and services sectors.

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



In **2024 total final energy consumption** (excluding non-energy use) was 1.2 per cent higher than in 2023. Domestic consumption rose by 3.6 per cent, with average temperatures in June and September 2024 being notably cooler than a year earlier. Transport consumption rose by 0.9 per cent, with jet fuel demand returning to near pre-pandemic levels, and other final users consumption also rose by 0.9 per cent. Industrial consumption fell by 1.6 per cent to a record low level in the published time series.

In the fourth quarter of 2024 total final energy consumption was 2.3 per cent higher than in the fourth quarter of 2023 with average temperatures broadly similar to last year. Domestic consumption rose by 5.3 per cent, other final users consumption rose by 1.8 per cent, and transport consumption rose by 1.6 per cent. Industrial consumption fell by 1.4 per cent to the lowest level recorded for the fourth quarter of the year in the published time series.

Section 2: Coal and derived gases

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Key headlines

Total coal demand in 2024 fell to a record low of 2.1 million tonnes, 54 per cent lower than in 2023, mainly due to a 55 per cent fall in coal for electricity generation The last remaining coal-fired power station - Ratcliffe-on-Soar - closed on 30 September 2024. Coal use has been phased out as electricity generation now favours renewables, gas and nuclear.

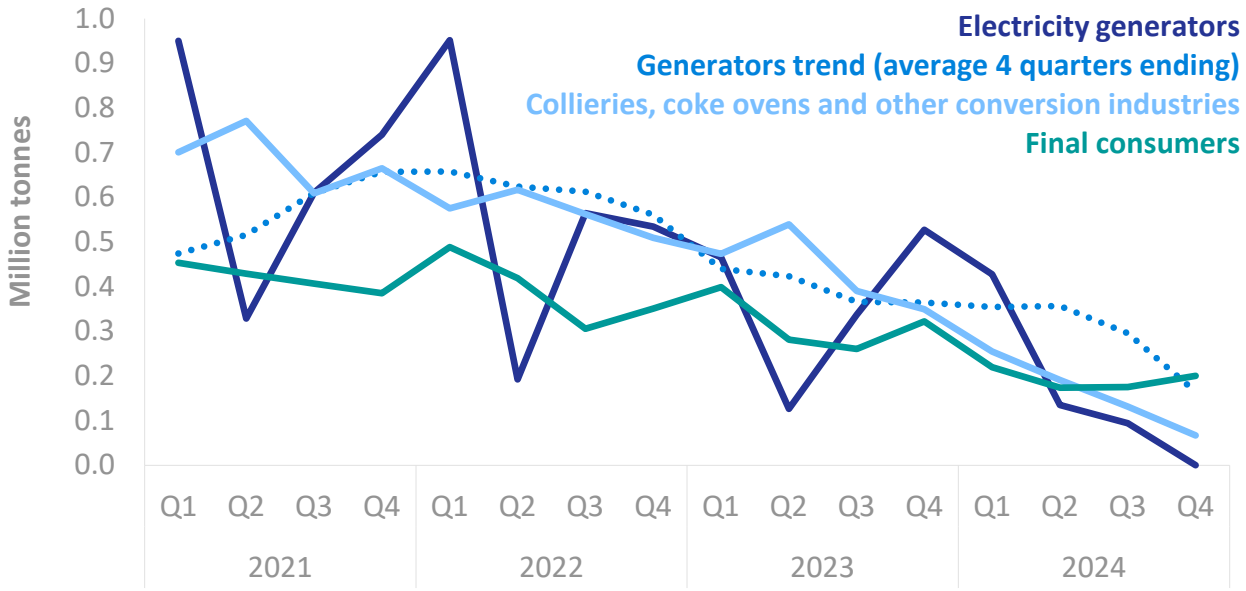
Coal production in 2024 fell to a record low of 107 thousand tonnes, down 79 per cent compared with 2023. With the last large surface mine Ffos-y-Fran closing at the end of November 2023, there is currently no large-scale surface mining in the UK. In the last ten years UK coal production has fallen by 99 per cent.

Coal imports fell to 1.8 million tonnes in 2024, 49 per cent down compared with 2023. Major importers were Colombia (37 per cent share), the EU (26 per cent) and South Africa (17 per cent).

In the fourth quarter of 2024, demand fell 78 per cent to 0.3 million tonnes. There was no coal-fired power station generation and there was no coke oven gas production as all coke ovens had closed. **Imports in the fourth quarter of 2024 fell to 303 thousand tonnes**, 68 per cent down on Q4 2023.

Total coal demand in 2024 fell to a record low of 2.1 million tonnes, 54 per cent lower than in 2023. Much of this decrease was due to the 55 per cent fall in coal used in electricity generation. The last remaining coal-fired power station - Ratcliffe-on-Soar - closed on 30 September 2024. Coal use has been phased out as electricity generation now favours gas, nuclear and renewables. Coal use has declined since the early 1970s as more fuels, principally gas, entered the market. Coal consumption has fallen by 96 per cent since the end of 2014.

Chart 2.1 Coal Consumption (Energy Trends Table 2.1)

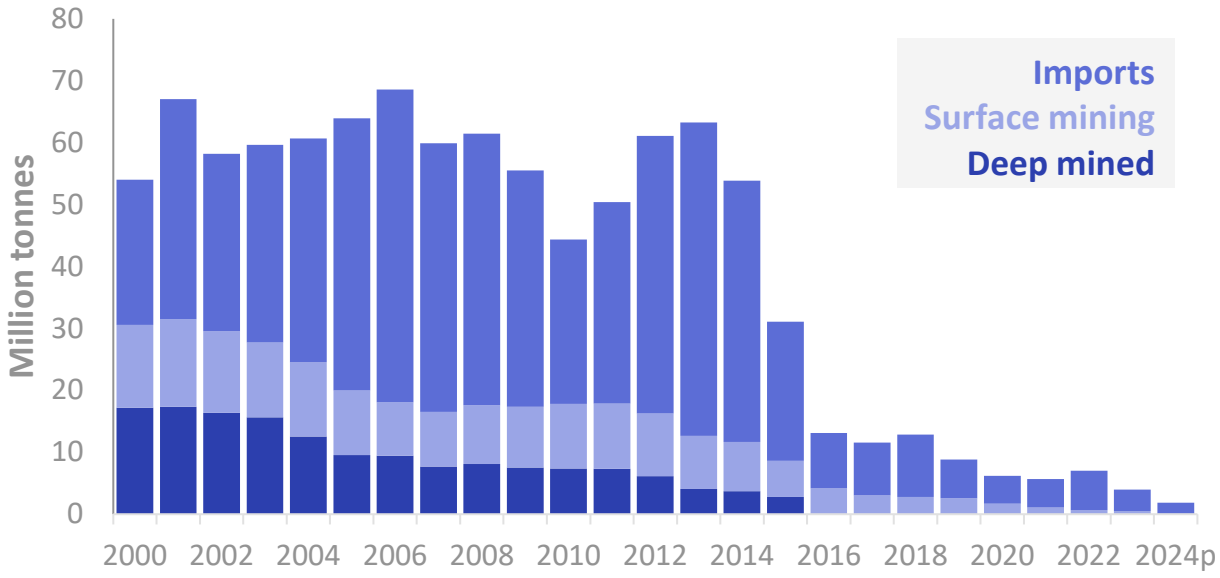


There was no coal-fired generation in the fourth quarter of 2024. The last coal-fired power plant - Ratcliffe-on-Soar - closed on 30 September 2024. Coal use has been phased out as electricity generation now favours gas, nuclear and renewables.

Domestic coal production has fallen steadily because of coal mine closures and reduced demand. **In Q4 2024, UK coal production fell to 37 thousand tonnes**, a 75 per cent fall compared to Q4 2023. This was due to

the last large surface mine Ffos-y-Fran closing at the end of November 2023. There is currently no large-scale surface mining in the UK. Production was down 79 per cent as a whole for 2024 compared to 2023.

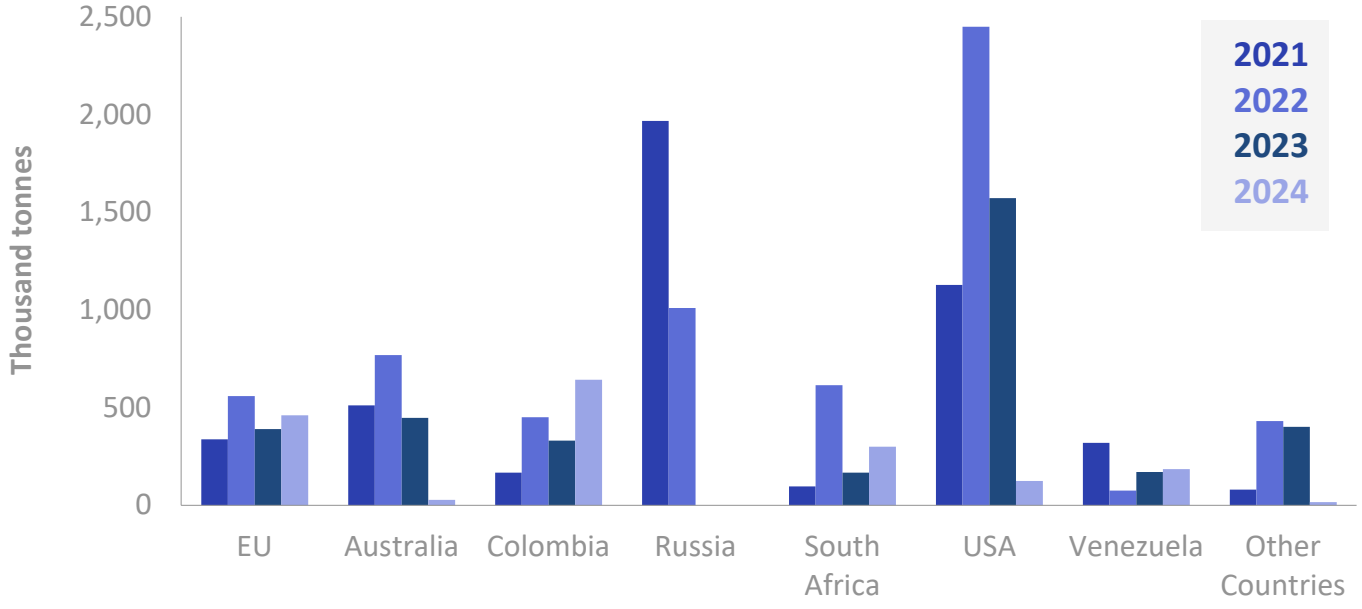
Chart 2.2 Coal Supply (Energy Trends Table 2.1)



Coal imports fell to 1.8 million tonnes in 2024, 49 per cent down compared with 2023. Volumes remained historically low due to a steep fall in UK demand for coal. Imports had peaked at 50.6 million tonnes in 2013. In 2024 Colombia was the largest exporter of coal to the UK with a share of 37 per cent. This was followed by European Union with 26 per cent and South Africa with 17 per cent.

In Q4 2024, coal imports fell to 303 thousand tonnes, 68 per cent down on Q4 2023. Colombia (55 per cent), the European Union (24 per cent) and Venezuela (21 per cent) accounted for all imports apart from a tiny proportion. The UK banned Russian coal imports in August 2022. This reflects a decreasing reliance on Russian energy in line with that seen for both oil and gas.

Chart 2.3 Coal Imports (Energy Trends Table 2.4)



Section 3: Oil and oil products

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Key headlines

Primary oil production fell to 30.7 million tonnes in 2024 (down by 9.1 per cent), the lowest level since North Sea production was established in the 1970s. Subsequently exports fell by 1.3 million tonnes (-4.7 per cent) to a record low of 26.3 million tonnes.

Total net imports reached a record high of 31.6 million tonnes (up 7.2 per cent).

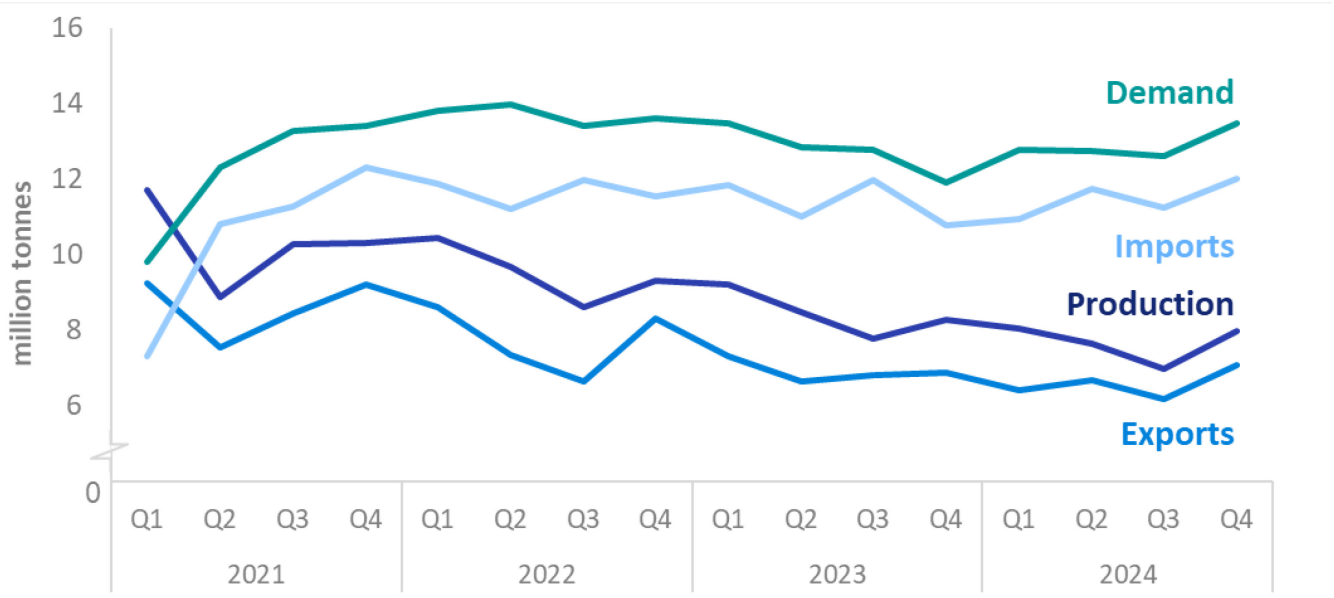
Broadly, refinery production, trade, and demand for petroleum products were stable in 2024 compared to the year before. More interestingly, demand for petrol and jet fuel were each around pre-pandemic demand for the first time, but diesel demand was down because fewer miles are being driven.

In the final quarter of 2024 primary oil production was down by 3.7 per cent compared to the year before. Imports increased by 12 per cent to meet a 13 per cent increase in refinery demand (and production). Product demand and exports remained stable, meaning imports were down by 8.1 per cent.

Oil stocks increased by 1.6 million tonnes (17 per cent) at the end of 2024 compared to 2023, of which 1.3 million tonnes was an increase in product stocks. There was a substantial uplift in stocks held abroad for the UK since the annual baseline rollover in July saw an increase in the UK stocking obligation.

Primary oil production fell to a record low since North Sea production began in the 1970s, down by 9.1 per cent in 2024 compared to 2023 to reach 30.7 million tonnes. Production has continued to decline since a recent peak of 52.9 million tonnes in 2019 and in 2024 was 42 per cent below that peak. Similarly, exports have been in decline since 2019 and in 2024 were down by 4.7 per cent compared to 2023, reaching a new record low of just 26.3 million tonnes.

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



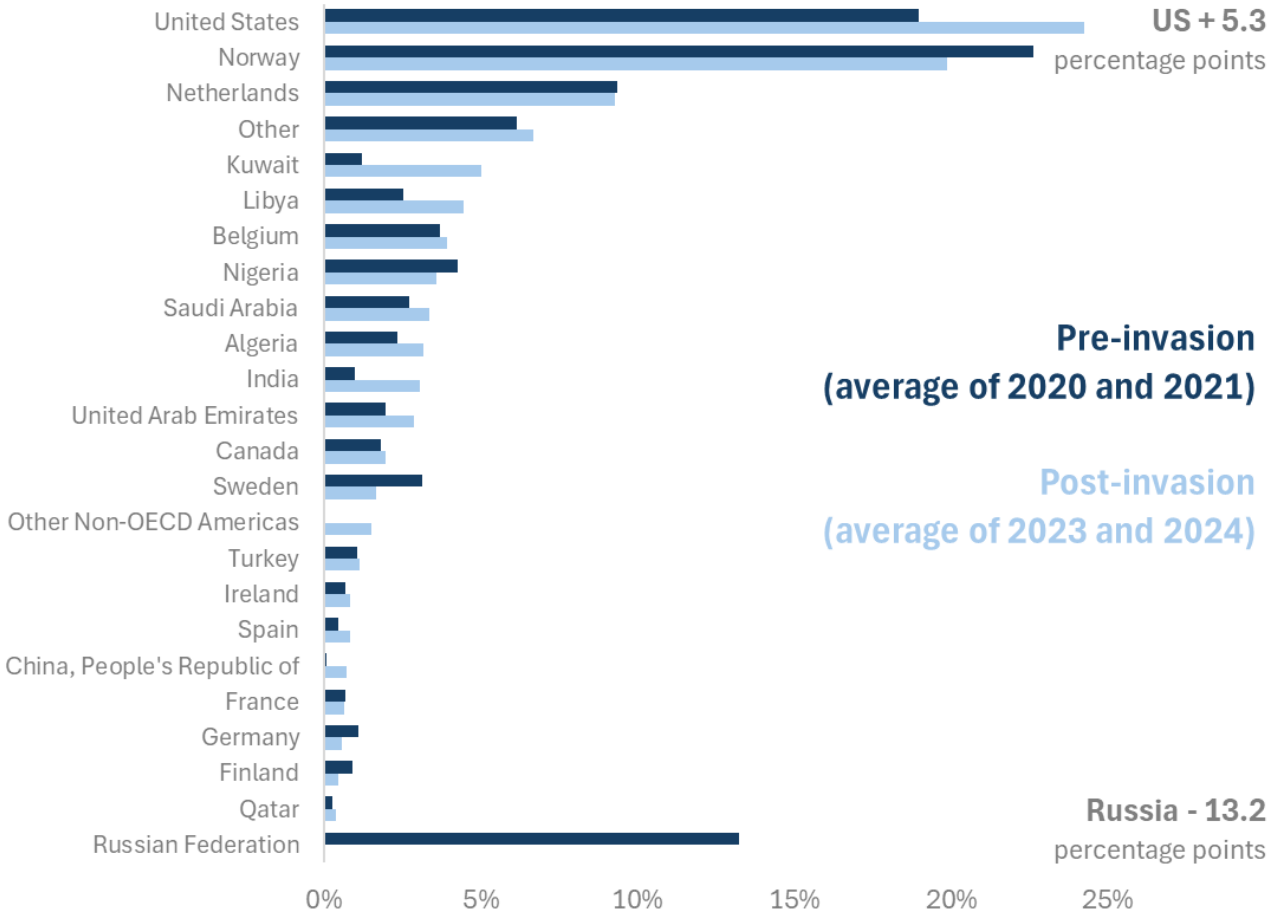
In the final quarter of 2024 primary oil production was 3.7 per cent lower compared with the same period in the previous year. A sharp uptick in exports of feedstocks saw total primary exports increase by 3.2 per cent, but crude oil and natural gas liquid (NGL) exports were down by 1.6 per cent compared to the year before. Imports increased by 12 per cent to meet a 13 per cent increase in refinery demand.

Total net imports reached a record high of 31.6 million tonnes (up 7.2 per cent, or 2.1 million tonnes), with a 2.2 million tonne increase in net imports of primary oils and 0.5 million tonne increase in net imports of petroleum products. This overall total was offset by a 0.6 million tonne fall in net imports of process oils.

Total oil imports increased in 2024 by 1.4 per cent compared to 2023 with the top three sources being the United States, Norway and the Netherlands. The United States and Norway together accounted for two-thirds of crude oil imports, and the Netherlands made up one fifth of product imports.

Typically import sources remain fairly stable year on year, but two events in the last 10 years have changed the way the UK trades to meet demand for oil. Prior to the illegal invasion of Ukraine in early 2022, Russia was a crucial supplier of road diesel and heavy feedstocks to the UK, meeting a fifth of diesel demand (and a third of diesel imports) on average in 2020 and 2021. However, when Russia invaded Ukraine many companies self-sanctioned and ceased importing oil from Russia immediately. The UK introduced sanctions in December 2022. Chart 3.2 shows the changing patterns of trade before and after the invasion, with Russia dropping from a 13 per cent share of all imports (around 8.7 million tonnes in 2020 to 2021) to zero after the ban came into effect (in 2023 and 2024).

Chart 3.2 Share of UK total oil imports from top sources pre- and post-invasion of Ukraine (Energy Trends Table 3.14)



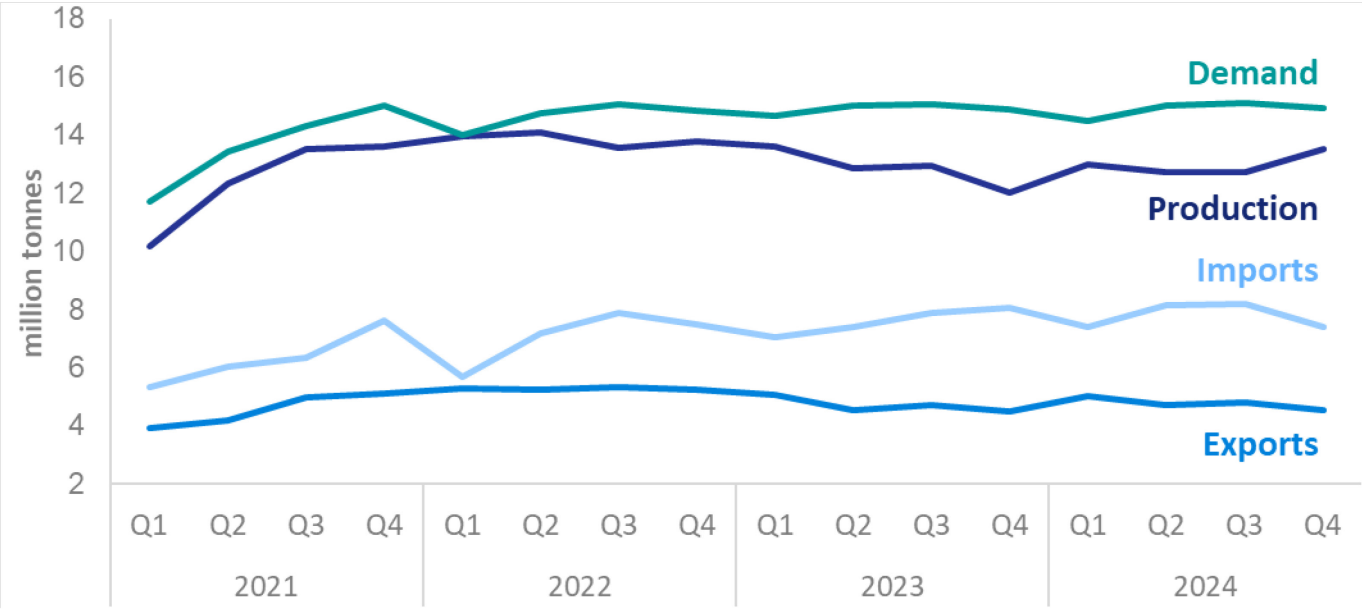
Note: Due to companies self-sanctioning throughout 2022, Chart 3.2 show pre- and post-invasion excluding that period with two-year averages from 2020-2021 and 2023-2024.

To compensate for the loss in supply from Russia the UK began trading with new partners. Imports from Other Non-OECD Americas grew in two years from zero to 1.5 million tonnes in 2024 (a 1.9 per cent share). Similarly, imports from China grew from less than 0.1 per cent average in 2020 and 2021, to an 0.7 per cent (0.5 million tonnes) on average in 2023 and 2024. Most imports from China are of jet fuel, but China also supplies just under 10 per cent of UK biodiesel imports and just over 60 per cent of sustainable aviation fuel imports. Imports from Algeria (all crude) doubled between 2019 and 2024, rising to more than three per cent of a total oil import share.

Two other main changes seen in Chart 3.2 are the increasing share of imports from the US and decreasing share from Norway. Historically, Norway was the UK's primary source for crude oil imports until the US lifted its ban on crude exports in 2015. After five years of rapid growth, imports of crude from the US have grown sharply to rival and even exceed those from Norway since 2020, gaining a further 5.3 per centage points since (but not because of) the invasion.

Due to the changes in patterns of oil import suppliers since the ban on Russian oil, Energy Trends Table 3.14 has been updated to reflect new suppliers and drop countries with a diminishing share. There have not been any imports from Russia since November 2022, so this country was removed from January 2023 onwards. Finland and Qatar were also removed due to reduced import shares (each less than 0.5 per cent in 2023-2024). Three new countries replaced them, with the table now showing data for Algeria, Other non-OECD Americas, and China, from the start of 2023.

Chart 3.3 Production and trade of petroleum products (Energy Trends Table 3.2)



In Quarter 4 2024, indigenous production of petroleum products increased by 13 per cent on the same period in 2023, an increase of 1.5 million tonnes driven by large increases of diesel, jet fuel and fuel oil. Exports and demand remained stable, so with the higher production imports decreased by 8.1 per cent.

Demand in 2024 was stable compared to 2023 (down just 0.2 per cent) and remains suppressed compared to 2019 (down 12 per cent). However, since 2019 transport demand has been steadily increasing:

Petrol demand in 2024 fully recovered to pre-pandemic levels for the first time since the end of travel restrictions, up by 0.5 per cent in 2024 compared to 2019 (and up 3.3 per cent compared to 2023).

Jet demand increased by 8.0 per cent compared to the year before and at 11.9 million tonnes had climbed to within one percentage point of pre-pandemic demand of 12.1 million tonnes in 2019.

Diesel demand was down by 4.9 per cent compared to 2023, and by nearly a fifth compared to 2019 because fewer miles are being driven in diesel vehicles for work purposes. See Energy Trends special article for further details.

UK oil stocks continue to exceed our treaty obligation to hold 90 days of net imports under membership of the International Energy Agency, with stocks up by 1.6 million tonnes in December 2024 compared to the year before following the annual baseline rollover in Quarter 3. Primary stocks at the end of 2024 were 5.5 million tonnes, with a further 5.8 million tonnes of product stocks. Around 85 per cent of all stocks were held in the UK.

Section 4: Gas

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Key headlines

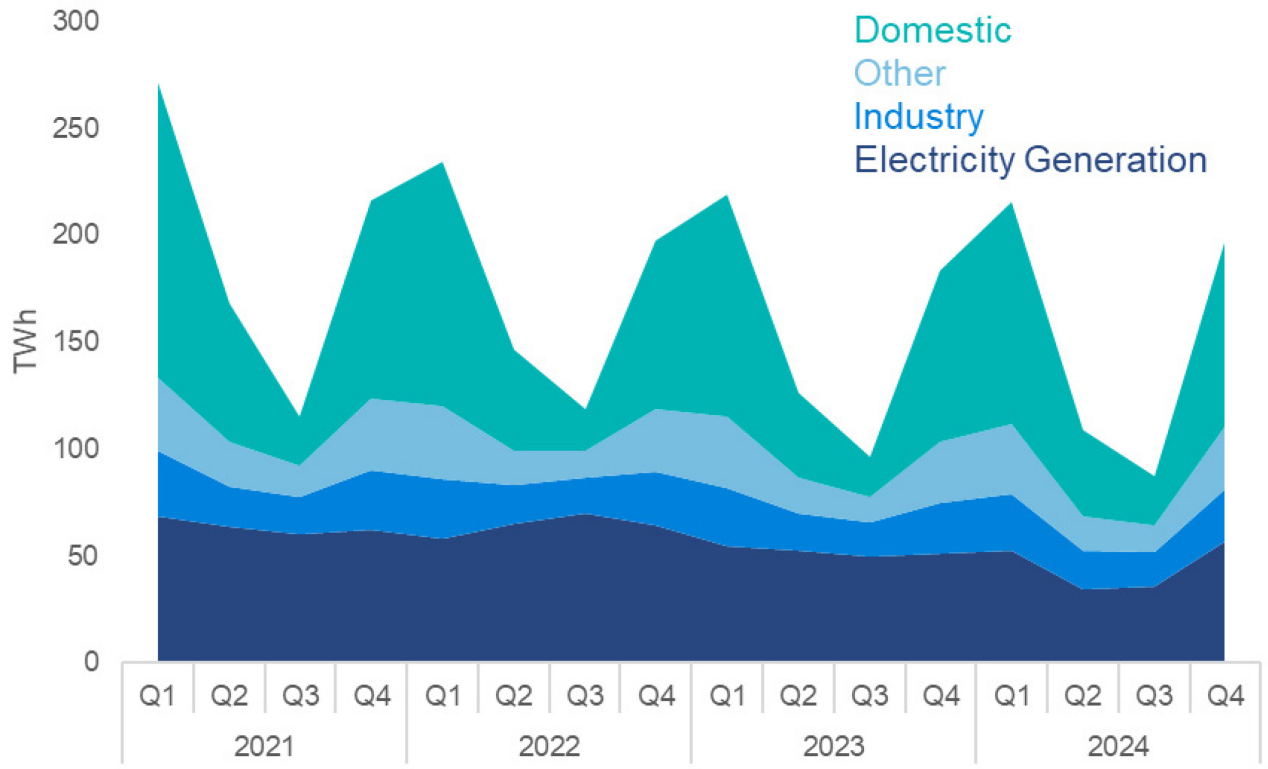
In 2024, gas demand fell by 2.8 per cent on 2023, again at similar levels to those last seen in the early 1990s. The fall in demand was driven by record low gas used for electricity generation falling 14 per cent on 2023, a low last seen in the mid-1990s. Demand by final consumers increased by 2.8 per cent, with domestic (household) demand increasing by 4.6 per cent but remaining below recent (2017-2021) averages.

Imports and exports were down as trade returns to 'typical' levels. Imports and exports were down 7.9 and 33 per cent respectively. The decline in imports was driven by LNG (liquified natural gas) imports which almost halved. Both decreases indicate a return to typical levels, last seen before the Russia- Ukraine conflict, which has impacted trading patterns since 2022.

Gas production fell by 11 per cent in 2024 compared to 2023, the lowest output on record due to expected natural decline. Production remained equivalent to half of demand in 2024 (due to notably low demand).

Trends in the final quarter of 2024 largely mirrored the annual data, with production dropping 4.6 per cent and demand from final consumers continuing to increase. Unlike earlier in the year however, demand for gas for generation increased on the same quarter last year, up nearly 10 per cent.

Chart 4.1 Demand for natural gas (Energy Trends Table 4.1)

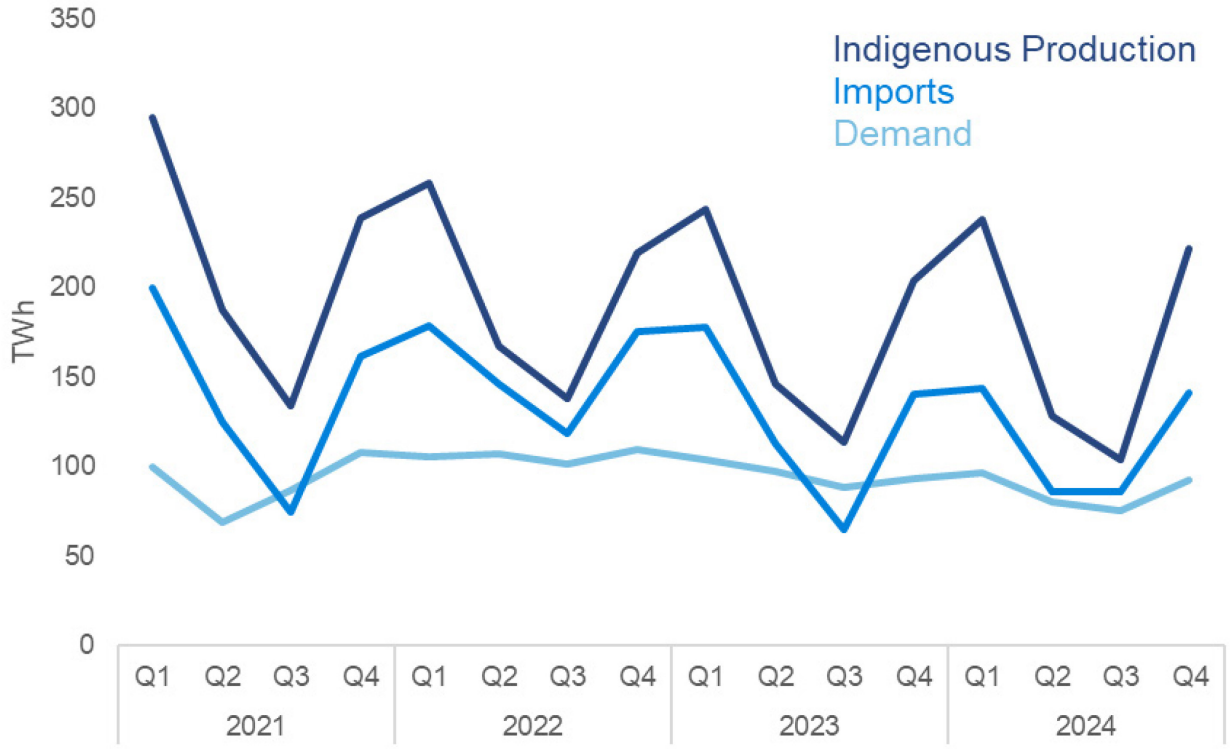


Gas demand fell to the lowest level since the early 90s in 2024 down 2.8 per cent on 2023. This was driven by a substantial drop in demand for gas for electricity generation. Gas demand for electricity generation fell to the lowest level since 2013, down 14 per cent as a result of lower electricity demand and increased imports of electricity (see Chapter 5 for more information).

Conversely demand for final consumption increased by 2.8 per cent. This was driven by an increase in domestic (household) consumption which was up 4.6 per cent in 2024 compared to 2023, after higher costs and temperatures saw lower demand in 2022 and 2023. Industrial consumption remained stable but low, following the trend of the past 5 years. Other sectors, including public administration and commercial also remained stable.

Demand in Quarter 4 2024 increased by 7.2 per cent compared to the same quarter in 2023. Domestic (household) demand increased by 7.5 per cent with similar temperatures indicating this might be a recovery following higher prices in the previous years. Industrial consumption was stable on Quarter 4 2023, whilst demand by other final users (such as services and public administration) increased by 3.6 per cent.

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

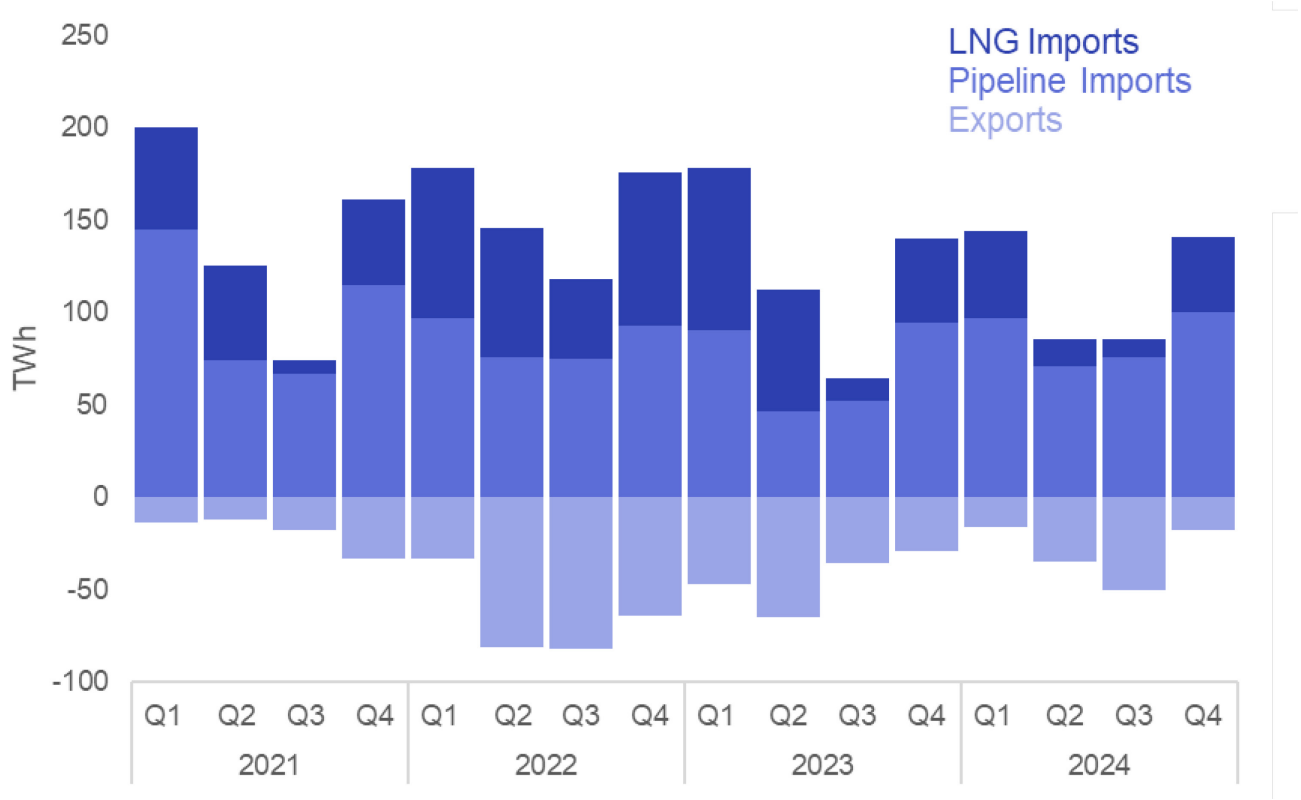


Imports and exports fell in 2024 compared to the 2023 indicating a return to typical pre-2022 trading patterns. Imports fell by 7.9 per cent, 11 per cent down on the pre-2022 5-year average. Exports fell by 33 per cent just above the pre-2022 average. The drop in exports was largely the result of reduced exports to Belgium which fell by 56 per cent.

Gas production was down 11 per cent in 2024 compared to 2023; UK gas production was equivalent to half of demand in 2024. Production has been equivalent to around half of demand for over a decade and stayed at 50 per cent in 2024, despite the decrease in production, due to low demand.

In Quarter 4 2024 production fell by 4.6 per cent, imports were stable on Quarter 4 2023 whilst exports fell by 38 per cent compared to the highs in the previous year.

Chart 4.3 Imports of gas by origin (Energy Trends Table 4.3)



Liquified natural gas (LNG) imports fell in 2024, down 47 per cent. Norway remained the UK's largest import source of natural gas (and provided almost all pipeline imports), accounting for 76 per cent of imports and equivalent to 50 per cent of demand. LNG imports almost halved in 2024 compared to highs in 2023 and made up a quarter of total imports.

The US remained the largest source of LNG after overtaking Qatar for the first time in 2022. Imports of LNG from the US made up 68 per cent of LNG imports, 17 per cent of total imports and 11 per cent of demand. Qatari imports dropped by 71 per cent in 2024 but still remained the second largest source of LNG. Other LNG sources made up a quarter of LNG imports in 2024.

Section 5: Electricity

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Key headlines

Total electricity demand in 2024 increased slightly for the first time since 2021, to 318.7 TWh (up 0.6 per cent from last year), as domestic consumption and consumption by other final users, including commercial use, increased for the first time since 2020 and 2021 respectively. Domestic consumption rose by 3.5 per cent to 95.8 TWh, while consumption by other final users, including commercial use, rose by 2.0 per cent to 81.0 TWh. Conversely, industrial consumption fell by 0.6 per cent to 85.7 TWh, the lowest level since the mid-1980s.

Net imports rose by 40 per cent to reach a record 33.4 TWh in 2024. High net imports continued to reduce the need for UK generation. After falling to the lowest value since 1983 last year, total electricity generation fell further by 2.6 per cent to 285.0 TWh.

Renewable generation rose by 6.5 per cent to a record 144.7 TWh in 2024, also achieving a record share of 50.8 per cent of total UK generation. This is the first year where renewables share of generation has exceeded 50 per cent. Electricity generated from bioenergy rose by 18 per cent to 40.1 TWh, while solar increased by 6.5 per cent to 14.8 TWh and wind up by 2.1 per cent to 84.1 TWh. Meanwhile, generation from fossil fuels fell by 16 per cent to 89.7 TWh, reaching a level last seen in the 1950s. With stable nuclear output, **low carbon generation reached a record 65.0 per cent in 2024.**

Quarterly trends in final consumption broadly mirrored annual trends, as consumption by end users rose by 1.1 per cent in Quarter 4 of 2024 compared to Quarter 4 of 2023. Domestic consumption rose by 2.9 per cent and consumption by other final users, including commercial use, rose by 0.5 per cent. Industrial consumption fell by 0.5 per cent. In contrast to annual trends, renewable generation fell by 6.4 per cent from Quarter 4 of 2023 to Quarter 4 of 2024, to 37.5 TWh due to less favourable conditions for generation.

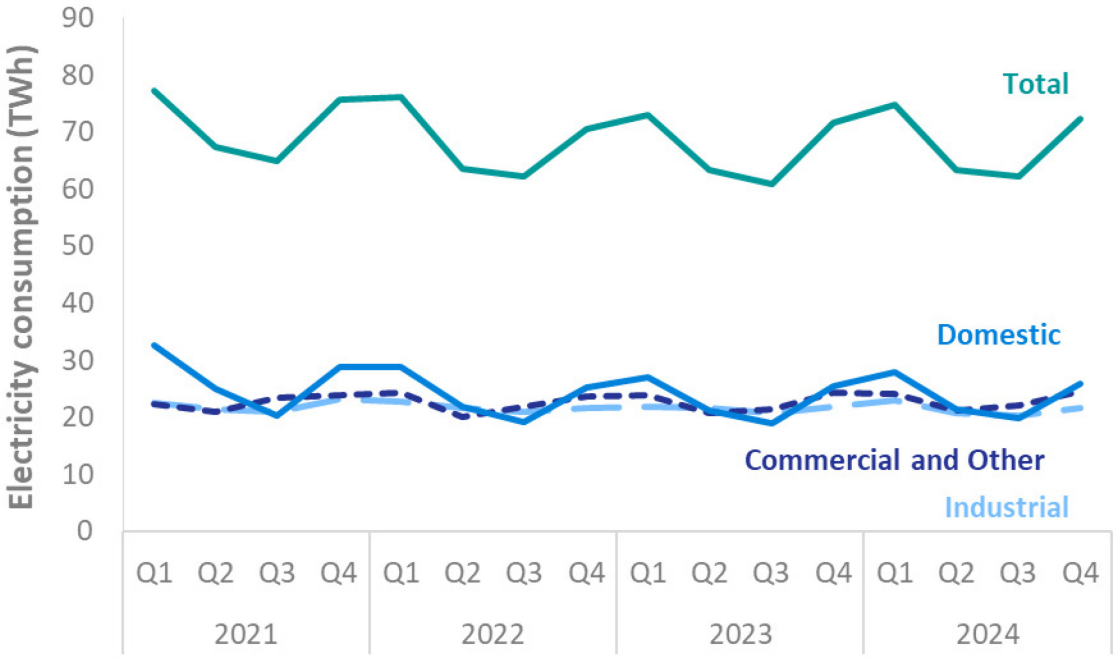
Total electricity demand in 2024 increased slightly for the first time since 2021, to 318.6 TWh (up 0.6 per cent from last year). Similarly, final consumption by end users also rose for the first time since 2021, by 1.6 per cent to 273.4 TWh. This may be due in part to some easing in electricity prices on the levels seen in 2023.

Domestic consumption and consumption by other final users, including commercial use, both showed some recovery, after falling to their lowest levels since the late 1980s last year. Domestic consumption rose by 3.5 per cent to 95.8 TWh, while consumption by other final users, including commercial use and transport, rose by 1.8 per cent to 91.9 TWh. Conversely, industrial consumption (including iron and steel) fell further by 0.6 per cent to 85.7 TWh, reaching a new record low value since the mid-1980s.

Quarter 4 of 2024 saw total UK electricity demand fall by 0.4 per cent compared to the same period in 2023, reaching 84.4 TWh with fewer losses and less use by energy industry. Consumption by end users rose by 1.1 per cent from Quarter 4 of 2023 to 72.4 TWh in Quarter 4 of 2024, despite both quarters having similar average temperatures. This may be due to colder temperatures in December, when most demand for electricity used for heating usually occurs but a lower energy price cap might also have contributed.

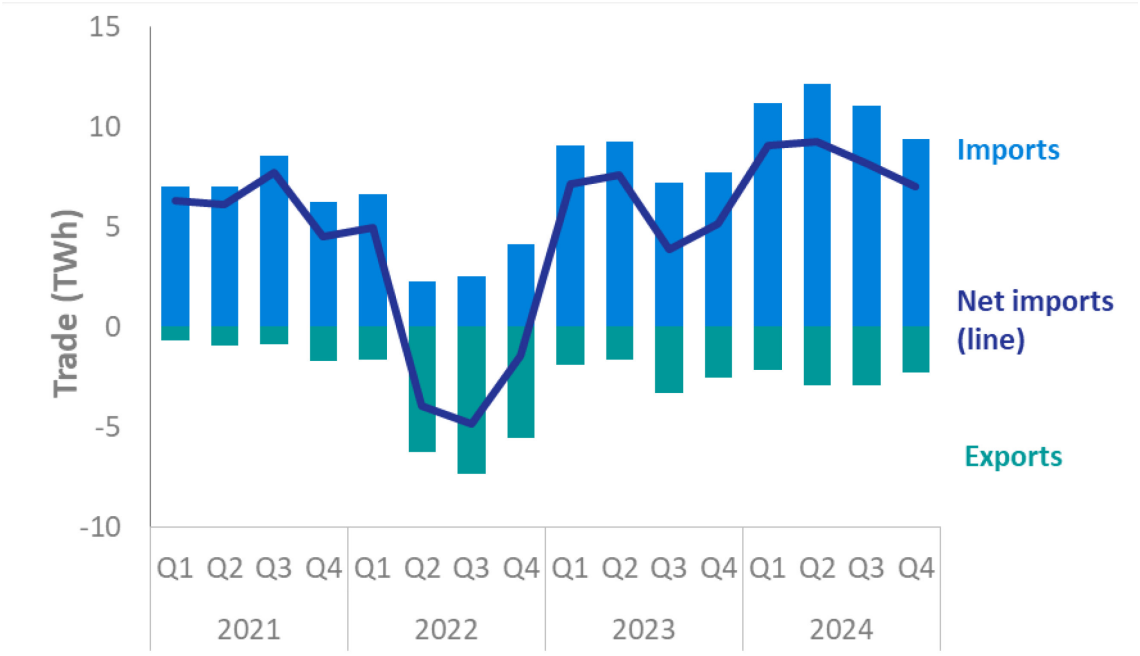
Domestic consumption rose by 2.9 per cent from to Quarter 4 of 2023 to 26.2 TWh in Quarter 4 of 2024. Similarly**,** consumption by other final users, including commercial use, rose by 0.5 per cent to 24.5 TWh. Industrial consumption fell by 0.5 per cent to 21.7 TWh.

Chart 5.1 Electricity consumption by sector (Energy Trends Table 5.2)



Despite a slight increase in total demand, total electricity generation fell 2.6 per cent to 284.9 TWh in 2024, reaching the lowest level since 1983. This was due to a 40 per cent rise in net imports to a record 33.4 TWh, due to favourable price differentials across the interconnectors. After reaching a record high in 2023, imports rose by a further 31 per cent to reach a new record high of 43.7 TWh.

Chart 5.2 Electricity trade and net imports (Energy Trends Tables 5.2 & 5.6)

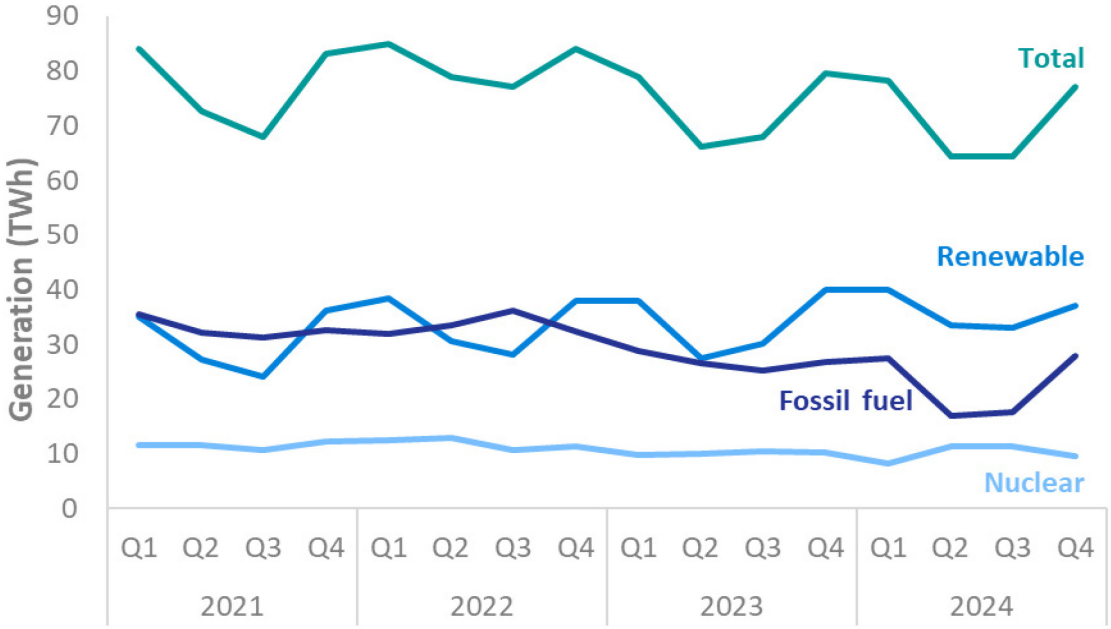


Renewable generation rose by 6.5 per cent to a record 144.7 TWh in 2024, reaching a record share of 50.8 per cent of total UK generation. This is the first year where the renewable share of generation has exceeded 50 per cent. Electricity generated by wind rose by 2.1 per cent to record 84.1 TWh, with 2024 having slightly higher average wind speeds than 2023 and with further increases in capacity. Despite increased capacity, offshore wind fell by 1.5 per cent to 48.9 TWh partially due to a fault in one of the subsea export cables. Onshore wind generation rose by 7.6 per cent, reaching 35.1 TWh and a share of 12.3 per cent of total generation. The share for total generation by wind was 29.5 per cent, up 1.4 percentage points from 2023 and only 0.8 per cent less than gas, which remains the largest single contributor to total generation. Despite lower

average daily sun hours across 2024, solar generation increased by 6.5 per cent to 14.8 TWh, reaching a new record high in the recorded time series and reflecting increased solar capacity. Finally, after falling considerably in 2023 due to all operational sites experiencing outages throughout the year, nuclear generation remained stable at 40.6 TWh in 2024. Low carbon sources represented 65.0 per cent of total generation in 2024, 4.7 percentage points higher than in 2023 and a new record.

Generation from fossil fuels decreased by 16 per cent in 2024 to 89.7 TWh, reaching levels last seen in the 1950s. Gas generation fell by 15 per cent to 86.3 TWh and coal fell by 50 per cent to 1.9 TWh. The decrease for gas reflected displacement of UK-based generation as a result of strong renewable generation and high imports, while the decrease for coal was due to the closure of the last coal powered station in 2024. The share of electricity generated by fossil fuels was down by 5.2 percentage points to 31.5 per cent, but gas remained the single largest supplier of electricity with a share of 30.3 per cent of total UK generation.

Chart 5.3 Electricity generated, by fuel type (Energy Trends Table 5.1)



Total electricity generation fell by 3.0 per cent to 77.1 TWh in Quarter 4 of 2024, the lowest Quarter 4 value within the recorded time series. The fall in generation is mainly the result of higher imports, due to favourable interconnector prices. Net imports rose by 36 per cent from Quarter 4 of 2023 to 7.0 TWh, the highest Quarter 4 value within the recorded time series. This came as imports increased by 22 per cent from Quarter 4 of 2023, and exports fell by 8.6 per cent.

Renewable generation fell by 6.4 per cent to 37.5 TWh in Quarter 4 of 2024, with the share of all generation falling by 1.7 percentage points to 48.6 per cent. Similarly, the share of low carbon sources fell by 2.1 percentage points to 61.1 per cent, as nuclear generation fell by 5.8 per cent. Apart from bioenergy and the small amount of tidal, generation by all renewable technologies fell compared to the same period last year due to less favourable conditions for generation. After reaching the highest value within the recorded time series in Quarter 4 of 2023, and surpassing generation by gas for the first time, wind generation fell by 11 per cent to 23.6 TWh. Solar generation fell by 1.7 per cent to 1.8 TWh, while bioenergy rose by 7.8 per cent to 10.6 TWh.

Fossil fuel generation rose by 3.0 per cent to reach 27.5 TWh in Quarter 4 of 2024, as generation by gas rose by 9.3 per cent to 27.1 TWh and generation by oil rose by 3.1 per cent to 0.4 TWh. Generation by coal fell to zero, as the last coal fired power station closed in September. The share of generation from fossil fuels rose by 2.1 percentage points to 35.7 per cent.

Section 6: Renewables

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Key headlines

Renewable generation was a record 144.7 TWh in 2024, up 6.5 per cent from 2023, with new capacity more than offsetting less favourable weather conditions. Increased generation was driven by record levels of generation from bioenergy, wind, and solar PV.

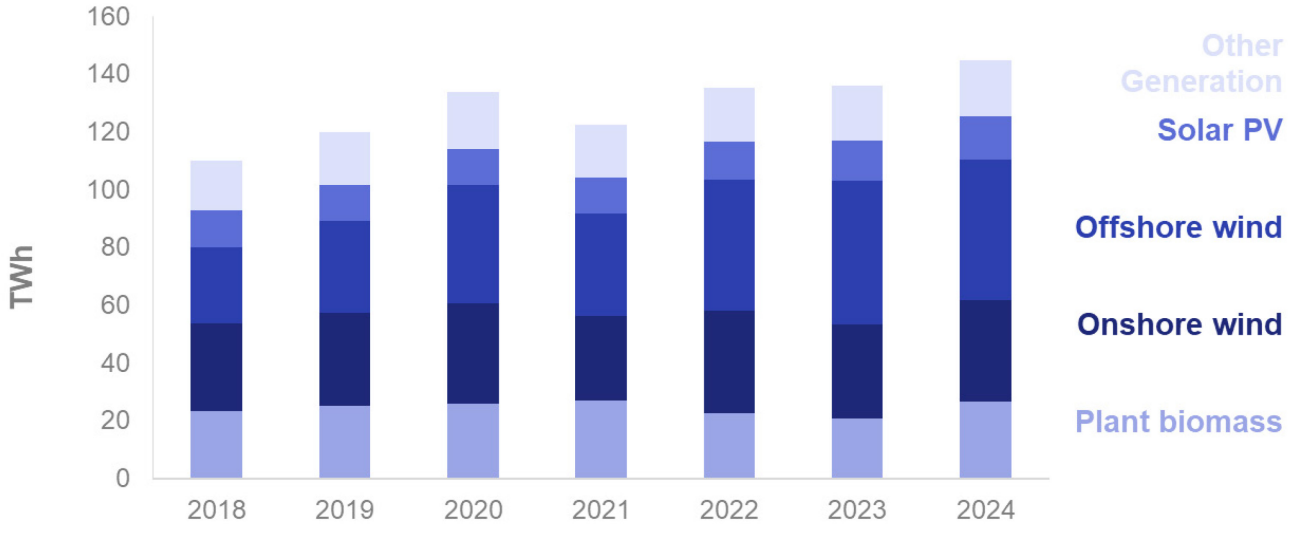
Renewable's share of electricity generation was 50.8 per cent in 2024, the first time that more than half of generation has come from renewables. This was the result of growth in renewable generation and a fall in non-renewable generation.

A total 4.2 GW of capacity was added taking the total installed capacity to 60.7 GW, up from 9.3 GW in 2010. The new capacity was largely made up of wind (1.4 GW offshore and 0.8 GW onshore) and solar PV (1.6 GW).

Generation for 2024 Quarter 4 was 37.5 TWh, down by 2.6 TWh (6.4 per cent) on 2023 Quarter 4, mainly due to less favourable weather conditions. In particular, offshore wind generation was down by 14 per cent on last year, this was partly down to lower average wind speeds in the South East, curtailment and a fault with a subsea export cable early in the quarter. This fall was partly offset by an increase in plant biomass generation.

Renewables share of generation was 48.6 per cent in 2024 Quarter 4, 1.8 percentage points down on 2023 Quarter 4.

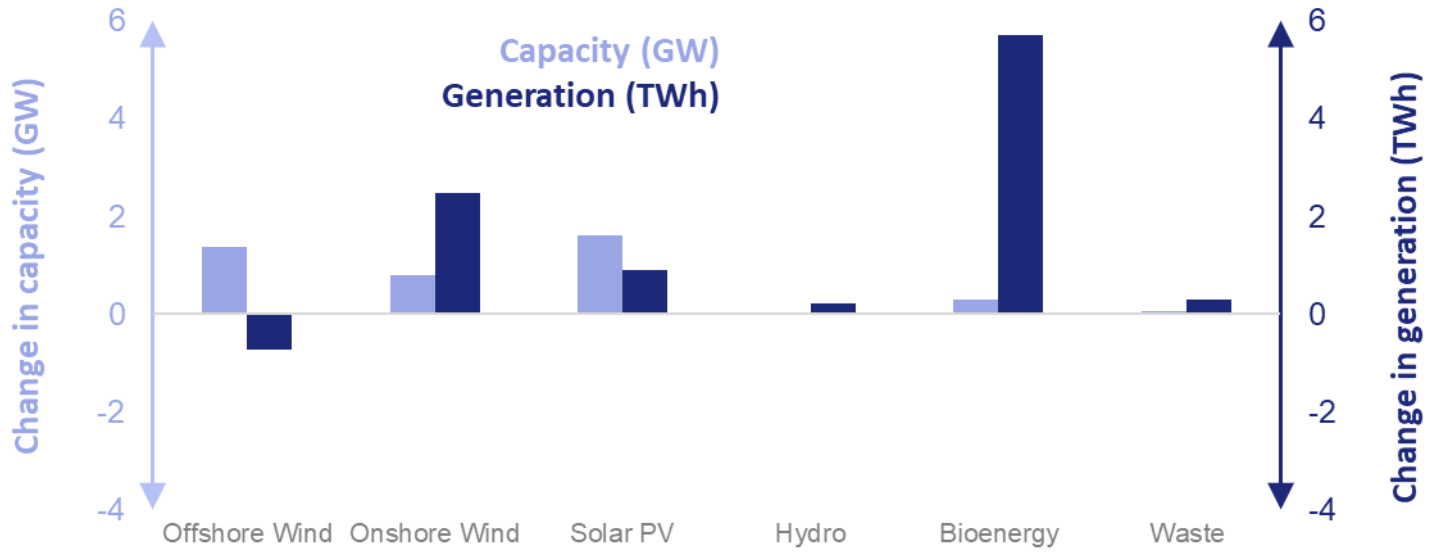
Chart 6.1 Renewable generation from 2018 (Energy Trends Table 6.1)



Since 2018, renewable generation has increased by 31 per cent with offshore wind accounting for almost two thirds of the increase. For the first time, in 2019, offshore generation overtook onshore and the divergence has continued since then. This is largely due to new capacity which saw strong growth from 2017 onwards. Although offshore capacity is still lower than onshore, the gap has closed to just 0.6 percent lower in 2024. It's ability to outperform onshore wind generation relative to installed capacity is down to newer, larger turbines installed off the coast. Furthermore, wind speeds are often stronger offshore. In 2020, unusually high wind speeds and rainfall resulted in a 12 per cent increase in renewable generation compared to 2019, though the following year weather conditions reversed and in addition, there were unusually low sun hours. Although

weather conditions stabilised and new capacity was added (notably in offshore wind), overall renewable generation growth was subdued in 2022 and 2023 largely due to reduced output at two large biomass power plants (output resumed to more usual levels in 2024, see next paragraph for more information).Chart 6.2 shows in more detail the trends between 2023 and 2024.

Chart 6.2 Change in renewable generation and capacity between 2023 and 2024 (Energy Trends Table 6.1)

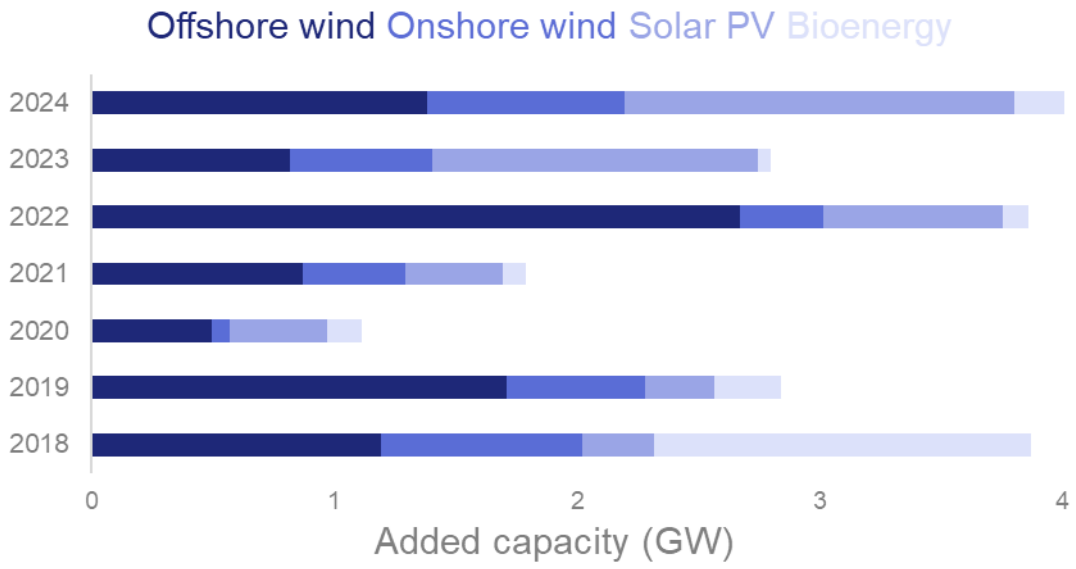


Most notable this year is the high increase in bioenergy generation, up 18 per cent achieving a record in 2024. Although new capacity contributed to the growth, the sharp increase was mostly due to plant biomass returning to more usual levels following reduced output at two major plants in 2022 and 2023. Although plant biomass remains 1.7 percent lower than in 2021, increased generation from energy from waste and anaerobic digestion facilitated the record for overall bioenergy. The trends in wind generation are different between onshore and offshore wind. Although both saw an increase in capacity, only onshore wind displayed an increase in generation (by 7.6 per cent, compared with a 1.5 per cent decrease in offshore generation). Industry attributes a fault with a subsea export cable, curtailment, and lower wind speeds in the South East as contributory factors to the fall in offshore wind generation. Overall, the increase in onshore wind offset the drop in offshore wind and resulted in a record for overall wind generation.

Solar PV generation also achieved a record with a 9.9 per cent increase in installed capacity more than offsetting fewer sun hours. The 1.6 GW of new capacity was the largest added since 2016. Hydro generation increased by 4.1 per cent despite a slight decrease in rainfall, and no change in capacity.

New capacity added in 2024 was 4.2 GW, the highest since 2017. Since 2020, new offshore wind has represented almost half of the total new installed capacity, with solar PV accounting for 32 per cent and onshore wind, the bulk of the remainder. New capacity for offshore wind included Neart na Gaoithe (NnG) (448 MW) and Moray West (882 MW) in Scotland. Both of these plants came online later in the year so while they have added 1.3 GW of capacity between them, they are yet to have a large impact on generation.

Chart 6.3 Added capacity for the leading technologies (Energy Trends Table 6.1)

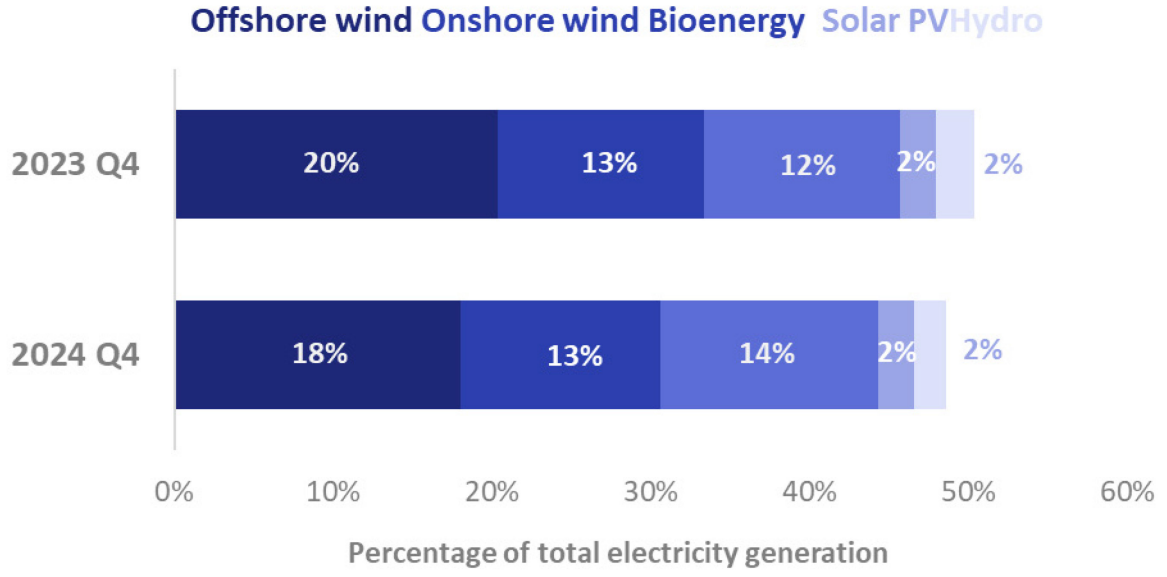


In 2024, new wind capacity represented just over half of the total added capacity, a similar share to 2023, with offshore wind accounting for almost two thirds of this. In 2023, new solar PV capacity represented almost half of the total, and although growth in solar PV capacity for the year was strong (9.9 per cent), in 2024 it made up 39 per cent of new capacity. This was in part due to an increase in bioenergy capacity.

Whereas offshore wind sites tend to be few in number but large scale, the growth in solar PV has been dominated by numerous installations of less than 50 kW, including 147,000 new domestic installations in 2024. These figures may be missing some unsubsidised solar installations below 150 kW capacity that are not registered on the Microgeneration Certification Scheme (MCS). For more details see the solar deployment tables (opens in a new window).

In the fourth quarter, 0.8 GW of new capacity was installed, around two thirds of which was accounted for by wind. Solar PV capacity increased by 1.4 per cent, slightly more than Quarter 3 but less than the first two quarters of 2024. There was no new bioenergy capacity in the fourth quarter, for the second quarter in a row. The majority for the year was installed in the first quarter and included Teesside (plant biomass- 250 MW).

Chart 6.4 Renewables' share of electricity generation – Q4 2023 and Q4 2024 (Energy Trends 6.1)



In 2024 Quarter 4, renewable's share of generation was 48.6 per cent. This was 1.8 percentage points lower than 2023 Quarter 4, when renewables' share exceeded 50 per cent for the first time. This was partially driven by lower average wind speeds in the latter part of the year, with offshore wind's share decreasing by 2.4

percentage points and onshore wind’s share by 0.4 percentage points. Bioenergy’s share increased by 1.4 percentage points, and Solar PV’s share was up marginally to 2.3 per cent, but clearly lower than the summer peak of 8.9 per cent in the second quarter of the 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:

Estimates of whole UK energy flow incorporating end use energy efficiency, 2023

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:
http://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:
http://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	0.10551	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

National 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 and should be labelled 'accredited official 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

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

Estimates of whole UK energy flow incorporating end use energy efficiency, 2023

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Key headlines

Energy efficiency plays a significant role in energy security and curbing emissions but published energy statistics typically report energy losses from conversion losses prior to consumption, with limited focus on losses at the end use level.

This article reports end use estimates of "useful" and "rejected" energy proportions for the domestic, industry, services and transport sectors. These estimates are based on desk research and should be interpreted with caution as the estimates might not accurately reflect actual efficiencies by end users.

Applying these energy efficiency estimates to the UK's consumption data for 2023 indicates that rejected energy - largely from 'wasted' heat from electricity generation and from internal combustion engines - is 55 per cent of the total energy consumed in the UK in 2023.

The domestic sector has the highest useful energy proportion (84 per cent), followed by the services sector (72 per cent), industry (54 per cent), and transport (32 per cent). Efficiency is estimated to have improved in all sectors since 2017, except industry, which has seen no overall change.

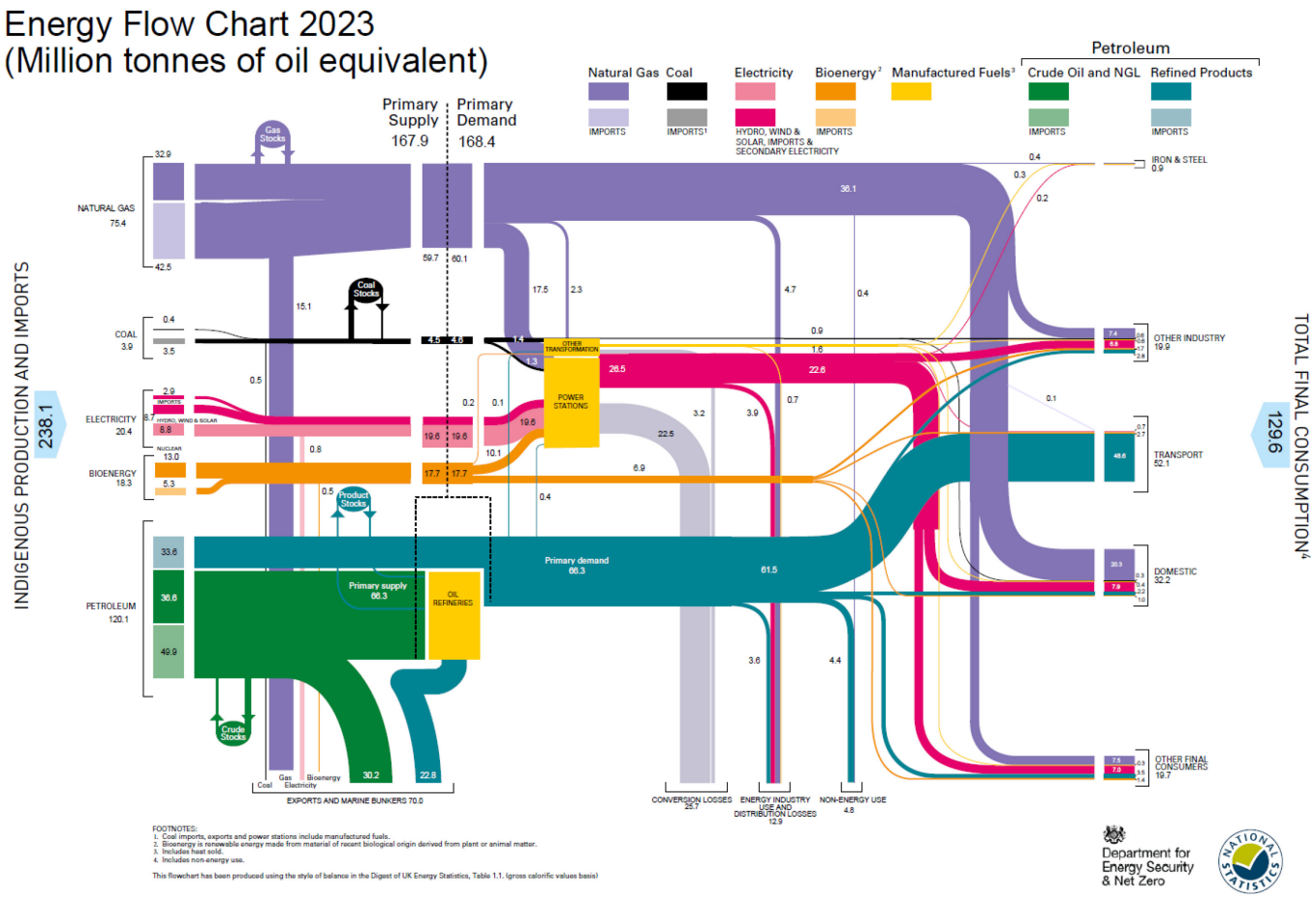
Introduction

The energy system is complex, ranging from production and trade import of primary fuels, electricity generation and other transformations, and delivery to final consumers. Energy is 'lost' at various points throughout the system, typically as heat generated during energy transformation (e.g. waste heat from fossil fuel electricity generation) or in end use applications (e.g. passenger and commercial vehicles). A good understanding of where energy might be lost is critical for identifying areas for further advancements, which could ultimately reduce the energy required as input to the system.

One method to visualise energy efficiency is through energy flow charts, or 'Sankey diagrams.' The Department for Energy Security and Net Zero (DESNZ) publishes these charts in the Digest of UK Energy Statistics (DUKES), illustrating energy systems from supply to consumption across various sectors. The chart also includes intermediate energy steps such as transformation of one type of energy to another and conversion losses, which is energy lost from transformations (e.g. during electricity generation). Similar charts are also published internationally such as those by the International Energy Agency[1] and Eurostat[2]. Figure 1 presents the UK energy flow chart for 2023.

[1] https://www.iea.org/commentaries/understanding-and-using-the-energy-balance
[2] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Sankey_diagrams_for_energy_balance

Figure 1: UK Energy flow chart, 2023 (million tonnes of oil equivalent)



While these flow charts capture conversion and other losses, they generally do not account for losses occurring at the end use level (with limited exceptions such as the Lawrence Livermore National Laboratory (LLNL) diagrams[3]). DESNZ (then known as the Department for Business, Energy & Industrial Strategy) published analysis in 2019 that broke down sectoral energy consumption into "useful" and "rejected" energy at the end use level[4]. The analysis was integrated into sectoral energy flow charts, providing a more detailed view of energy efficiency. This report builds on that analysis by incorporating recent data.

Definitions:

- Useful energy: Energy that is utilised for its intended purpose. For example, the light emitted by a computer monitor.
- Rejected energy: Energy that does not serve its intended purpose. For example, heat emitted by a computer monitor.
- End use: Energy directly consumed by users. For example, natural gas used in a condensing boiler for space heating.
- Conversion losses: Energy lost in the process of transforming energy. For example, some heat is lost when generating electricity from coal combustion.

Limitations of the Analysis:

- The analysis does not account for detailed technical factors underlying energy efficiency. For simplicity and consistency, losses caused by user behaviour, such as leaving lights on when not at home, are excluded.
- End use efficiency estimates reflect the performance of appliances and do not include losses like heat escaping through walls.

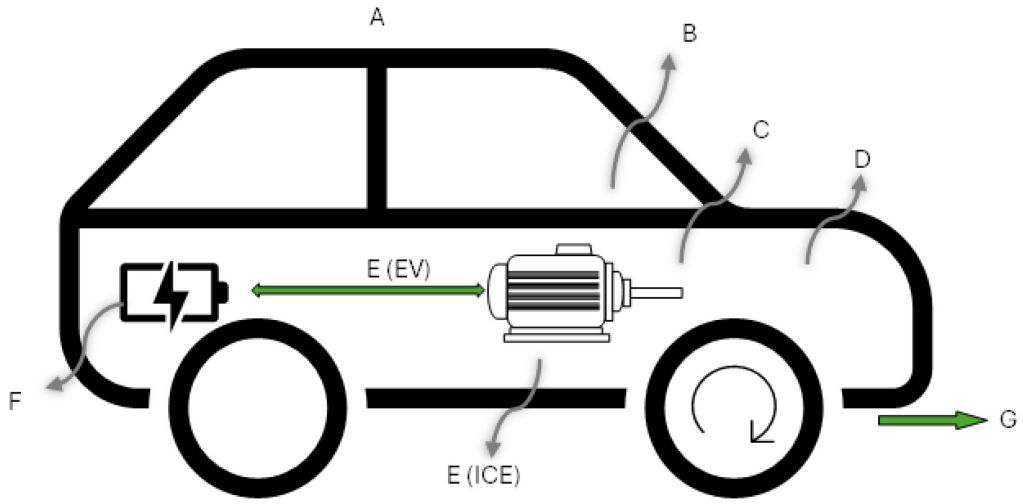
[3] https://flowcharts.llnl.gov/

[4] https://www.gov.uk/government/publications/energy-trends-june-2019-special-feature-article-experimental-statistics-on-whole-uk-energy-flow-incorporating-end-use-energy-efficiency

- Unintended energy outputs at the end use level are all considered to be rejected energy, even though in some cases the energy does not go to waste (such as heat loss from an oven, which could warm a kitchen in winter).
- Efficiency estimates are sourced from various data sets, which may have methodological inconsistencies and hence reflect real world activities with varying degrees of accuracy.

Figure 2 illustrates how energy efficiency proportions can be calculated using the example of electric vehicles (EVs) and internal combustion engine (ICE) vehicles. In the table below, "energy to wheels" represents useful energy, while other losses are categorised as rejected energy. These data used are drawn from official US fuel economy data[5]. While energy use varies by vehicle and driving conditions, the estimates shown are based on analysis of over 100 vehicles that provides an *illustration* of the general difference between vehicle types.

Figure 2: A breakdown of energy efficiency components of an electric and internal combustion engine vehicle (Fuel Economy[6])



Label	Conventional Petroleum vehicle (ICE)		Electric vehicle (EV)	
A	Idle losses	3 per cent (included within C and D)	Idle losses	~0 per cent
B	Auxiliary electrical losses	0-2 per cent	Auxiliary electrical losses	0-4 per cent
C	Parasitic losses	4-6 per cent	Accessory losses	3 per cent
D	Engine losses	68-72 per cent	Electrical drive system losses	18 per cent
E	Drivetrain losses	3-5 per cent	Net regenerative braking energy returned to the battery and subsequently to the road	+22 per cent (recovered energy)
F	No battery charging	0 per cent	Energy lost in charging the battery	10 per cent
G	**Energy to wheels** (useful energy)	**16-25 per cent**	**Energy to wheels** (useful energy)	**65-69 per cent + 22 per cent = 87-91 per cent**

[5] https://www.fueleconomy.gov/feg/atv-ev.shtml
[6] https://www.fueleconomy.gov/feg/atv-ev.shtml

The example in Figure 2 shows that EVs lose 18 per cent of their energy through losses in the electrical drive system, whereas ICE-powered vehicles lose 68-72 per cent as heat from fuel combustion in the engine. EVs also feature a regenerative braking system, which recovers ~ 22 per cent of the energy that is otherwise lost during braking. While braking energy is considered “useful” – since it serves its purpose of slowing the vehicle – regenerative braking provides the additional benefit of storing recovered energy for future use. This results in a total percentage exceeding 100 per cent for EVs, with 87–91 per cent categorised as useful energy.

In contrast, ICE-powered vehicles have a much lower overall proportion of useful energy: 24-38 per cent for hybrids and 16-25 per cent for conventional vehicles[7]. Most of the rejected energy in these vehicles is heat lost in the engine (65-69 per cent in hybrids and 68-72 per cent in conventional vehicles). Although hybrid vehicles include regenerative braking, they recover only 5-9 per cent of their braking energy because they rely on both an ICE and electric system[8]. Conventional ICE vehicles, typically lacking regenerative braking altogether, have even lower overall efficiency.

This example emphasises the importance of evaluating energy efficiency at the end use level, complementing assessments of upstream losses like conversion losses. Although electricity generation can have greater conversion losses than the refining and transport of liquid fuels, EVs are significantly more efficient at the end use level compared to ICE vehicles.

Method

This study utilised two main inputs: end use energy consumption sourced from DUKES[9] and Energy Consumption in the UK (ECUK)[10]; and energy efficiency estimates, which represent the proportions of "useful" and "rejected" energy at the end use level. The efficiency estimates were drawn from various sources, including government publications, research studies, academic articles and departmental estimates derived from desk research.

End use consumption and efficiency are calculated for sub-sectors within the four main sectors: domestic, services, industry and transport. Conversion losses and other energy losses prior to end use are counted as rejected energy. Energy is also used in the energy industry and in the absence of any conclusive data is assumed to be 50 per cent useful and 50 per cent rejected and is a separate consumer from the four main sectors.

For the industry sector, all efficiency data was sourced from energy flow charts from the US Department of Energy[11]. In the domestic and services sectors, some efficiency estimates were derived internally based on departmental assumptions or product policy data. Together, these datasets enable users to analyse trends in end use energy efficiency.

These estimates are based on desk research and should be interpreted with caution as the estimates might not accurately reflect actual efficiencies by end users.

Energy consumption values for all end uses were multiplied by the corresponding efficiency estimates to calculate "useful" energy in thousand tonnes of oil equivalent (ktoe), with the remainder categorised as "rejected" energy. Efficiency proportions and estimates of saved energy were also compared against results from the 2019 study[12] to highlight changes in energy efficiency over time.

[7] https://www.fueleconomy.gov/feg/atv.shtml
[8] https://www.fueleconomy.gov/feg/atv-hev.shtml
[9] https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2024
[10] https://www.gov.uk/government/statistics/energy-consumption-in-the-uk-2024
[11] https://www.energy.gov/eere/iedo/manufacturing-energy-and-carbon-footprints-2018-mecs
[12] https://www.gov.uk/government/publications/energy-trends-june-2019-special-feature-article-experimental-statistics-on-whole-uk-energy-flow-incorporating-end-use-energy-efficiency

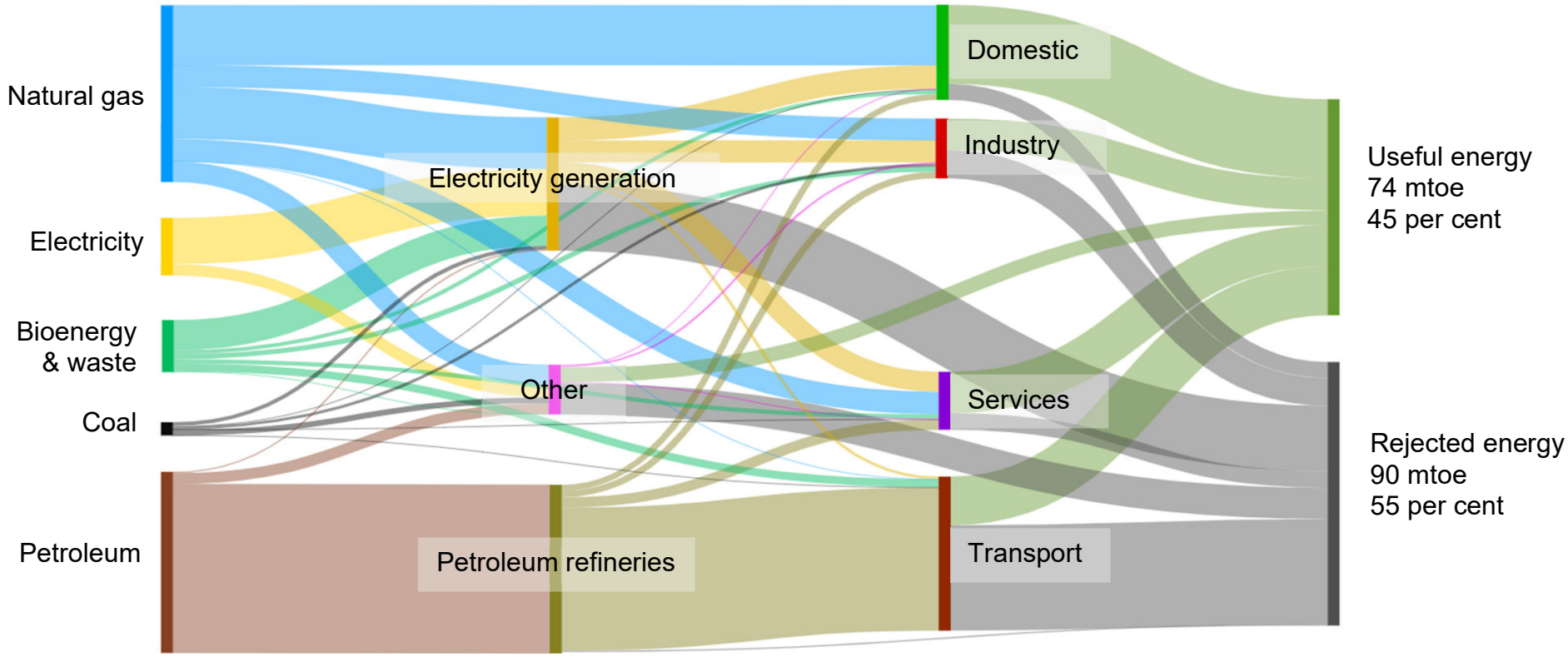
To aid transparency, the data underlying this study, including rationales and sources for efficiency proportions, can be accessed at: https://www.gov.uk/government/publications/energy-trends-march-2025-special-feature-article-estimates-of-whole-uk-energy-flow-incorporating-end-use-energy-efficiency-2023. Users may wish to update these estimates with other proportions where appropriate.

Energy flow chart

Figure 3 presents the energy flow chart generated from the sectoral consumption and end use efficiency data. This chart illustrates the energy flow into sectors and its division into useful and rejected energy at the end use level. Conversion losses and other non-sectoral energy uses are included in the analysis and shown in the flow chart's intermediate nodes. More details of upstream energy flows are published in the energy flow chart collection[13].

[13] https://www.gov.uk/government/collections/energy-flow-charts

Figure 3: Energy flow chart with final “useful” and “rejected” end use energy, 2023 data.



Of approximately 164 million tonnes of oil equivalent (mtoe) of energy consumed in 2023 as natural gas, coal, electricity, bioenergy & waste, and petroleum, 74 mtoe (45 per cent) contributed to useful or intended outputs, while the remaining 90 mtoe (55 per cent) was rejected. A detailed breakdown of useful and rejected energy proportions by sector and end use is available in the spreadsheet accompanying this report.

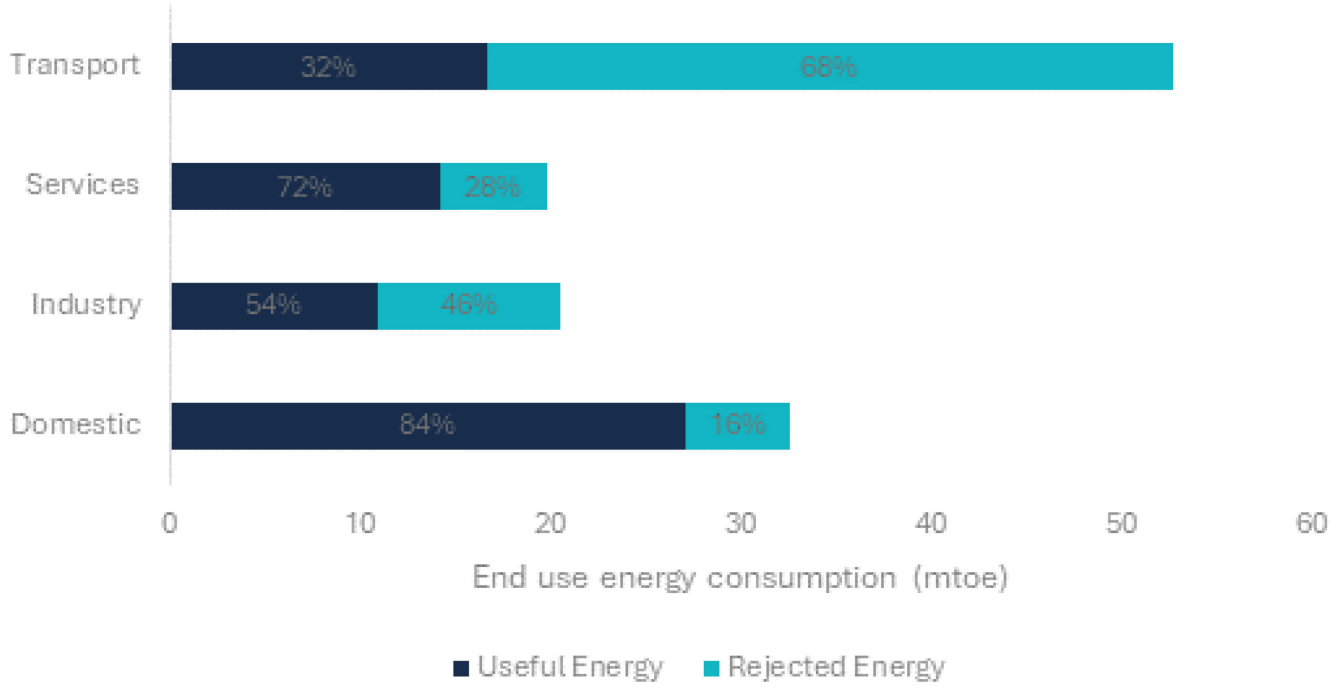
Comparative analyses

Differences in energy efficiency rates between sectors in 2023

End use energy efficiency proportions vary significantly across sectors, influenced by factors such as the type of fuel used and the efficiency of end use appliances. The analysis shows that only 32 per cent of energy in the transport sector is categorised as "useful," compared to 72 per cent in the services sector, 54 per cent in the industry sector, and 8 per cent in the domestic sector.

Figure 4 illustrates energy consumption categorised as "useful" or "rejected" in million tonnes of oil equivalent (mtoe) for each sector in the UK.

Figure 4: “Useful” and “rejected” energy proportions by sector (mtoe), 2023



Data from DUKES shows that the road transport sector consumes only 1 per cent of its final energy as electricity, relying predominantly on liquid fuels. In contrast, the services sector (including agriculture) consumes the highest proportion of electricity at 35 per cent. For electricity, most energy losses happen upstream of end use energy (e.g. conversion losses), resulting in a higher proportion of useful energy at the end use level. In the transport sector, however, most energy is consumed directly as fuel, so inefficiencies from fuel combustion are represented as rejected energy at the end use level.

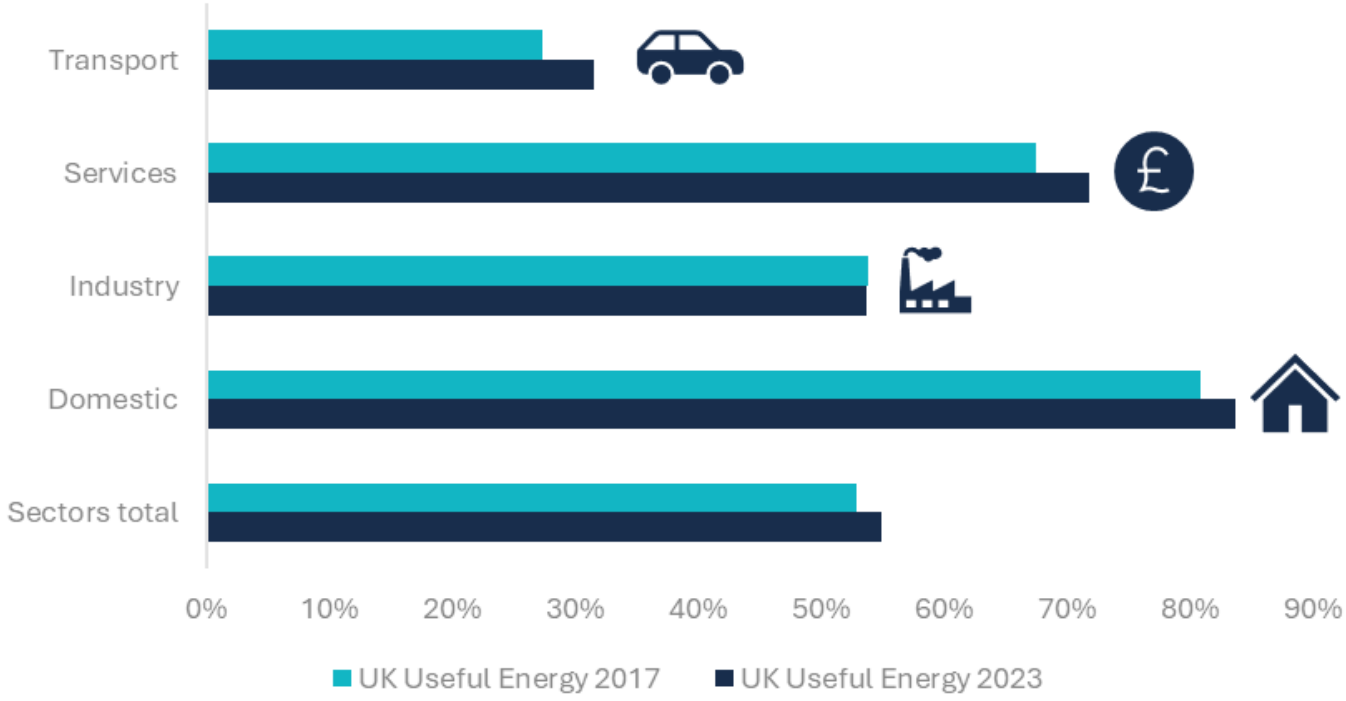
This contrast is apparent when comparing the end use efficiency of electric cars, estimated at approximately 89 per cent, with that of cars running on petrol and diesel, which have an estimated average efficiency of about 21 per cent. Despite their higher efficiency, electricity consumption in road transport was only 531 ktoe in 2023, 1.4 per cent of the total energy consumption in road transport, which reflects the different installed base of electric and petroleum vehicles.

Efficiency changes from 2017 to 2023

Efficiency changes across all sectors reflect both real improvements in end-use appliances (e.g. more efficient household appliances) and methodological updates, such as incorporating more recent energy efficiency data sources to better estimate the proportion of useful energy. However, data sources are limited for some end uses. Achieving a more accurate comparison of efficiency changes over time would require more reliable and consistent data. The results below should be interpreted with caution.

Between 2017 and 2023[14] energy efficiency improved in the domestic (3 percentage points), services (5 percentage points), and transport (5 percentage points) sectors. Industry was the only sector not to see an increase in energy efficiency during this time period and was broadly static. The industrial figures should be treated with significant caution and are included here only for completeness. Data on industrial efficiencies are taken from US sources, and these are broadly unchanged on 2017 and are unlikely to represent UK activities. Transformation losses have also decreased, dropping from 36 mtoe in 2017 to 26 mtoe in 2023, due to lower energy consumption and the shift towards more efficient fuels for electricity generation, such as a reduction in coal use (now less than 20 per cent of 2017 levels) and an increase in primary electricity production from renewable sources such as solar energy. As a result of these changes, the overall proportion of useful energy has risen from 42 per cent in 2017 to 45 per cent in 2023.

Figure 5: Change in end use energy efficiency since 2017



Domestic

The most significant change in the domestic sector is in gas used for space and water heating which accounts for 20 mtoe out of a total of 32 mtoe used. This change is largely driven by improvements in boiler efficiency, with more than 1.5 million boilers installed annually[15]. Additionally, the installed user base for heat pumps has

[14] Note that 2017 estimates are derived from the previously published efficiencies and consumption data. The use of updated 2017 consumption data does not materially impact the percentage of energy classed as useful.

[15] https://assets.publishing.service.gov.uk/media/63e25c96e90e076266ed429c/Improving_boiler_standards_and_efficiency_consultation.pdf

grown. This is reflected in the number of government-supported heat pump installations, which increased by 28,000 units (40 per cent) in 2023[16]. Heat pumps extract energy from the environment, resulting in a useful energy proportion exceeding 100 per cent - meaning the heat output is greater than the electrical energy input.

Industry

At an aggregate level, the industry sector saw no overall change in energy efficiency. The “food and drinks” and “paper, printing and publishing” sub-sectors showed the largest positive change, with a 2 per cent and 4 per cent increase in their useful energy ratios. However, this improvement was offset by a 6 per cent efficiency decrease in the "mineral products" sub-sector. It should be kept in mind that efficiency ratios for this sector are based on US sources, as noted above. They should be treated with caution.

Services

Energy efficiency improvements in the services sector are similar to those in the domestic sector, with space heating using gas being the largest energy-consuming sub-sector (6 mtoe out of a total of 20 mtoe consumed by this sector) and the biggest contributor to energy savings. Notable gains were also made in lighting, where the continued adoption of LED technology, driven by policies phasing out less efficient bulbs, has played a key role[17].

Transport

The transport sector continues to exhibit the lowest proportion of useful energy (32 per cent) among all sectors, as the majority of its consumption comes from petroleum-fuelled vehicles with ICEs, which were estimated to output 21 per cent useful energy. Research into improving ICE efficiency continues, as even small gains can significantly reduce rejected energy[18]. Despite this, the sector remains a major contributor to a lower UK average end use efficiency, due to its high energy consumption at a low-end use efficiency rate, especially as total UK consumption continues to decrease.

Electric vehicles (EVs) are steadily increasing in numbers and starting to contribute to efficiency improvements in transport. Battery electric cars were 3 per cent of all cars in the UK at the end of 2023 and accounted for 16 per cent of new car registrations that year[19]. Another notable recent change has been in public transport, where 5 per cent of UK buses are now electric[20]. The recent Zero Emissions Vehicle Mandate aims to phase out ICE vehicles, targeting 100 per cent EV sales for cars and vans by 2035, which would further improve end use efficiency[21].

[16] https://www.gov.uk/government/statistics/heat-pump-deployment-statistics-september-2024
[17] https://www.gov.uk/government/news/end-of-halogen-light-bulbs-spells-brighter-and-cleaner-future
[18] https://gtr.ukri.org/projects?ref=EP per cent2FM009424 per cent2F1
[19] https://commonslibrary.parliament.uk/research-briefings/cbp-7480/
[20] https://commonslibrary.parliament.uk/research-briefings/cdp-2024-0097/
[21] https://www.gov.uk/government/news/government-sets-out-path-to-zero-emission-vehicles-by-2035

International comparisons

The previous analysis included an international comparison between the UK and the US, which is updated in this section. However, it is important to interpret these results cautiously, as the data used for this study are limited in precision and consistency. While other studies have attempted to measure efficiency in other ways, such as with the Odyssee-MURE project for the EU[22], none have published a breakdown of useful and rejected energy in this format, which limits the possibility for wider comparisons of energy efficiency between the UK and other countries.

Figure 6: International comparison of sectoral energy efficiency between UK and US

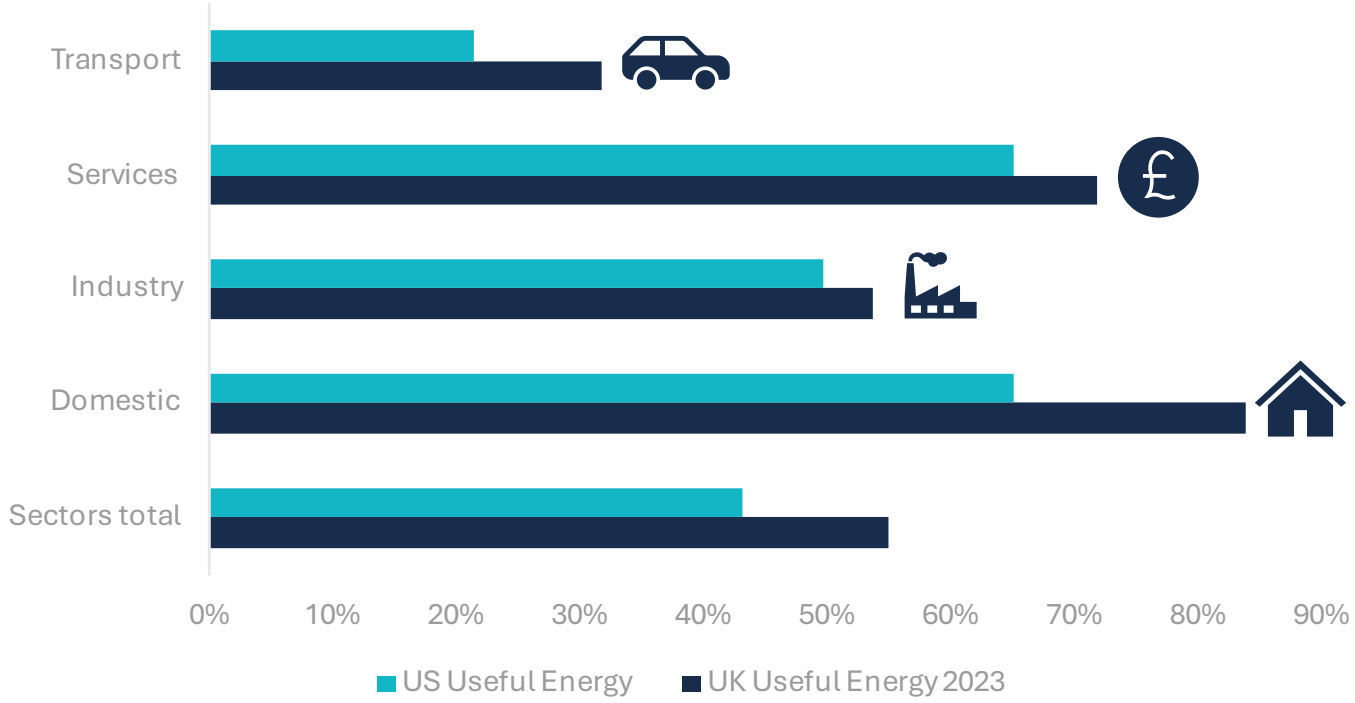


Figure 6 broadly compares UK and US energy efficiency by sector (at end use level excluding generation). Across the 4 sectors, the overall proportion of useful energy is higher in the UK (55 per cent) than in the US (43 per cent), largely reflecting differences in sectoral energy consumption patterns. For instance, the largest energy consumers in the US are the industrial and transport sectors, which have the lowest end use efficiency, but account for 72 per cent of sectoral energy consumption. In contrast, the transport and industry sectors also have the lowest end use efficiency in the UK but account for only 48 per cent of sectoral energy consumption.

When examining sectors more closely, the domestic and transport sectors show the largest differences in useful energy proportions, with the UK showing 18 per cent and 11 per cent higher efficiency in each sector respectively compared to the US. The higher domestic efficiency in the UK is likely due to the widespread use of more efficient heating systems, such as condensing boilers and centralised heating. For transport, the UK's higher population density and urbanisation levels results in shorter average trip distances and greater use of public transport, which are more efficient than cars.

For the industry sector, the efficiency proportions are derived using US subsector splits, as outlined in the methodology. Thus, differences in useful energy proportions are primarily due to varying energy consumption

[22] https://www.odyssee-mure.eu/

distributions among subsectors in the two countries. The difference in end use efficiency in the services sector is small according to this analysis and is not attributed to a specific difference between the UK and the US.

The flowchart in Figure 3 showed the overall proportion of useful energy including transformation losses is 45 per cent in the UK. In the US, the overall efficiency including transformation losses is reported to be 32 per cent[23]. Transformation losses account for 35 per cent of the total rejected energy in the UK and 31 per cent for the US. The 13-percentage-points difference in overall efficiency between the UK and US is partly due to differences in transformation losses and partly due to differences in energy efficiency and consumption patterns across sectors.

Conclusion:

This study provides an initial exploration of end-use energy efficiency, complementing existing data on energy efficiency upstream of end use energy. It updates the 2019 report with more recent consumption and efficiency values and includes key technologies that have become more prominent since the last publication, such as heat pumps in the domestic sector and electric vehicles in transport.

The findings of this analysis should be viewed as preliminary. Data on energy efficiency are not widely available and drawn from several sources that could be inconsistent.

The analysis highlights trends in sectoral energy efficiency, with the transport sector emerging as the least efficient due to its reliance on petroleum fuels, which generate significant end-use losses. By contrast, the domestic sector remains the most efficient, supported by improvements in heating technologies. Changes since 2017 show progress across most sectors, driven by advancements in technologies like EVs.

This study is a foundation for future efforts to better understand and report on energy efficiency, particularly at the end-use level. Users are welcome to explore the provided worksheet to update energy efficiency and consumption values and generate their own analyses of useful energy proportions, see https://www.gov.uk/government/publications/energy-trends-march-2025-special-feature-article-estimates-of-whole-uk-energy-flow-incorporating-end-use-energy-efficiency-2023. Feedback is welcome and will help in shaping future iterations of this work.

[23] https://flowcharts.llnl.gov/commodities/energy

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

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