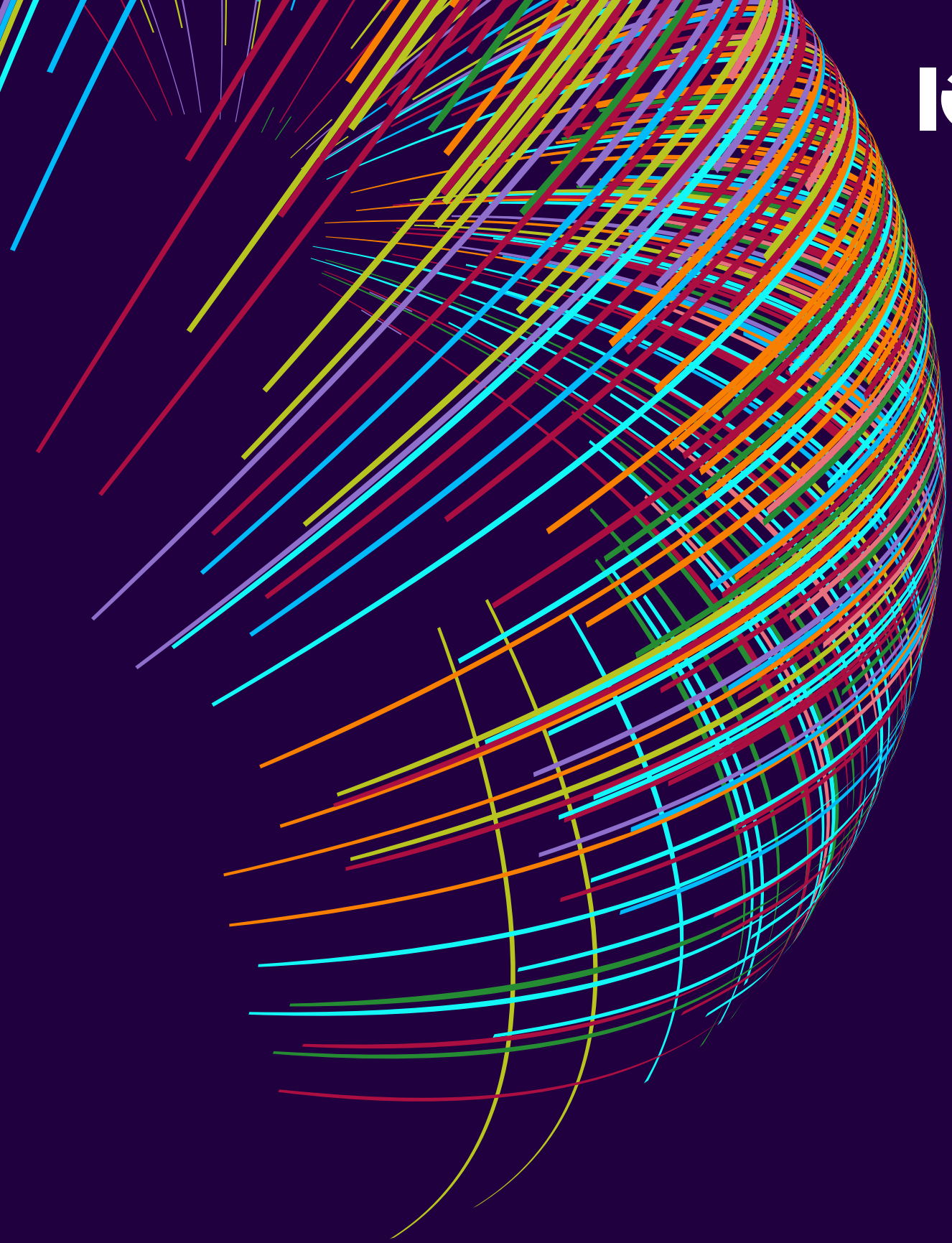

Global Energy Review 2025

INTERNATIONAL ENERGY AGENCY

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Abstract

This edition of the *Global Energy Review* is the first comprehensive depiction of the trends that took place in 2024 across the entire energy sector, covering data for all fuels and technologies, all regions and major countries, and energy-related carbon dioxide (CO_2) emissions.

The latest data show that the world's appetite for energy rose at a faster-than-average pace in 2024, resulting in higher demand for all energy sources, including oil, natural gas, coal, renewables and nuclear power. This growth was led by the power sector, with demand for electricity rising almost twice as fast as wider energy demand due to higher demand for cooling, rising consumption by industry, the electrification of transport and the growth of data centres and artificial intelligence.

Nearly all of the rise in electricity demand was met by low-emissions sources, led by the record-breaking expansion of solar PV capacity, with further growth in other renewables and nuclear power. Gas demand also picked up substantially, while oil and coal consumption increased more slowly than in 2023.

CO_2 emissions from the energy sector continued to increase in 2024 but at a slower rate than in 2023. A key driver was record-high temperatures: if global weather patterns in 2023 had repeated in 2024, around half of the increase in global emissions would have been avoided. At the same time, the continued rapid adoption of clean energy technologies is limiting emissions growth, according to new analysis – avoiding 2.6 billion tonnes of additional CO_2 emissions per year.

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Key findings

- **Global energy demand grew by 2.2% in 2024 – faster than the average rate over the past decade. Demand for all fuels and technologies expanded in 2024.** The increase was led by the power sector as electricity demand surged by 4.3%, well above the 3.2% growth in global GDP, driven by record temperatures, electrification and digitalisation. Renewables accounted for the largest share of the growth in global energy supply (38%), followed by natural gas (28%), coal (15%), oil (11%) and nuclear (8%).
- **Emerging and developing economies accounted for over 80% of global energy demand growth.** In China, growth in energy demand slowed to under 3% in 2024, half the rate in 2023 and well below China's average annual growth of 4.3% in recent years. Nevertheless, China still saw the largest demand growth in absolute terms of any country in 2024. India saw the second-largest rise in energy demand in absolute terms – more than the increase in all advanced economies combined.
- **Advanced economies also saw a notable return to growth in energy demand after several years of declines, with demand rising by almost 1%.** The United States saw the third-largest absolute demand growth in 2024 after China and India. The European Union returned to growth for the first time since 2017 (aside from the post-Covid rebound in 2021).
- **Global oil demand growth slowed markedly in 2024, in line with the IEA's forecast. Oil's share of total energy demand fell below 30% for the first time ever**, 50 years after peaking at 46%. Demand for oil rose by 0.8% in 2024, compared with a 1.9% increase in 2023. However, trends varied between sectors and regions. Oil demand from global road transport fell slightly, driven by declines in China (-1.8%) and advanced economies (-0.3%). Oil demand from aviation and petrochemicals grew.
- **Natural gas saw the strongest demand growth among fossil fuels.** Demand increased by 2.7% in 2024, rising by 115 billion cubic metres (bcm), compared with an average of around 75 bcm annually over the past decade. China had the largest absolute growth in gas demand in 2024 of over 7% (30 bcm), with growth also strong in other emerging and developing economies in Asia. Gas demand expanded by around 2% (20 bcm) in the United States. Consumption grew modestly in the European Union, notably for industrial use.

- **Global coal demand rose by 1%.** Power generation was the main driver of growth as high temperatures pushed up electricity consumption for cooling. Intense heatwaves drove coal use higher in both China and India, which together represented the large majority of the global demand increase of around 65 million tonnes of coal equivalent (Mtce). China remained the largest coal consumer globally, accounting for a record 58% of global coal use.
- **Global electricity consumption rose by nearly 1 100 terawatt-hours (TWh) in 2024, more than twice the annual average increase over the past decade.** The increase – more than Japan's annual electricity consumption – was the largest ever, outside of years when the global economy rebounded from recession. China made up more than half of the global increase in electricity demand, but the rise was broad-based, with growth of 4% in other emerging and developing economies. Electricity demand reached a new high in advanced economies.
- **Rising global electricity use was driven by factors such as increasing cooling demand resulting from extreme temperatures, growing consumption by industry, the electrification of transport, and the expansion of the data centre sector.** Electricity use in buildings accounted for nearly 60% of overall growth in 2024. The installed capacity of data centres globally increased by an estimated 20%, or around 15 gigawatts (GW), mostly in the United States and China. Meanwhile, the continued growth in the uptake of electric vehicles resulted in a rise in electricity use in transport. Global sales of electric cars rose by over 25%, surpassing 17 million units and accounting for one-fifth of all car sales, in line with the IEA's projections for 2024.
- **In 2024, 80% of the growth in global electricity generation was provided by renewable sources and nuclear power.** Together, they contributed 40% of total generation for the first time, with renewables alone supplying 32%. New renewables installations hit record levels for the 22nd consecutive year, with around 700 GW of total renewable capacity added in 2024, nearly 80% of which was solar PV. Generation from solar PV and wind increased by a record 670 TWh, while generation from natural gas rose by 170 TWh and coal by 90 TWh. In the European Union, the share of generation provided by solar PV and wind surpassed the combined share of coal and gas for the first time. In the United States, solar PV and wind's share rose to 16%, overtaking that of coal. In China, solar PV and wind reached nearly 20% of total generation.
- **In 2024, over 7 GW of nuclear power capacity was brought online, 33% more than in 2023**. The new capacity added was the fifth-highest level in the past three decades. Electricity generation from nuclear in 2024 rose by 100 TWh, equalling the largest increase this century outside of the post-Covid rebound. Construction starts for nuclear power plants grew by 50% in 2024, exclusively using Chinese and Russian designs.

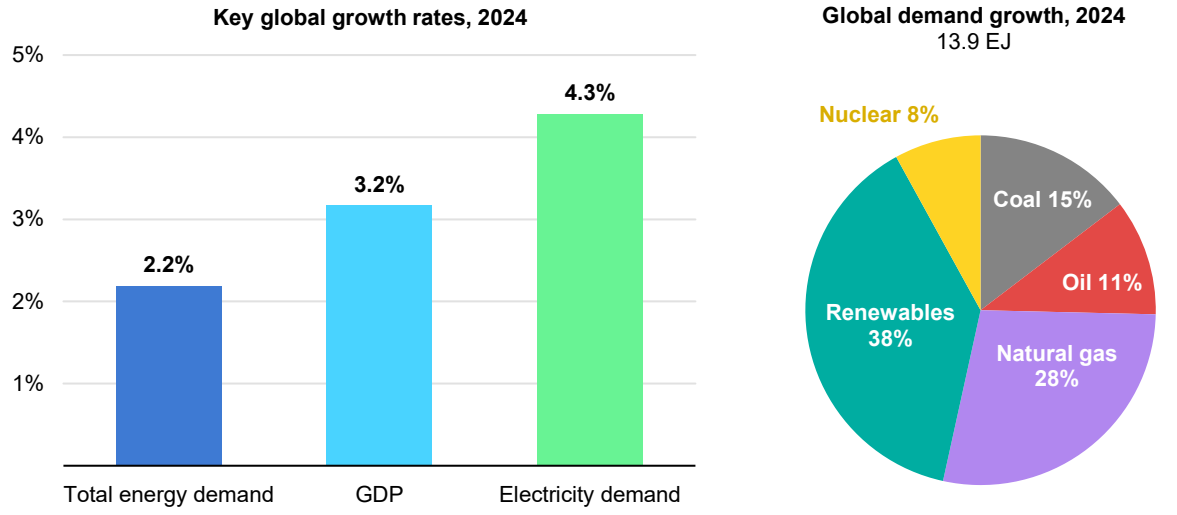
- **Growth in energy-related carbon dioxide (CO_2) emissions continues to decouple from global economic growth. Emissions growth slowed to 0.8% in 2024, while the global economy expanded by more than 3%.** The global increase of 300 million tonnes of CO_2 was influenced by record high temperatures. If weather in 2024 had remained consistent with 2023, itself the second-hottest year on record, about half of the increase in global emissions would have been avoided. Still, the deployment of solar PV, wind, nuclear, electric cars and heat pumps since 2019 now prevents 2.6 billion tonnes of CO_2 annually, the equivalent of 7% of global emissions. Most emissions growth in 2024 came from emerging and developing economies outside China. Emissions growth in China slowed in 2024, though per-capita emissions are now 16% higher than in advanced economies and nearly twice the global average. Emissions in advanced economies fell by 1.1% to 10.9 billion tonnes in 2024 – a level seen 50 years ago, when their GDP was more than three times smaller.
- **Energy intensity improvements continued to slow in 2024.** After improving at an average rate of around 2% annually between 2010 and 2019, energy intensity improvements slowed to 1.2% per year between 2019 and 2023 and only 1% in 2024. Key reasons for this recent slowdown include investment- and manufacturing-intensive post-Covid growth in major emerging and developing economies such as China and India; higher energy demand due to extreme temperatures; and a trend of poor growth in hydropower output that was only partially reversed in 2024, leading to more consumption of less-efficient fuels in some regions.

Global trends

Energy demand accelerates, with electricity leading the way

Different elements of the world's energy system saw very different rates of growth in 2024, reflecting both the impact of short-term factors and deeper structural trends. Global energy demand grew by 2.2% in 2024, a notably faster rate than the annual average of 1.3% seen between 2013 and 2023. This uptick was partly due to the effect of extreme weather, which we estimate added 0.3 percentage points to the 2.2% growth. Despite this, energy demand grew more slowly than the global economy, which expanded by 3.2% in 2024, close to its long-term average.

Key global growth rates and the share of energy demand growth by source, 2024



Electricity demand grew more rapidly than both overall energy demand and GDP, increasing by 4.3% in 2024. The absolute increase in demand was the largest ever recorded (excluding the jumps in years when the global economy recovered from recession). This reflects structural trends such as growing access to electricity-intensive appliances like air conditioning and a shift towards electricity-intensive manufacturing, as well as increasing power demand from digitalisation, data centres and AI, and the increasing electrification of end-uses. In all, the power sector made up three-fifths of the total increase in global energy demand.

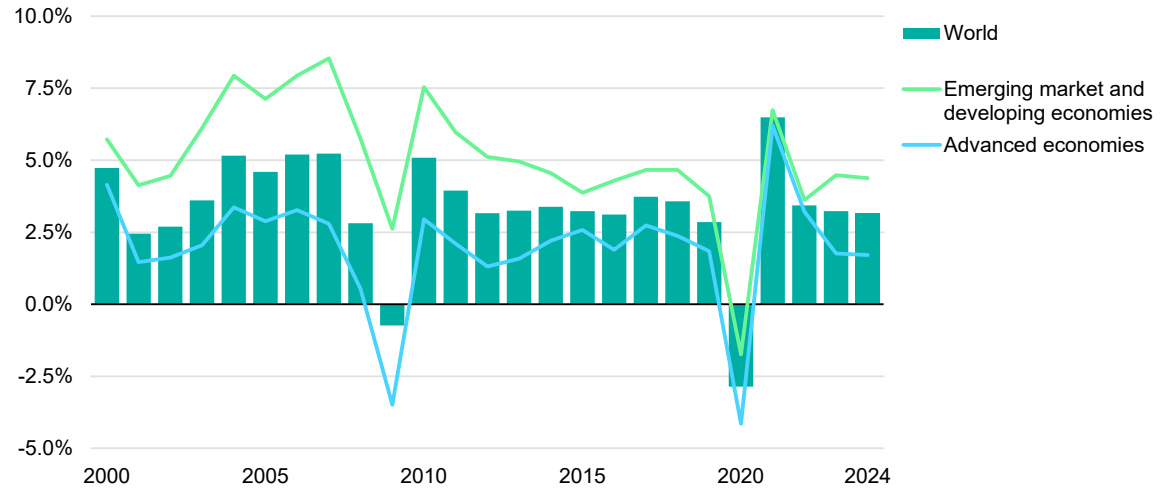
Renewables accounted for the largest share of the growth in total energy supply (38%), followed by natural gas (28%), coal (15%), oil (11%) and nuclear (8%). The

energy intensity of the global economy improved by a mere 1%, continuing the slowdown seen in recent years. The rise in energy-related CO_2 emissions slowed to 0.8%, compared with 1.2% in 2023.

The global economy saw moderate growth in 2024

After the upheaval of the Covid-19 pandemic and the subsequent global economic recovery, the world economy saw further moderation in growth trends in 2024. Global growth averaged 3.2%, close to its pre-pandemic average of 3.4% from 2010 to 2019. Inflation continued to decline in 2024 following sharp post-pandemic price spikes and the impact of the war in Ukraine. Global energy prices have also moderated, with oil prices on a downward trend after the highs of 2022. Yet geopolitical risks persisted, and some markets remained exposed to volatility. The main European gas price benchmark, the TTF, doubled by December 2024 from its lows in February 2024.

Annual rate of change in world GDP, 2000-2024



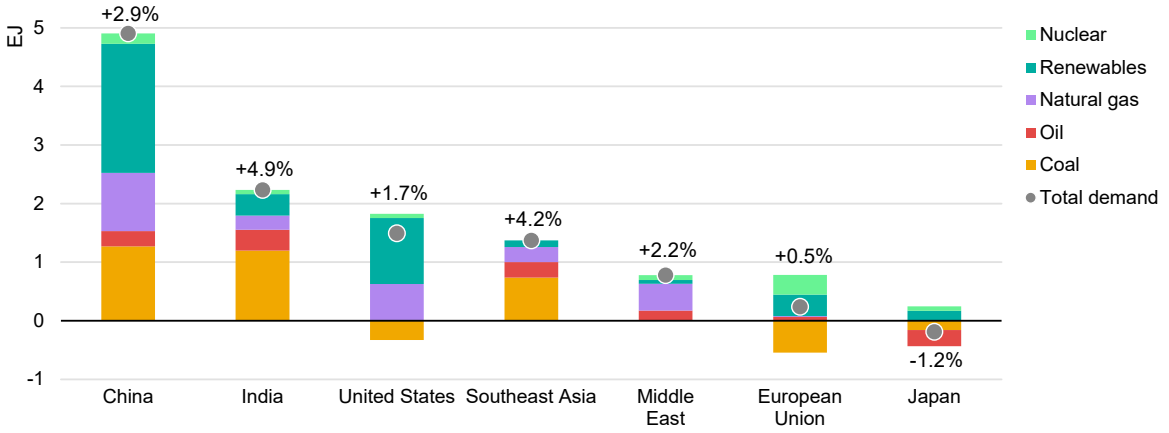
GDP growth in advanced economies slowed slightly to 1.7% in 2024. Continued stronger growth in the US was bolstered by healthy sentiment and consumer confidence. By contrast, the European Union saw weaker growth, amid competitiveness concerns. In emerging market and developing economies growth remained robust but slowed slightly to 4.4%. People's Republic of China (hereafter, "China") reported growth at 5%, supported by strengthening manufacturing output and exports, while the real estate contraction continued. The rate of growth in India slowed to 6.5%. Brazil saw improved economic performance in 2024, with GDP expanding 3.7%.

Energy demand growth varied sharply by region, with the largest growth coming from China

Global energy demand rose by 2.2% in 2024, reaching nearly 650 EJ. This was led by a notable shift back to growth in advanced economies where demand grew by almost 1% (+2 EJ), after declining 2% in 2023. Demand in the European Union returned to growth for the first time since 2017 (aside from the post-Covid rebound in 2021), aided by easing energy prices and a lower base after reductions in recent years. In the United States, demand grew by 1.7%, while demand in Japan continued its long-term decline, falling 1.2%.

The rate of energy demand growth in emerging market and developing economies slowed in 2024, falling to below 3%, down from nearly 4% in 2023. This was led by the slowdown in demand growth in China, which halved from 2023 – in part reflecting the last effects of the country's post-Covid reopening in early 2023. Growth also decelerated in India, falling to below 5%.

Change in energy demand, selected regions, 2023-2024



Nevertheless, despite this deceleration, four-fifths of total global energy demand growth still took place in emerging market and developing economies, with three-fifths of the total in Developing Asia. Growth in India alone was more than the increase in demand in all advanced economies combined.

Demand for all fuels and technologies grew in 2024, but non-fossil sources increased the most

Across the energy system, all fuels and technologies saw growth in 2024, although at different speeds. Among fossil fuels, natural gas grew the fastest, with demand rising by 2.7% to reach a new all-time high in 2024. Higher demand was focused in fast growing Asian markets, with growth of over 7% in China, and over 10% in

the smaller Indian market. Advanced economies saw a return to growth in 2024 after two years of declines linked to higher prices. Globally, demand growth was driven by higher industrial use, and by increased gas use in power generation (in part due to the impact of extreme weather).

Global oil demand growth slowed in 2024, rising by 0.8%, after increasing by 1.9% in 2023. This reflected the end of the post-pandemic mobility rebound, slower industrial growth and the increasing growth of substitutes like electric vehicles. Demand was largely flat in advanced economies (down by 0.1%). Oil demand growth saw a sharp deceleration in China (+0.8%), and grew around 1% in other emerging market and developing economies. In terms of sectors, growth was led by petrochemicals and aviation, while demand from road transport fell marginally.

Coal demand increased by just over 1% in 2024 to reach an all-time high, but the growth rate has slowed in recent years after a strong post-Covid rebound. Increased use in power generation supported growth, but metallurgical coal demand was undermined by the decrease in steel production. Coal demand growth is driven by markets in Developing Asia, with China alone now consuming nearly 40% more coal than the rest of the world combined. Consumption in advanced economies continued to decline, falling by over 5% in 2024.

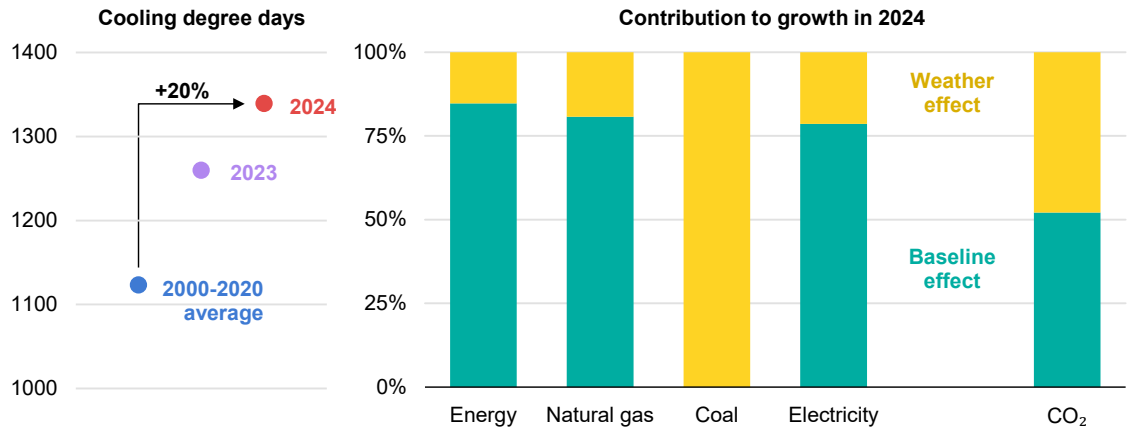
Other non-fossil fuel energy sources (including nuclear and renewables, bioenergy and waste) grew by over 5% in 2024, and made up nearly half the total growth in global energy demand in the year. Nuclear power rose by nearly 4%, while renewables grew at nearly 6%, led by the accelerated expansion of solar PV and wind. Energy supply from hydropower increased by 4.4%, posting a recovery from the record drop seen in 2023 due to droughts in major hydro markets.

High temperatures helped drive higher energy demand

Global energy demand was impacted by extreme temperatures in 2024 – the warmest year recorded, surpassing the previous record set in 2023. Global cooling degree days (a measure of cooling needs) were 6% higher in 2024 than in 2023, and 20% higher than the long-term average between 2000 and 2020. Regions with high cooling demand were particularly affected, including China, India and the United States.

In addition to driving cooling demand, temperature trends can also impact electricity generation, including from hydropower. In all, we estimate that weather effects contributed about 15% of the overall increase in global energy demand. The effects were higher for electricity, coal and natural gas consumption, as electricity demand is directly impacted by cooling, while coal and gas stepped in to meet higher electricity demand in several regions. We estimate that temperature effects contributed around 20% to the increase in electricity and natural gas demand and drove the entire increase in coal demand. For CO_2 emissions, weather effects contributed around half of the 2024 increase.

Cooling degree days in 2023 and 2024 compared with long-term average and contribution of total weather effects to change of energy demand and emissions, 2024



Energy intensity improvements slowed further

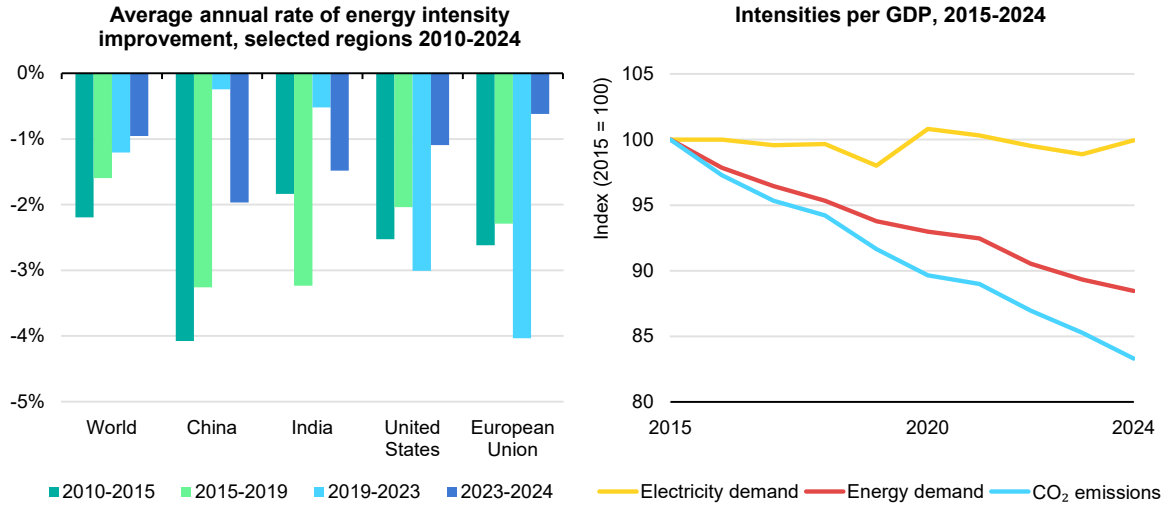
The primary energy intensity improvement of the economy, a key metric of energy efficiency, continued to slow in 2024. After improving at an average rate of around 2% annually from 2010 to 2019, the measure declined to 1.2% in recent years (2019-2023) and fell to around 1% in 2024. Key reasons for this slowdown in recent years include investment- and manufacturing-intensive economic recoveries in major emerging market and developing economies such as China and India; high energy demand due to extreme temperatures; and a trend of poor growth in hydropower output that was only partially reversed in 2024, leading to greater consumption of less-efficient coal power in some regions.

In 2024, energy intensity improvements slowed in advanced economies after several years of rapid progress due to high energy prices and weaker economic conditions in energy-intensive sectors. In contrast, China and India saw faster energy intensity improvements, although still below pre-Covid-19 rates.

The carbon intensity of global economic activity is the product of two factors: the energy intensity of GDP and the carbon intensity of total energy supply. As noted above, the energy intensity of GDP improved by around 1% in 2024. The carbon intensity of total energy supply improved by 1.1% in 2024. Combining these factors gives an improvement in the CO_2 intensity per unit of economic activity of 2.1% in 2024. This is slightly slower than the average improvement seen over the last decade and was caused by the slowdown in the improvement in energy intensity.

Electricity consumption growth has – amid wider electrification trends – remained broadly in line with GDP growth over the last decade. In 2024, the electricity intensity of GDP increased by 1%, as electricity demand growth exceeded the increase of GDP.

Rates of improvement in energy intensity



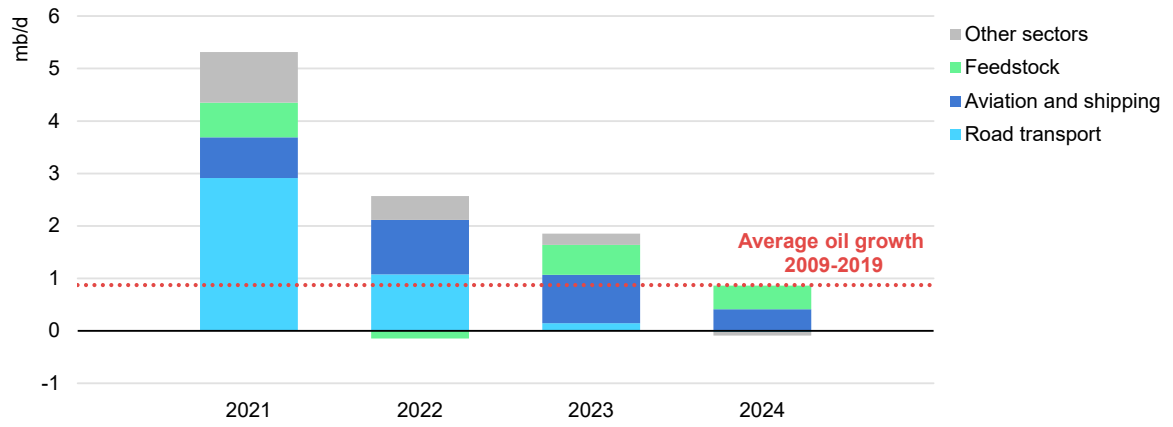
Oil

Oil demand growth loses momentum

Growth in global oil demand slowed markedly in 2024, with consumption rising by 0.8% (1.5 EJ or 830 kb/d) to 193 EJ after jumping by 1.9% in 2023. This reflected the end of the post-pandemic mobility rebound, slower industrial growth and the increasing impact of electric vehicles. This 0.8% increase in demand – below the pre-pandemic growth rate of over 1% in the decade to 2019 – was closely in line with the IEA's first forecast for 2024 set out in June 2023, which noted that structural macroeconomic trends would reassert themselves as Covid pandemic effects eased. Oil's share of total energy demand fell below 30% for the first time ever, 50 years after peaking at 46%.

In 2024, chemical feedstocks and aviation each accounted for around half of oil demand growth in energy terms (in volumetric terms, the share of feedstocks was higher, at around 70%). After rebounding strongly following the end of Covid-19 lockdowns in many countries, growth in oil demand from the road transport sector has slowed markedly in recent years. Since 2022, it has accounted for just 5% of growth in global oil demand in energy terms.

Global oil demand growth by sector, 2021-2024



The 2024 deceleration in demand growth was most visible in China. In 2023, the country's oil use surged by 8.7% after lockdowns were lifted, but in 2024, it rose by 0.8% – well below the average annual growth rate prior to the Covid-19 pandemic. Most of this growth was recorded in 1Q24, owing to the residual impact of lockdowns in 1Q23. The slowdown was driven by a mix of factors, including the very rapid deployment of electric vehicles, growth in natural gas-powered trucks, the huge expansion of high-speed rail, and the ongoing downturn in the property sector. In 2023, oil demand had also been boosted by a major year-on-year oil price decline, with benchmark Brent crude prices falling by 18% compared with 2022 (and product prices falling further). In 2024, average prices fell only marginally year-over-year and the absence of a comparable boost contributed to the more muted demand uplift.

As a result, while global oil consumption in 2024 recovered to 1.3% above 2019 levels, this was almost entirely due to higher demand for petrochemical feedstocks, which climbed by over 12% over the previous five years. This growth is highly concentrated in China, where feedstock use rose by more than the total net increase in world oil demand. Feedstock demand growth has remained strong – principally due to the absence of efficiency improvements or widespread substitution impacting plastic production or demand.

Non-feedstock uses of oil remain dominated by transport applications in road, aviation and shipping. In 2024, these non-feedstock uses were virtually equal to 2019 levels, despite aggregate global GDP growth of about 14% over this five-year period. This highlights the impact of factors such as electric vehicles and high-speed rail, efficiency improvements and remote working.

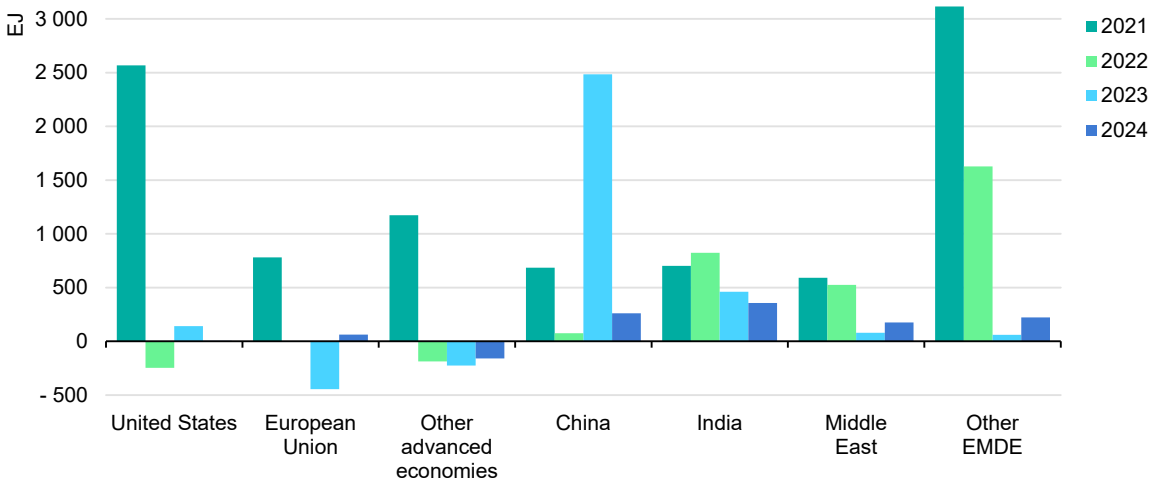
Liquid biofuel demand increased by 0.2 EJ in 2024 compared with 2023, reaching over 4% of global transport fuel consumption. Brazil, India, Indonesia and the United States accounted for 90% of this growth. Brazil alone contributed nearly half of the expansion, driven by continued policy support for biofuel blending and rising transport fuel demand. In the United States, which accounted for one-fifth of global demand growth, the increase was supported by federal and state-level policy measures. India and Indonesia together contributed a further 20%, reflecting higher blending mandates and increased fuel consumption.

Oil demand: regional and sectoral oil demand trends

Oil demand was largely steady in advanced economies in 2024, falling by 0.1%, compared with the 0.7% decline recorded in 2023. Nevertheless, demand remained 5.4% below its 2019 level. This drop was concentrated in oil products for road transport, with tighter vehicle efficiency standards, the higher share of EVs and more prevalent remote working, outweighing modest underlying economic growth.

US oil demand was flat in 2024 after ticking up in 2023. It remained 4.3% lower than in 2019, with non-feedstock uses down by 7% but petrochemical use nearly 18% higher. Teleworking has had a particularly large impact on US gasoline consumption, especially given the importance of driving for US commuters. In contrast, rising feedstock demand for export-focused polymer production has been supported by a sharp rise in domestic natural gas liquid (NGL) supplies.

Change in oil demand by region, 2021-2024



Transport fuel use in the European Union and Japan has been constrained by similar factors. While demand was flat in 2024, difficult industrial conditions helped

push EU oil consumption to 7.0% below 2019. Japan posted an 11.8% fall compared with pre-pandemic levels after 2024 demand dropped by 4.4%.

In 2023, China saw demand growth rise to a record 1.4 mb/d, as it emerged from a year of lockdowns, with surging mobility and the release of pent-up demand, especially for air travel. This coincided with a vast wave of petrochemical plants ramping up. Consumption for petrochemical feedstocks therefore increased by 900 kb/d, while demand for jet fuel/kerosene rose by 320 kb/d. In 2024, this shifted, with non-feedstock growth stalling.

In other emerging market and developing economies in Asia, fuel demand continues to rise. India (+3.4%) was the largest single global oil demand growth source in 2024, while demand in Southeast Asia (+2.6%) also rose significantly. India's dynamic economy has underpinned the advances of recent years, with urbanisation and rising car ownership lifting oil demand 11.6% higher in 2024 than 2019. Gasoline use in the world's most populous nation increased by 41.7% (+310 kb/d) from 2019 to 2024.

Across Africa and Latin America, rises in demand across 2023 and 2024 were much more uneven. A period of relatively high oil prices and a strong US dollar created challenges for importers, with several emerging market and developing economies seeing acute disruptions to fuel use. This is often connected to wider economic difficulties – as in Argentina and Sri Lanka – and the withdrawal or reduction of government subsidy schemes – as was the case in Egypt, Nigeria and Pakistan. As a result, demand in Africa declined in both 2023 and 2024, while the increase in Latin America was overwhelmingly due to growth in Brazil.

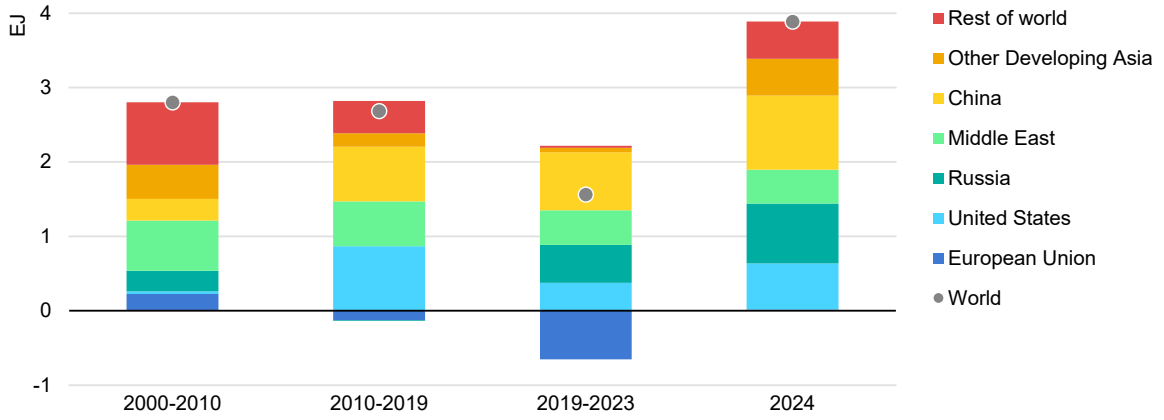
Natural gas

Natural gas demand returned to structural growth in 2024

Following the supply shock of 2022 and 2023, natural gas markets moved towards a gradual rebalancing and returned to structural growth in 2024. Global gas demand reached a new all-time high, with over three-quarters of growth coming from emerging market and developing economies. Preliminary data indicate that gas demand increased by 2.7%, or 115 billion cubic metres (bcm) (equivalent to around 4 EJ) in 2024. This was above the around 2% annual average growth rate from 2010 to 2019 and well above the rate of around 1% between 2019 and 2023, amid the Covid pandemic and global energy crisis. Emerging market and

developing economies in Asia accounted for around 40% of additional gas demand in 2024 on the back of continued economic expansion.

Change in natural gas demand by region, 2000-2024



Industry and power sectors drove higher consumption

From a sectoral perspective, global gas demand growth was largely supported by industry and electricity generation, which accounted for around 75% of incremental gas demand in 2024. This was bolstered by continued economic expansion in fast-growing markets in Asia, as well as some recovery in Europe's industrial gas demand, though it remained well below its pre-crisis level.

Gas demand for electricity generation grew by near 2.8% year-on-year, as strong increases in North America, fast-growing Asian markets and Eurasia were partially offset by lower gas-fired power generation in Europe. Extreme weather conditions, particularly heat waves in China, India and the United States, contributed to higher gas burn in the power sector in 2024. Extreme temperatures alone accounted for around one-fifth of the increase in global natural gas demand. Natural gas demand in the residential and commercial building sectors grew by around 1% in 2024.

Natural gas continued to displace oil and oil products in various sectors, supported by policies, regulations and market dynamics. In the Middle East, oil-to-gas switching in the power sector continued in 2024. In road transport, the rapid scaling up of natural gas-powered trucks in China – with record sales in 2024 – contributed to lower diesel demand there. The use of LNG as a bunkering fuel is also expected to increase amid more stringent emissions regulations for shipping.

Gas demand grew across regions

Natural gas demand in emerging market and developing economies in Asia expanded by around 6% in 2024, accounting for nearly 40% of incremental global gas demand. This strong increase was primarily driven by China and India. Both gas markets displayed high growth rates, supported by relatively low LNG prices during the first half of the year and widespread heatwaves in the second and third quarter of 2024. China's natural gas demand increased by over 7%, although demand growth turned negative in the last two months of the year. In India, natural gas demand increased by 10%, supported by a healthy macroeconomic environment, expanding natural gas grids and higher gas-based power generation needs due to high temperatures.

Natural gas consumption in North America rose by close to 1.8% (or around 20 bcm) in 2024. This growth was primarily supported by gas demand for electricity generation. Natural gas use in the residential and commercial sectors was below its 2023 level, as higher consumption in the fourth quarter could not compensate the demand decline recorded in the first quarter of 2024. Natural gas demand from industry increased marginally compared with 2023. In the United States, natural gas demand increased by an estimated 1.9% in 2024, primarily driven by the power sector, where the gas share rose to an all-time high of 43%.

Natural gas consumption in Latin America rose by 1.6% (or around 2 bcm) in 2024, driven by increased usage for power generation. This demand growth led to a 17% rise in LNG imports, although trends varied between countries. Natural gas demand increased particularly strongly in Brazil and Colombia. Both countries were hit by severe droughts, which limited hydropower availability and increased reliance on gas-fired power generation.

Natural gas consumption in the European Union rose by around 1% in 2024. The bloc's gas demand for power generation fell by around 5% in 2024 despite the increase of about 1.5% in total electricity demand. The steep decline in gas-fired power output was primarily driven by the strong increase in renewable electricity generation. Natural gas consumption in industry continued to recover in 2024, benefiting from the lower price environment, but it remained nearly 15% below its 2019 level. Natural gas demand in the Middle East grew by an estimated 2%, supported by stronger gas use by the power and industry sectors. In Africa, depressed upstream activity limited natural gas demand growth to below 1%.

Coal

Global coal demand growth slows

Global coal demand grew by 1.1% in 2024 in energy terms, rising by around 67 million tonnes of coal equivalent (Mtce) (or in physical terms by 1.4% or 123 million tonnes). The growth rate has been declining since the strong rebound in 2021 following the end of Covid-19 lockdowns in many countries.

The electricity sector continues to drive coal demand, accounting for two-thirds of global consumption. In 2024, global coal power generation grew by nearly 1% to 10 700 TWh, a new high. A key driver was record temperatures, which pushed up electricity demand for cooling (especially with intense heatwaves in China and India). The estimated effect of higher temperatures on coal demand in 2024 covers the entire annual increase in coal use. While coal remains the world's largest source of power generation, its share in the electricity mix is falling: its current share (35%) is the lowest since the IEA was founded in 1974.

Consumption of metallurgical coal fell by around 0.5% in 2024, driven mainly by the decline in global steel production. However, overall coal demand for non-power uses grew very slightly, driven by the growth and strong performance of coal-intensive sectors such as nickel mining in Indonesia and chemical production in China.

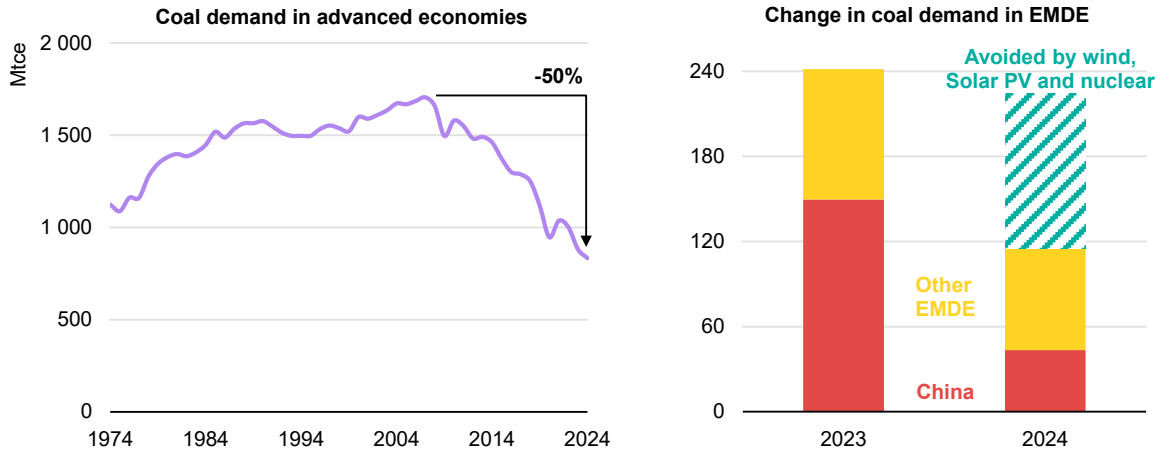
Developing Asia leads increasing coal demand

The share of global coal demand consumed in Developing Asia rose again in 2024, reaching nearly four fifths, up from below two fifths in 2000. In China, coal demand grew by 1.2% (43 Mtce) in 2024, reaching a new all-time high. The country now consumes nearly 40% more coal than the rest of the world combined, largely for power generation. Over one-third of all the coal consumed globally is burned by power plants in China. China's influence in global coal market trends is unparalleled by any country for any type of fuel, with China's share of global coal consumption now standing at 58%.

In 2024, electricity demand in China was very strong, rising by 7% (or over 550 TWh). Despite huge solar PV and wind capacity additions in recent years – as well as a recovery in hydropower output in the first half of the year due to higher rainfall, plus increases in nuclear, biomass and gas power generation – there was still a gap between the additional electricity demand and supply. Coal generation filled this gap, increasing by 1.2%. Coal consumption in China's iron and steel sector – larger than total coal consumption in any country except India – shrank by around 2%, as steel production declined by 1.7%. Cement production declined by around 9.5%, and we estimate a similar decline in the sector's coal

consumption. However, strong growth in coal used for chemicals and other products partially offset the wider drop in non-power coal consumption.

Coal demand in advanced economies, 1974-2024, and change in coal demand in emerging market and developing economies in 2023 and 2024



In India, the world's second-largest coal consumer, demand grew by around 5.5% or 40 Mtce in 2024, also reaching a new all-time high. Strong economic growth pushed up coal consumption in both the power and industry sectors. Coal power generation – which makes up nearly three-quarters of coal demand in India – grew by 5% in 2024 mirroring growth in electricity demand. Steel production grew by 6.3% in 2024. Coal-based sponge iron production increased by 10% and hot metal production increased by 4.4%, boosting industrial coal use.

In Southeast Asia – which in 2023 became the third-largest coal consuming region in the world, overtaking the United States – coal consumption continued to grow in 2024, rising by almost 8% (25 Mtce). The increase was mainly driven by three countries. In Indonesia, use by metallurgical industries – in particular, nickel producers – was the main growth driver. In the Philippines and Viet Nam, coal power generation was the main driver.

In advanced economies, coal demand has halved from the peak seen in 2007 and 2024 saw another decline. In the United States, coal consumption fell by 4% (around 10 Mtce), though this is a significant slowdown compared with the 17% drop recorded in 2023. Total electricity demand, which switched from decline in 2023 to growth in 2024, was the main driver of this trend; in the United States, coal is used almost exclusively for power generation.

In the European Union, coal demand continued its decline as an increasing number of countries closed coal power plants. The United Kingdom, where the world's first coal power plant was set up in 1882, joined the list of countries without

coal power capacity in September 2024. EU coal power generation fell 15% in 2024 and total coal demand fell by over 10% or 21 Mtce.

In 2024, global coal-based electricity generation grew by 90 TWh, while generation from wind, solar PV and nuclear grew 770 TWh. We estimate that without the increase in output from these three technologies in 2024, the increase of global coal demand would have been nearly two times higher.

Electricity

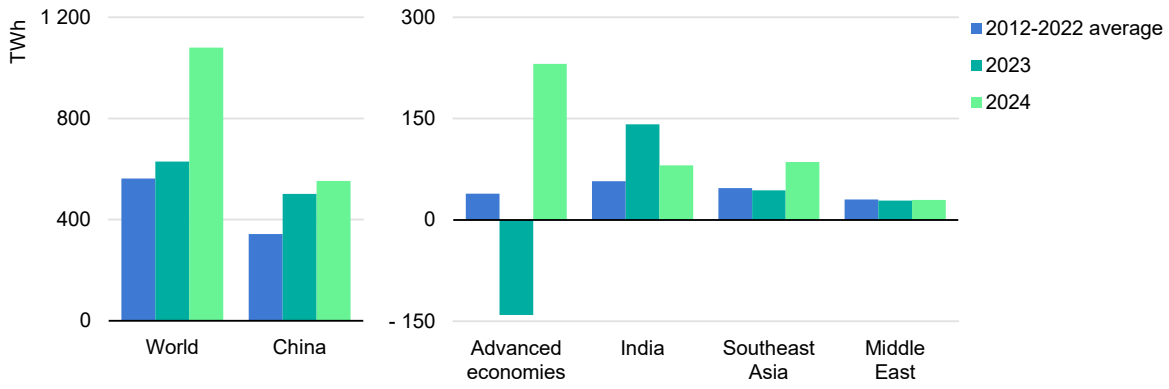
Electricity demand growth surged in 2024

Global electricity demand increased by 4.3% in 2024, a step change from the 2.5% growth seen in 2023. The average pace of electricity demand growth from 2010 to 2023 was 2.7%, double the rate of total energy demand growth over the same period. Electrification picked up across sectors, raising electricity demand in most major economies in 2024.

China accounted for the largest share of electricity consumption growth, but increases were seen globally

Almost all regions saw an acceleration in the rate of electricity consumption growth in 2024 compared with the annual average from 2012 to 2022. Globally, electricity consumption increased by 1 080 TWh, nearly two times the annual average of the past decade.

Change in total final consumption of electricity for selected regions, 2012-2024



Note: Total final consumption excludes own use for power plants and industry, and transmission and distribution losses.

In China, electricity consumption increased by more than 550 TWh (7%), almost as much as the average annual global increase in electricity consumption over the previous decade (2013-2023) and well above the China's own average increases during this period.

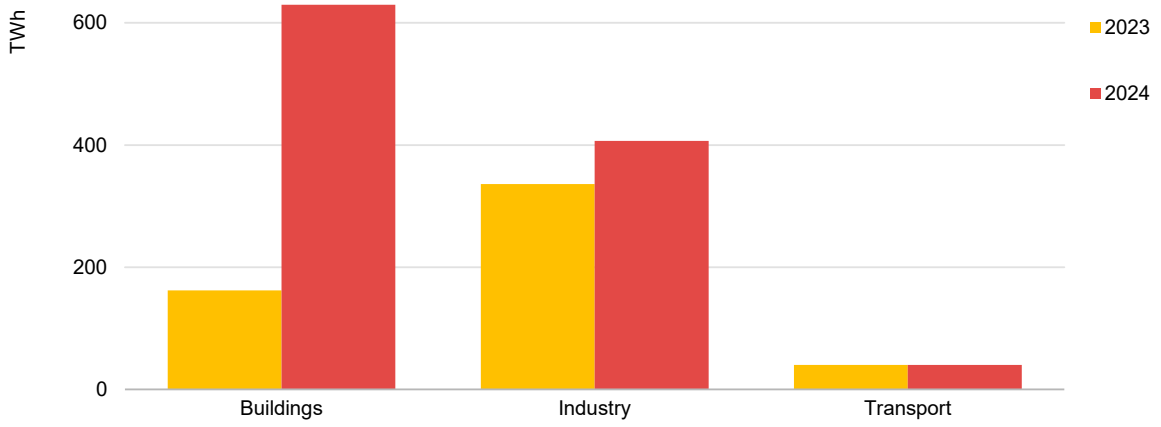
In 2023, advanced economies saw a 140 TWh decline in electricity consumption due to soft industrial output in some countries and milder weather conditions. In 2024, this reversed dramatically, with electricity consumption increasing by 230 TWh, led by growth in the United States. Strong demand for cooling, growth in the data centre sector and a pickup in industrial production were important factors behind this trend. The European Union's electricity consumption grew by about 1.5% in 2024, compared with near-zero growth on average from 2003 to 2023. Other advanced economies, including Australia and Korea, also saw upticks in the pace of electricity demand growth.

In India, the pace of electricity consumption growth slowed in 2024 compared with 2023, representing a normalisation after extremely unfavourable weather drove up demand in 2023. In Southeast Asia, on the other hand, consumption jumped by over 7% in 2024, compared with about 4% in 2023.

The buildings sector drove higher electricity demand in 2024, growing four times faster than in 2023

Global electricity consumption in buildings increased by more than 600 TWh (5%) in 2024, accounting for nearly 60% of total growth in electricity consumption. Key drivers included rising demand for air conditioning, which was bolstered by severe heatwaves in countries such as China and India, and demand for power from new data centres.

Annual change in electricity consumption by sector



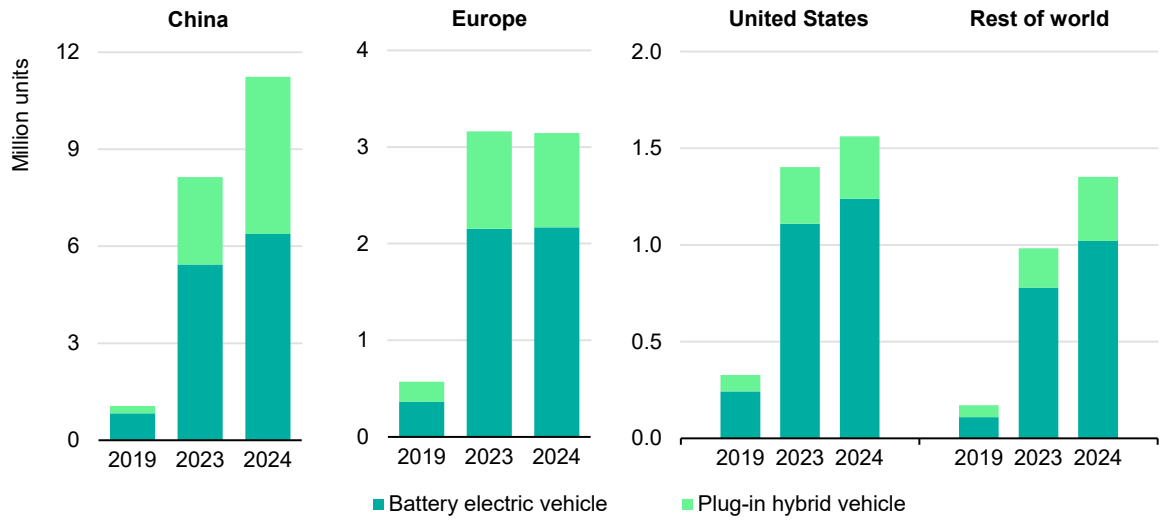
The industry sector made up nearly 40% of total growth in electricity demand in 2024. Electricity use in industry grew by nearly 4% in 2024, a step up from the pace in 2023, driven by increased activity in electro-intensive manufacturing and industrial growth more broadly. The continued uptake of electric vehicles raised electricity consumption in the transport sector by over 8% in 2024.

Technology: Electric vehicles

Electric car sales continued to rise globally in 2024, increasing by more than 25% to more than 17 million units, up from below 14 million units in 2023. This aligns with the IEA's preliminary estimate for annual sales in the 2024 edition of the *Global EV Outlook* publication. EV sales accounted for over 20% of all car sales in 2024.

China was the leading driver of growth, accounting for almost two-thirds of global electric car sales in 2024. The country's electric vehicle sales experienced an impressive annual growth rate of nearly 40%. A large share of this growth came from plug-in hybrid electric vehicles (PHEVs), where sales saw an 80% increase, compared with a nearly 20% rise in battery electric vehicles (BEVs). Growing demand for extended-range electric vehicles (EREVs) has supported this trend; the configuration is currently most prevalent in China. The country's market has been further supported by its vehicle trade-in scheme, which includes subsidies of up to nearly USD 3 000 to encourage consumers to replace older, less efficient cars with new energy vehicles.

Electric car sales in selected car markets



Note: Europe includes the European Union, Iceland, Israel, Norway, Switzerland, Türkiye, United Kingdom, Albania, Belarus, Bosnia and Herzegovina, Kosovo, North Macedonia, Republic of Moldova, Montenegro, Serbia and Ukraine.
Source: IEA analysis based on data from ACEA, EAFO, EV Volumes and Marklines.

The United States experienced sales growth of over 10%, largely driven by the release of new electric vehicle models and availability of EV tax credits, which provided financial aid to consumers.

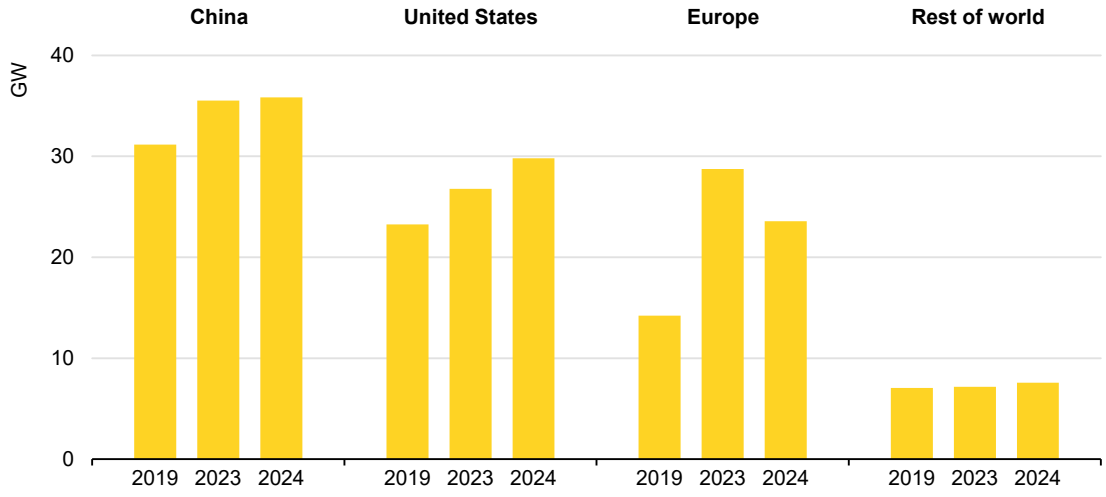
Electric car sales in the European Union fell by 6%, in large part due to decreased sales in Germany, where purchase subsidies were removed at the end of 2023. In contrast, EV sales in the United Kingdom surged, driven by the Zero-Emission Vehicle (ZEV) mandate. As a result, in 2024 the United Kingdom emerged as the leader in battery electric car sales among European countries, surpassing Germany for the first time.

Emerging market and developing economies outside China witnessed a significant 80% annual increase in EV sales, although this growth came from a relatively lower base compared with more mature markets. Markets such as Brazil and Indonesia saw sales increase by 140% and 190%, respectively.

Technology: Heat pumps

Global heat pump sales fell by 1% in 2024, recovering most of the decline recorded in the first half of the year, when global sales were down by 10% year-over-year.[1] Some markets, notably Japan and the United States, showed a strong recovery in demand in the second half of the year, but it was not enough to offset the sharp annual decline in Europe and stagnation in China.

Heat pump sales for selected regions



Source: IEA analysis based on the European Heat Pump Association (EHPA); the Air-Conditioning, Heating and Refrigeration Institute (AHRI); the Japan Refrigeration and Air Conditioning Industry (JRAIA), and ChinaIOL.

[1] Heat pumps refer to those that deliver heat directly to households and residential or commercial buildings for space heating and/or domestic hot water provision. They include natural source heat pumps, including reversible air conditioners used as primary heating equipment. They exclude reversible air conditioners used only for cooling, or used as a complement to other heating equipment, such as a boiler.

In China, annual capacity additions in 2024 remained at similar levels to 2023, with sales in some heat pump segments slowing down towards the end of the year. China remains the largest heat pump market globally, and it holds the largest share of manufacturing capacity for heat pump units and certain key components such as compressors.

In the United States, the second-largest heat pump market, sales rose by around 15% in 2024 on the previous year. This was driven by a 30% increase in the second half of the year compared with the same period in 2023, which compensated for the slight decline in sales in the first half. Throughout the year, heat pumps continued to gain market share over heating systems powered by fossil fuels. In 2024, heat pumps outsold natural gas furnaces by 30%, the largest gap ever recorded.

In Europe, the third-largest heat pump market, sales fell by a record 21%[2], seeing the largest decline ever recorded in the region both in relative and absolute terms. This drop was largely driven by Germany, where sales fell by almost 50%, and by France, where they declined by 25%. Several factors contributed to this trend, including high prices for electricity compared with natural gas (which in 2024 was well below its 2022 peak) and an uncertain political and regulatory landscape. A slowdown in the construction sector also had an impact on heat pump installations, since a large share are in new buildings.

In Japan, the fourth-largest heat pump market, sales increased by over 5%, recovering after a weak start to the year. Sales of both air-to-water systems (which are mainly used for domestic hot water in Japan) and air-to-air systems (which are typically used for space heating) increased on an annual basis.

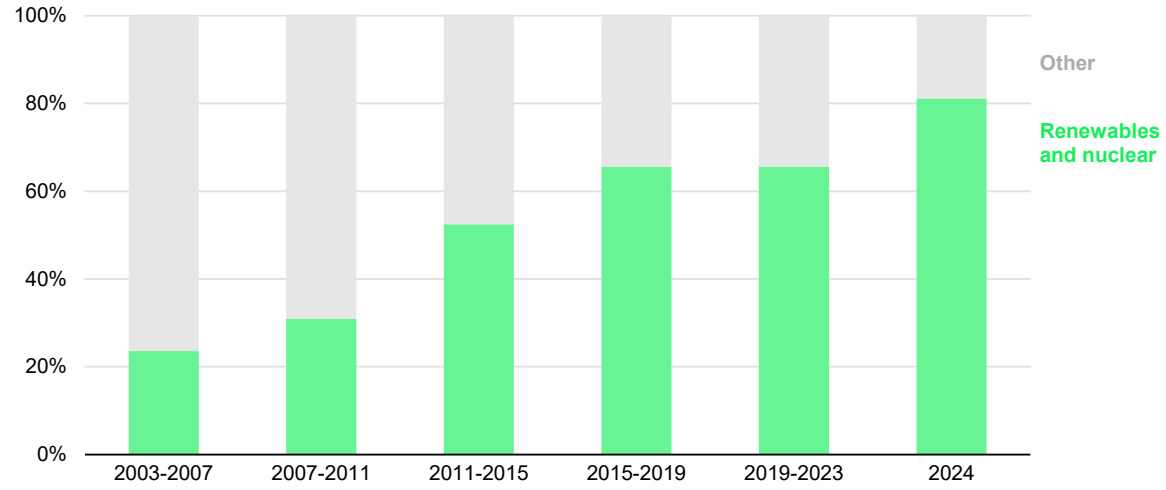
Electricity generation

Clean energy accounted for over 80% of total growth in electricity generation in 2024

Global electricity generation grew by over 1 200 TWh in 2024. Mirroring the rise in electricity demand, this annual increase of 4% represents a significant acceleration from the average growth rate of 2.6% seen between 2010 and 2023. Rising generation from renewables and nuclear power made up over 80% of global growth – a step up from 2023, when they accounted for two-thirds of total growth.

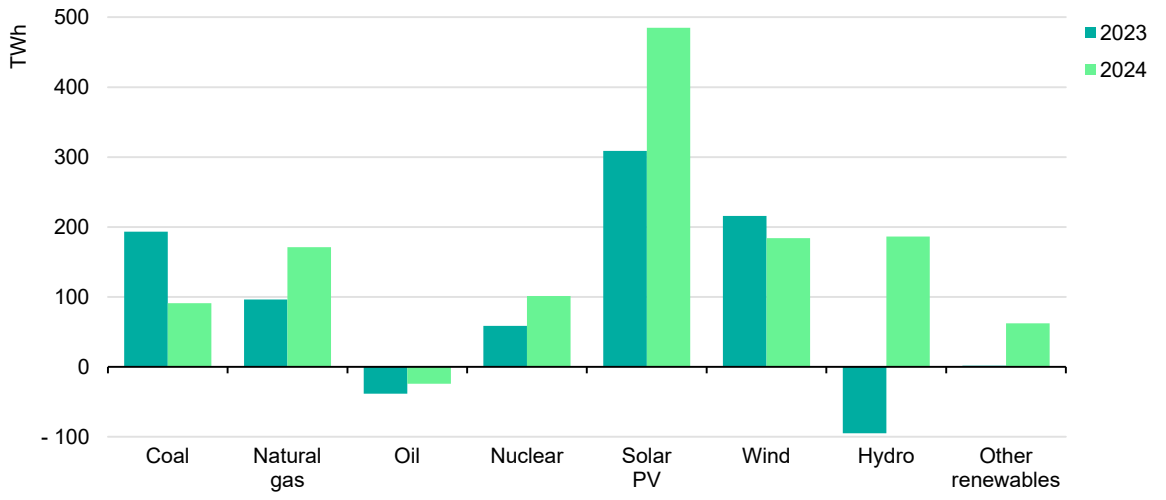
[2] The 23% from corresponds to data from the European Heat Pump Association (EHPA) covering Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Poland, Portugal, Sweden, and the United Kingdom.

Share of increase in global electricity generation, 2003-2024



In 2024, renewables alone made up almost three-quarters of the overall increase in power generation. Solar PV led the way, increasing by about 480 TWh – the most of any source and far exceeding the previous year. Global generation from solar PV has been doubling approximately every three years since 2016, and it did so again between 2021 and 2024. Wind expanded by about 180 TWh in 2024 as new projects were brought online. However, the annual growth rate of 8% was the lowest in the last two decades due to a high base, as well as permitting and licensing challenges in several regions. Hydropower generation also increased by 190 TWh in 2024, mainly due to wet weather in several major markets. Nuclear power output increased by nearly 4%, boosted by new projects and restarted operations at several reactors in France and Japan.

Annual change in global electricity generation by source



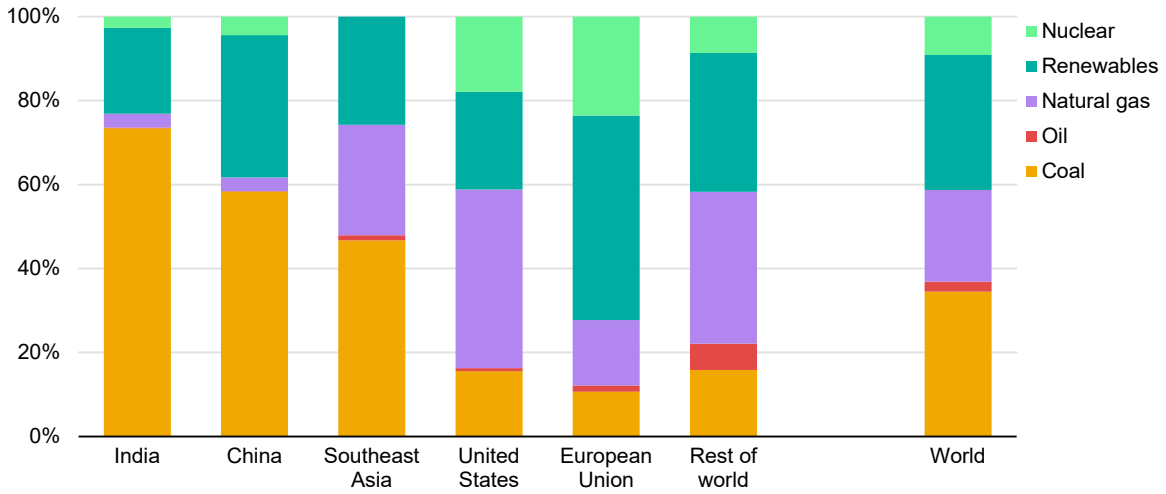
Electricity generation from fossil fuels increased by just over 1% in 2024, making up less than one-fifth of global growth in electricity generation. Natural gas generation increased by about 2.5% year-on-year, significantly more than in 2023, with reductions in natural gas prices in most major markets and hot weather in some regions delivering a boost. Output from coal-fired power plants increased by less than 1% in 2024, half the rate of growth seen the year before.

Fossil fuels made up nearly 60% of 2024 electricity generation, but the power mix is evolving

Coal remained the largest source of electricity generation in the world, a position it has held for more than 50 years. In 2024, it accounted for 35% of total power generation. Natural gas was the second-largest source of electricity, marking more than two decades in which it has provided over 20% of global electricity. Oil-fired power plants generated just a few percent of the total.

However, the global power mix is evolving. For the first time ever, power generation from renewables and nuclear covered two-fifths of total global generation in 2024. Renewables collectively accounted for one-third of electricity generation, led by hydropower (14% of total electricity generation), wind (8%), solar PV (7%) and bioenergy and waste (3%). Nuclear power covered 9% of global electricity generation.

Electricity generation mix for selected regions, 2024



In emerging market and developing economies, coal is often the primary source of electricity. In China, the largest electricity system in the world, coal provided almost 60% of generation, followed by about 35% from renewables, with smaller roles for nuclear and natural gas. In India, coal provided nearly three-quarters of

electricity supply, complemented by over 20% from renewables, with smaller contributions from nuclear power and natural gas. Southeast Asia got almost half of its electricity from coal and about one-quarter each from natural gas and renewables.

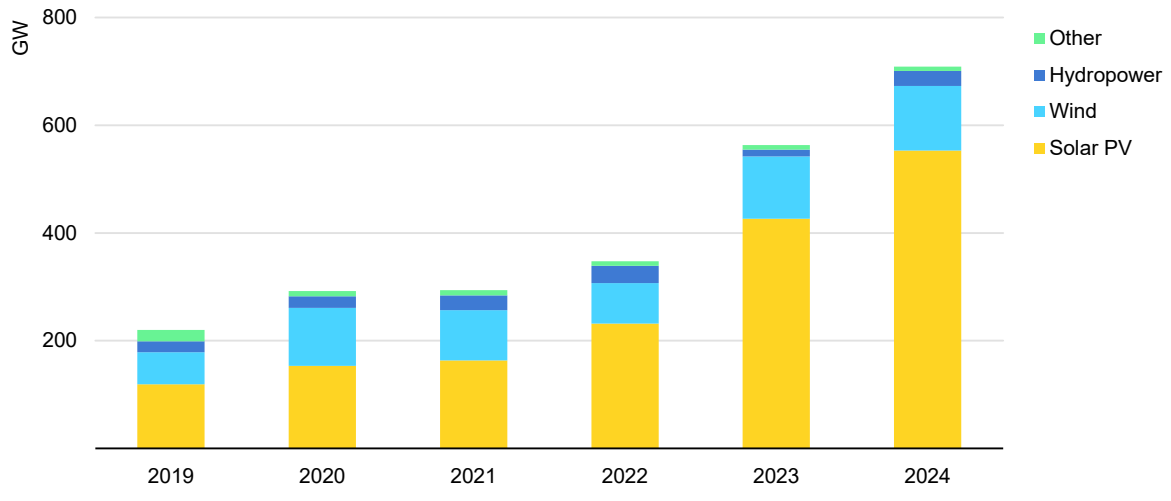
In advanced economies, renewables and natural gas play larger roles in electricity generation. In the United States, natural gas accounted for over 40% of all electricity generation in 2024, followed by renewables (23%), nuclear (18%) and coal (16%). In the European Union, renewables made up nearly half of electricity supply, well above the world average. The region also continued to rely on nuclear (23% of the total), with lower shares for natural gas (16%) and coal (11%).

Technology: Solar PV and wind

In 2024, global annual renewable capacity additions surged by an estimated 25% to around 700 GW – marking the 22nd consecutive year that renewables have set new records for expansion. Solar PV accounted over three-quarters of renewable capacity additions, followed by wind (17%) and hydropower (4%), with bioenergy, geothermal, concentrating solar power and marine making up the remainder.

Solar PV additions in 2024 rose by almost 30% year-over-year, totalling about 550 GW. With this growth, installed solar PV capacity worldwide reached an estimated 2.2 terawatts (TW). Annual wind additions remained stable at around 120 GW. Together, solar PV and wind accounted for 95% of overall renewable capacity growth in 2024. Hydropower installations more than doubled to over 25 GW thanks to large projects commissioned in China, Africa and Southeast Asia.

Total renewable capacity additions by technology, 2019-2024

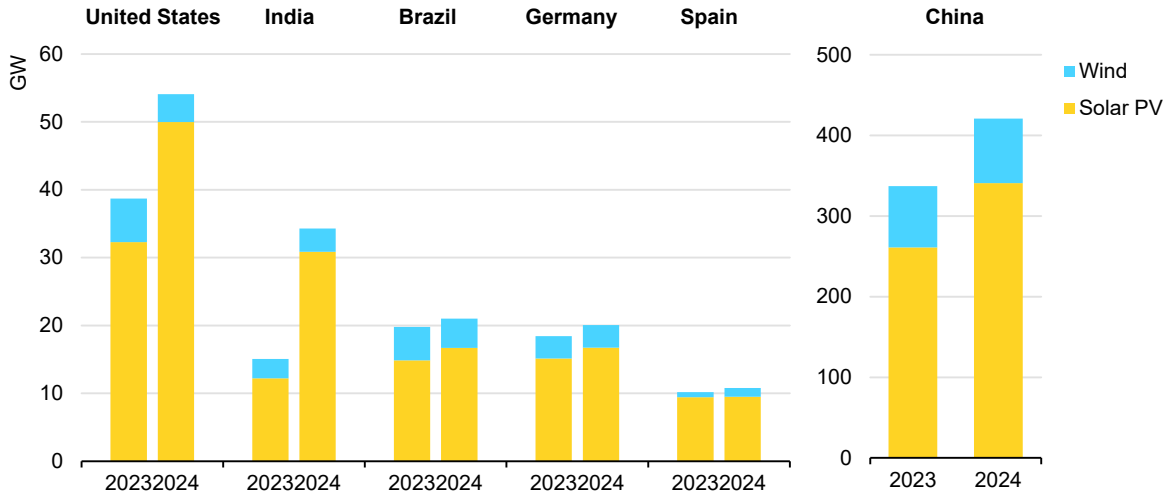


Note: 2024 values are based on both actual and estimated additions.

China continues to drive renewable capacity additions

China once again saw record expansion, making up almost two-thirds of all renewable capacity connected to the grid in 2024. Solar PV capacity additions (DC, direct current) reached over 340 GW, a 30% increase compared with 2023. Utility-scale plants drove over 60% of China's PV expansion, followed by distributed commercial and industrial installations. Incentives targeting rural economic development have significantly boosted the installation of residential solar systems in China since 2019, with these systems accounting for approximately one-fifth of the country's annual PV additions on average. However, last year, China's residential PV market (30 GW) accounted for less than 10% of the country's solar PV additions as incentives phased out. Meanwhile, wind growth remained stable but strong at 80 GW. The country surpassed its 2030 ambition of 1 200 GW of combined solar PV and wind capacity six years early, in mid-2024.

Solar PV and wind net additions in selected markets



Note: United States solar PV values are based on Renewables 2024 data.

The European Union installed around 60 GW of solar PV capacity in 2024, similar to in 2023. This was more than double the annual capacity added in 2021, before the energy crisis sparked by Russia's full-scale invasion of Ukraine in 2022. However, outside of three large markets (Germany, Italy and Spain), newly installed PV capacity declined year-on-year in over 15 EU member states. While high electricity prices – and new incentives that increased the economic attractiveness of residential and commercial systems – accelerated the expansion of solar PV in 2022 and 2023, lower energy prices in 2024 and declining policy support led to a slowdown in growth in many markets.

At the same time, three major solar PV markets saw record levels of expansion in 2024: the United States, India and Brazil. In the United States, almost 50 GW of new solar PV capacity was added to the grid, shattering the previous record in 2023. India installed around 30 GW, almost tripling the previous year's solar PV growth, while Brazil added over 16.5 GW thanks to large utility-scale additions, which supplemented the continued roll-out of distributed resources driven by a net metering scheme.

For wind, while China's additions increased slightly in 2024, EU wind additions were 20% lower compared with 2023. Long permitting timelines, supply chain challenges and auction schedules were key factors. Wind capacity additions in India exceeded those seen in 2023, while the United States and Brazil saw a decline compared with last year.

Technology: Nuclear

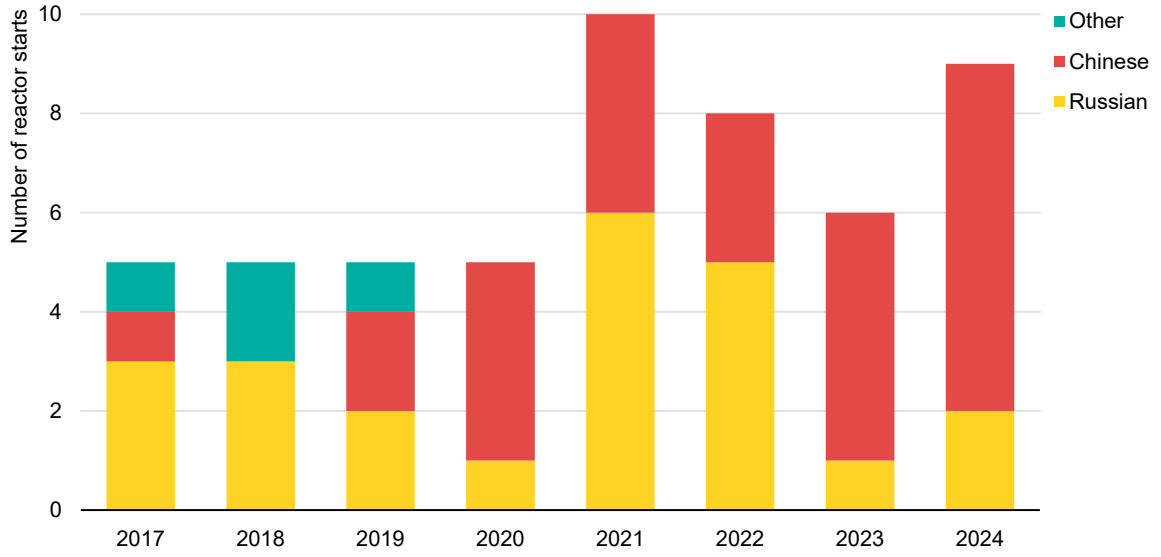
In 2024, over 7 GW of nuclear power capacity was brought online – 33% more than in 2023. That brought the total installed nuclear capacity to 420 GW. Of the six nuclear projects completed, all of which were large-scale reactors: two were in China, while France, India, the United Arab Emirates and the United States each finished one. New nuclear capacity added in 2024 was the fifth-highest in the last 30 years.

Nuclear construction starts increased 50% in 2024, exclusively using Chinese and Russian designs

Globally, there were nine construction starts of nuclear reactors in 2024, 50% more than in 2023. When completed, they are expected to have a total capacity of 11 GW. China began construction of six nuclear reactors in 2024 (all of Chinese design) – one of the highest number of starts in the country ever and extending its market leadership in terms of construction. Pakistan began construction of one reactor in 2024, the first Generation III+ design of Chinese origin used outside of China. Egypt and Russia each began constructing one nuclear reactor in 2024, both of Russian design. Over the past five years, all nuclear construction starts have used either Chinese or Russian designs.

As of February 2025, there were a total of 62 nuclear reactors under construction in 15 countries around the world with a total capacity of nearly 70 GW. China accounted for nearly half of all nuclear capacity under construction in the world. Egypt, India and Turkey each have about 5 GW under construction. Across advanced economies, a total of 9.5 GW is under construction, including two reactors in Japan, two in Korea, two in the United Kingdom and one in Slovakia.

Nuclear reactor construction starts by national origin of technology, 2017-2024



Note: Capacity is reported in gross terms.
Source: IEA analysis based on IAEA PRIS database (Accessed 6 February 2025).

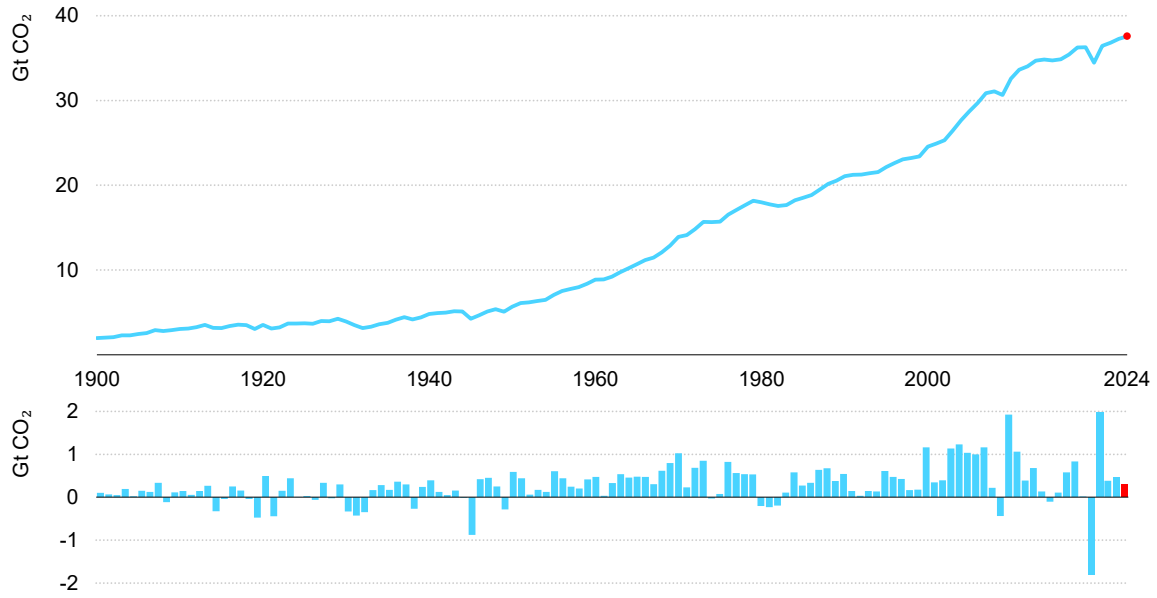
CO_2 Emissions

Energy sector carbon emissions reached a new record in 2024

Total energy-related CO_2 emissions increased by 0.8% in 2024, hitting an all-time high of 37.8 Gt CO_2 [3]. This rise contributed to record atmospheric CO_2 concentrations of 422.5 ppm in 2024, around 3 ppm higher than 2023 and 50% higher than pre-industrial levels. In 2024, CO_2 emissions from fuel combustion grew by around 1% or 357 Mt CO_2, while emissions from industrial processes declined by 2.3% or 62 Mt CO_2. Emissions growth was lower than global GDP growth (+3.2%), restoring the decades-long trend of decoupling emissions growth from economic growth, which had been disrupted in 2021.

[3] This includes CO_2 emissions from fuel combustion, industrial processes, and fugitive (flaring). Elsewhere in this report, unless explicitly mentioned, CO_2 emissions refer to emissions from fuel combustion and industrial processes excluding fugitive (flaring).

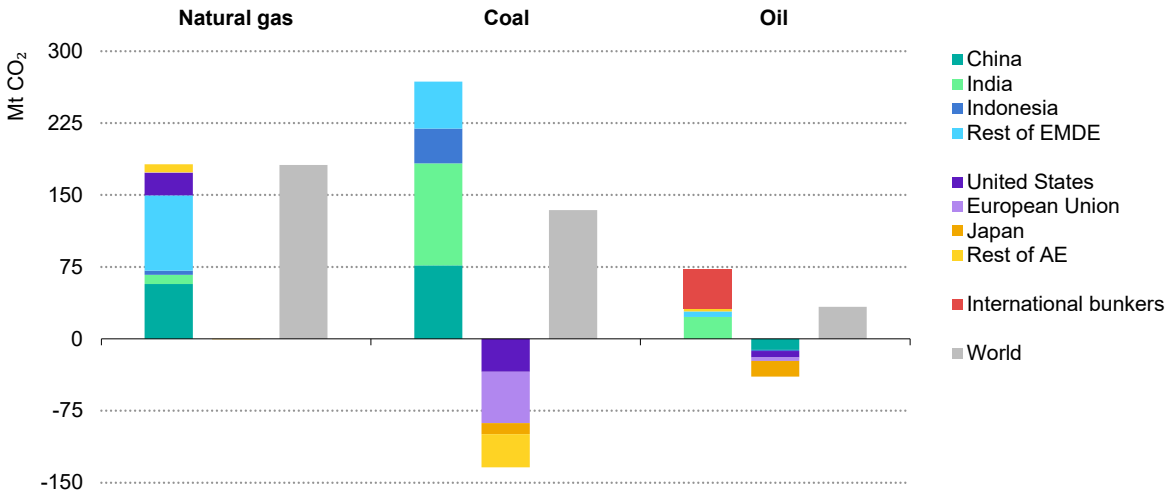
Global energy related CO_2 emissions and their annual change, 1990-2024



Natural gas and coal drove the increase in emissions

Natural gas emissions rose by around 2.5% (180 Mt CO_2) in 2024, making it the largest contributor to global carbon emissions growth. This increase was driven by higher consumption in China, the United States, the Middle East, and India.

Change in CO_2 emissions from combustion by fuel and region, 2023-2024



Notes: AE = advanced economies; EMDE = emerging market and developing economies. International bunkers include the demand for fuels for international aviation and international maritime transport.

Global coal emissions rose by 0.9% (135 Mt CO_2) in 2024. The increase was primarily fuelled by growing coal consumption in China, India and Southeast Asia, while demand declined in advanced economies, particularly in the United States and the European Union.

While global oil consumption rose by 0.8% in 2024, oil-related emissions increased by only 0.3%. This was despite aviation emissions surging by approximately 5.5% amid record global air passenger demand. The modest overall rise in emissions from oil use is largely due to the fact that petrochemical feedstocks accounted for 70% of the total volumetric increase in oil use.

Carbon emissions trends varied widely across regions

Emissions trends between regions diverged in 2024. CO_2 emissions grew in emerging market and developing economies and international aviation and marine bunkers, outweighing reductions from advanced economies led by the European Union, Japan and the United States.

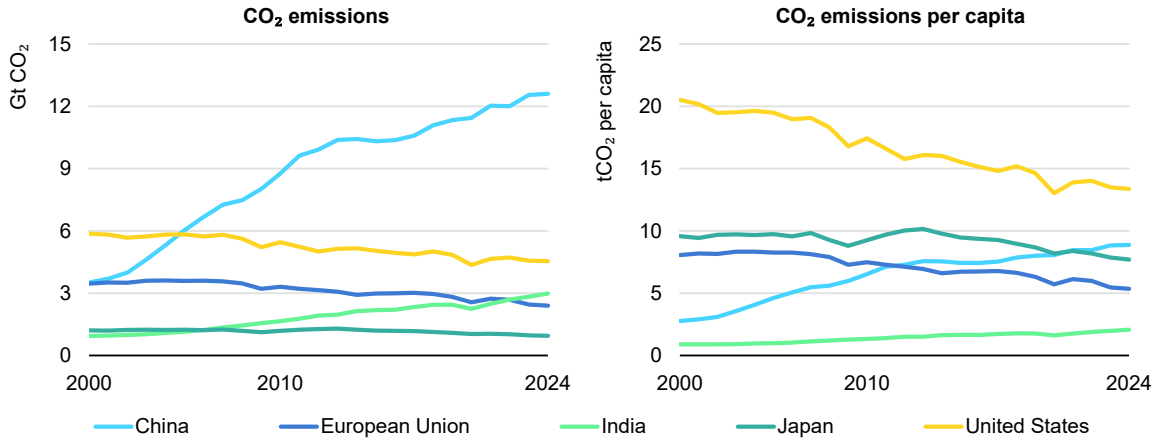
In emerging market and developing economies, energy-related CO_2 emissions increased by 1.5% (375 Mt CO_2) in 2024, driven by rising energy demand associated with rapid economic and population growth. Emissions from coal rose by 2%, while natural gas emissions increased by 3.7% and oil emissions rose by 0.3%, reflecting the continued reliance on fossil fuels to meet expanding industrial activity and improve energy access.

China's energy-related CO_2 emissions grew by an estimated 0.4% year-on-year in 2024, with most of the growth occurring in the first quarter due to the residual impact of lockdowns in early 2023. Energy demand surged throughout the year, driven by record-breaking heatwaves, economic stimulus measures, industrial growth and a strong rebound in the residential and service sectors. Despite these pressures, the expansion of clean energy – particularly in wind and solar PV – helped mitigate emissions growth. Hydropower generation also increased by 11% compared with 2023, partially rebounding from the droughts of 2022/2023. Abundant spring rainfall, particularly in southern China, contributed to record-high hydro generation during the season. However, persistent droughts in the northern regions and extreme summer heatwaves limited further gains. Additionally, industrial process emissions declined by over 5%, largely due to a nearly 10% contraction in cement production caused by weak demand from a struggling real estate market and reduced infrastructure investment.

India's energy-related CO_2 emissions rose by 5.3% in 2024, the highest rate among major economies, driven by rapid economic growth, infrastructure development and surging energy demand. Severe and prolonged heatwaves further boosted electricity consumption, which rose by 5%, straining power systems despite record-breaking additions of nearly 35 GW in solar PV and wind

capacity. However, the growth in renewables could not keep pace with rising demand, leaving fossil fuels dominant in the electricity mix.

CO_2 total emissions and CO_2 per capita emissions by region, 2000-2024



In advanced economies, energy-related CO_2 emissions decreased by 1.1% (120 Mt CO_2) in 2024, driven by a 5.7% decline in coal emissions and a 0.5% drop in oil emissions. Natural gas emissions increased by 0.9%. The reduction reflects advanced economies' continued deployment of low-emissions energy sources, with renewables and nuclear power accounting for over 50% of electricity generation, led by strong growth in wind and solar.

The United States' energy-related CO_2 emissions decreased by 0.5% (20 Mt CO_2) in 2024, reflecting mixed trends across fuel sources. Emissions from coal dropped by 4.5% as the country registered the lowest coal power generation levels in nearly 60 years, while oil emissions fell by 0.3%. However, natural gas emissions increased by 1.3%, driven by its role as the largest US electricity source, accounting for almost 43% of the generation mix. For the first time, solar and wind surpassed coal in electricity generation.

The European Union's energy-related CO_2 emissions decreased by 2.2% (55 Mt CO_2) in 2024. Emissions from coal dropped by 11%, while oil emissions declined by 0.3%. Natural gas emissions remained flat. Power sector emissions fell by almost 10% year-on-year, driven by a record-low fossil fuel share of 28% in electricity generation. Renewables accounted for almost 50% of electricity production, led by wind and solar, which reached a record share of 28%, for the first time surpassing the combined share from coal and gas. Above-average rainfall in the European Union also contributed to increased hydropower generation.

Several factors played a key role in the emissions increase

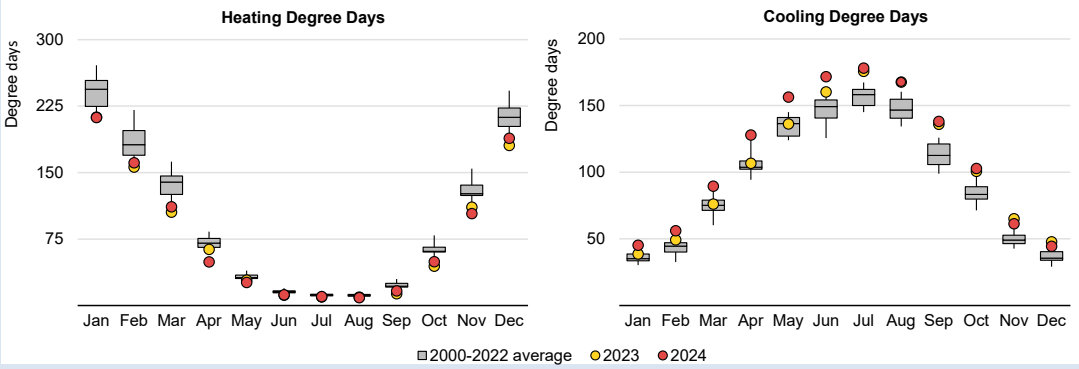
A series of factors shaped the change in CO_2 emissions between 2023 and 2024. Extreme temperatures around the globe and poor wind conditions in Europe drove up fossil fuel use in the power sector. However, a partial recovery from the severe droughts of 2023 allowed for increased hydropower generation, in part offsetting the impact of temperature and wind conditions. Aviation continued its recovery from the Covid-19 pandemic, contributing to higher emissions. Additionally, 2024 was a leap year, meaning an extra day of emissions – an impact that remains hard to quantify but could be up to 100 Mt CO_2. The cumulative net impact of these effects accounts for more than 90% of the overall increase in emissions, or around 275 Mt CO_2 of the observed increase of 295 Mt.

Record high temperatures drive a rise in emissions in 2024

Global temperatures have significant impacts on energy sector emissions, largely by affecting energy demand for heating and cooling. They can play an important role in energy-related emissions variations from one year to another.

2023 was the warmest year on record, setting a very high baseline, but 2024 proved to be even warmer, becoming the first year that was more than 1.5 °C above pre-industrial levels. 2024 was the warmest year recorded for all continental regions except Australia and Antarctica. From January to June 2024, every month set a new temperature record, and in the following months, temperatures were either the second-warmest on record – behind 2023 – or tied with 2023 as the warmest.

Comparison of global heating degree days and cooling degree days in 2024 vs. 2023 and the 2000-2022 average



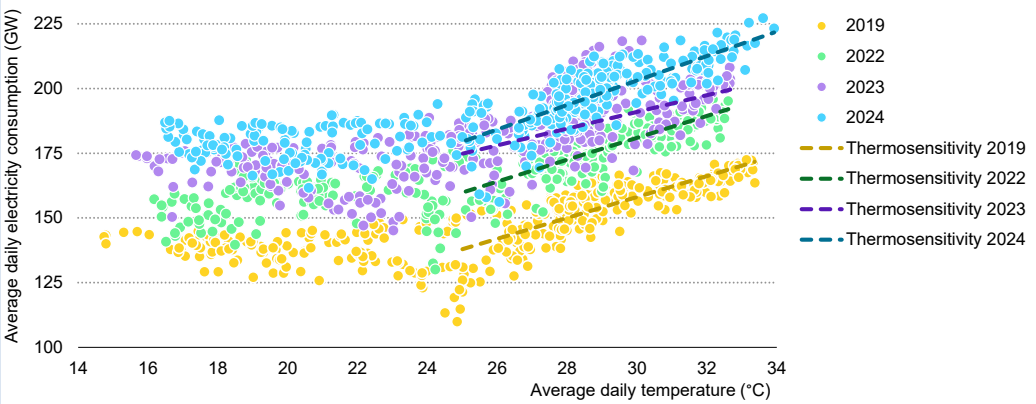
Notes: Cooling degree days illustrate how hot average daily temperatures were and are measured relative to 21 ºC. Heating degree days illustrate how cold average daily temperatures were and are measured relative to 18 ºC.

The winter of 2024 was as warm as that of 2023, resulting in only a marginal impact on the number of heating degree days. The most significant increase occurred during the summer months, with cooling degree days rising by over 6% compared with their peak in 2023. Overall, higher temperatures contributed to increase emissions by 230 Mt CO_2 in 2024 compared with 2023, accounting for around 80% of the total increase in energy-related emissions.

Two-thirds of the increase in emissions associated with temperature changes between 2023 and 2024 originated from China and India.

China experienced intense heatwaves in 2024, with the southern part of the country enduring the second strongest summer heatwave in history. Exceptionally warm months in August and September significantly boosted electricity demand for cooling, forcing the country to ramp up coal-fired power generation to meet the demand. As a result, extreme temperatures in 2024 contributed to approximately 100 Mt of additional CO_2 emissions compared with 2023 – two times more than the total increase in emissions in China in 2024.

Trends in electricity demand based on temperature in India, 2019-2024



In India, intense heatwaves in May and June triggered a sharp rise in electricity demand for cooling, placing significant strain on the country's power grid. To meet this surge in demand, higher fossil fuel usage led to an additional 50 Mt of CO_2 emissions – making up one-third of India's total emissions increase in 2024.

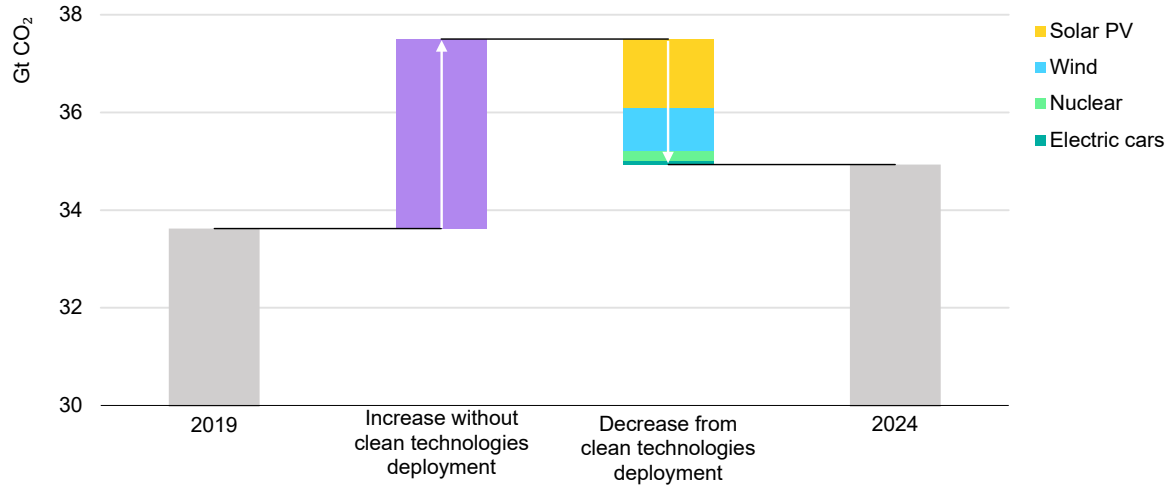
The repeated occurrence of heatwaves over the years, combined with economic growth and rising incomes in emerging market and developing economies, has led to greater adoption of cooling systems. As a result, in 2024, the increase in electricity demand for cooling in response to the same temperature change was higher than the year before. While this trend is partially offset by the adoption of more efficient appliances, particularly in advanced economies and China, it continues to drive a long-term rise in temperature-related emissions. In 2024, this effect was especially pronounced in India, where thermosensitivity – the responsiveness of electricity demand to temperature changes – increased significantly compared to previous years.

Despite the increase in emissions, clean energy technologies are making a difference

The rapid deployment of five key clean energy technologies – solar PV, wind power, nuclear power, electric cars and heat pumps – from 2019 to 2024 avoided annual fossil fuel energy demand of more than 30 EJ. This is equivalent to 6% of total global fossil fuel demand in 2024, or more than the combined total energy demand of Japan and Korea last year.

While this progress was not sufficient to halt the rise in global emissions – which have increased by 1.2. Gt CO_2 since 2019 – it has initiated a structural slowdown in energy-related CO_2 emissions. Collectively, these technologies now prevent around 2.6 Gt of emissions annually, equivalent to 7% of global energy-related CO_2 emissions. Without them, the increase in global CO_2 emissions over the same period would have been three times larger. The impact is even more pronounced in some markets. In Australia, China, the European Union and New Zealand, the deployment of these five technologies over the past six years prevented the equivalent of more than 10% of total energy-related emissions in 2024.

Change in CO_2 emissions from fuel combustion and avoided emissions from deployment of selected clean technologies, 2019-2024



At the global level, the deployment of solar PV over the last six years is now avoiding around 1.4 Gt of annual emissions, equivalent to the combined annual emissions of France, Germany, Italy and the United Kingdom. Avoided annual emissions from wind power amounted to around 900 Mt of CO_2; from nuclear 190 Mt of CO_2; and from electric cars and heat pumps, 80 Mt and 65 Mt of CO_2, respectively. Although the reductions from electric cars and heat pumps are lower than from the other technologies studied, they are set to increase in coming years as stock turnover raises the share of these technologies not just in terms of annual new sales, but also in the overall stock of equipment in use.

Data and methodology

The IEA drew upon a wide range of statistical sources to construct estimates of energy demand and energy-related CO_2 emissions for 2024.

Sources included the latest monthly data submissions to the IEA Energy Data Centre, real-time data from power system operators across the world, statistical releases from national administrations, and recent data from IEA market reports, which covers coal, electricity, energy efficiency, natural gas, oil and renewables. Data on technology deployments come from a wide range of sources, including national statistics, industry associations, and commercial data providers. The definitions for regions, fuels and sectors are in Annex C of the *World Energy Outlook 2024*.

The scope of CO_2 emissions in this report included emissions from all uses of fossil fuels for energy purposes, including the combustion of non-renewable waste, as well as emissions from industrial processes such as cement, iron and steel, and chemicals production. Estimates of industrial process emissions drew upon the latest production data for iron and steel, clinker for cement, aluminium and chemicals. CO_2 emissions from international aviation and marine bunkers were included at the world level only.

Economic growth rates underlying this analysis were those published by the International Monetary Fund's J*anuary 2025 World Economic Outlook Update*. All monetary quantities are expressed in USD (2024) in purchasing power parity (PPP) terms.

	Total energy supply (EJ)			Growth rate	
	2022	2023	2024	2022-23	2023-24
Total energy supply	**622**	**634**	**648**	**1.8%**	**2.2%**
Renewables	89	92	97	3.1%	5.8%
Nuclear	29	30	31	2.2%	3.7%
Natural gas	144	145	149	0.7%	2.7%
Oil	188	192	193	1.9%	0.8%
Coal	172	175	177	2.0%	1.2%

	Electricity generation (TWh)			Growth rate	
	2022	2023	2024	2022-23	2023-24
Total	**29 153**	**29 897**	**31 153**	**2.6%**	**4.2%**
Renewables	8 643	9 074	9 992	5.0%	10%
Nuclear	2 684	2 743	2 844	2.2%	3.7%
Natural gas	6 526	6 622	6 793	1.5%	2.6%
Oil	801	762	738	-4.8%	-3.2%
Coal	10 452	10 645	10 736	1.8%	0.9%

	Technology deployment			Growth rate	
	2022	2023	2024	2022-23	2023-24
Electrical capacity (GW)					
Nuclear	8	6	7	-30%	33%
Solar PV	232	426	553	84%	30%
Wind	75	116	119	54%	2.9%
Electric vehicles (Millions)	**10**	**14**	**17**	**34%**	**26%**
Heat pumps (GW)	**112**	**109**	**108**	**-2.7%**	**-1.5%**

	CO_2 emissions (Mt CO_2)			Growth rate	
	2022	2023	2024	2022-23	2023-24
CO_2 emissions*	**36 819**	**37 270**	**37 566**	**1.2%**	**0.8%**
Natural gas	7 438	7 502	7 684	0.9%	2.4%
Oil	11 250	11 344	11 377	0.8%	0.3%
Coal	15 192	15 489	15 623	2.0%	0.9%
Bioenergy and waste	240	241	250	0.7%	3.5%
Industrial process	2 700	2 694	2 632	-0.2%	-2.3%

*Includes industrial process emissions

	Total energy supply (EJ)			Growth rate	
	2022	2023	2024	2022-23	2023-24
World	**622**	**634**	**648**	**1.8%**	**2.2%**
United States	91	90	91	-1.4%	1.7%
European Union	55	52	52	-4.5%	0.5%
China	160	169	174	5.7%	2.9%
India	43	45	48	6.7%	4.9%

	Electricity generation (TWh)			Growth rate	
	2022	2023	2024	2022-23	2023-24
World	**29 153**	**29 897**	**31 153**	**2.6%**	**4.2%**
United States	4 473	4 419	4 556	-1.2%	3.1%
European Union	2 792	2 718	2 769	-2.6%	1.9%
China	8 947	9 564	10 205	6.9%	6.7%
India	1 814	1 958	2 059	7.9%	5.2%

	CO_2 emissions* (Mt CO_2)			Growth rate	
	2022	2023	2024	2022-23	2023-24
World	**36 819**	**37 270**	**37 566**	**1.2%**	**0.8%**
United States	4 717	4 567	4 546	-3.2%	-0.5%
European Union	2 683	2 455	2 401	-8.5%	-2.2%
China	12 013	12 552	12 603	4.5%	0.4%
India	2 691	2 836	2 987	5.4%	5.3%

*Include industrial process emissions

Acknowledgements, contributors and credits

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