# 1.1 Renewables hit 30% of global electricity

Strong growth in wind and solar drove the share of renewables in the global electricity mix above 30% for the first time. 102 countries had a renewable generation share of 30% or higher, up from 98 in 2022 and for 69 countries the renewables share exceeded 50%, up from 66 in 2022. Combined with nuclear, 39.4% of global electricity now comes from low-carbon sources.

Global growth in wind and solar pushed renewables to make up more than 30% of the global electricity mix in 2023

Share of global electricity generation from renewable sources (%)
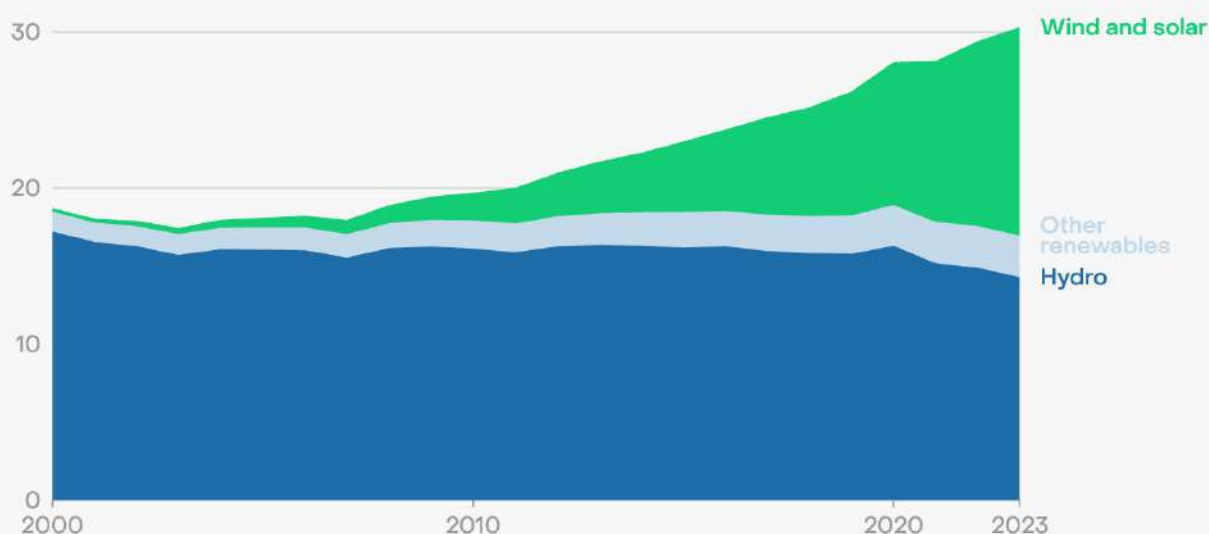
Source: Annual electricity data, Ember

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Record solar and wind generation

Wind and solar generation continued to expand faster than any other source of electricity. Together they reached a new record high of 13.4% (3,935 TWh) in 2023, gaining another 1.5 percentage points of the global electricity mix compared to 2022 (11.9%, 3,422 TWh).

China was the main contributor, accounting for 51% of the additional global solar generation in 2023 and 60% of new global wind generation. Other major contributors to global wind growth include the EU (24%) and Brazil (7%), while global solar growth was provided by the EU (12%) and the US (11%). Together the top four solar growth economies – China, the EU, the US and Brazil – accounted for 81% of solar power growth in 2023.

Solar growth outpaced wind, but both were slower than expected

Solar is leading the energy revolution, adding more than twice as much new electricity as coal in 2023. It was the fastest–growing source of electricity generation for the 19th year in a row. 2023 was the second consecutive year in which global growth in solar generation (+307 TWh, +23%) outpaced wind (+206 TWh, +9.8%). Solar reached a 5.5% share of the global electricity mix (1,631 TWh), up from 4.6% in 2022. Wind still provides a higher share of global electricity, at 7.8% in 2023 (2,304 TWh).

Solar outpaced wind generation growth in 2023 for the second year running

Annual change in electricity generation (TWh)

Solar ■ Wind
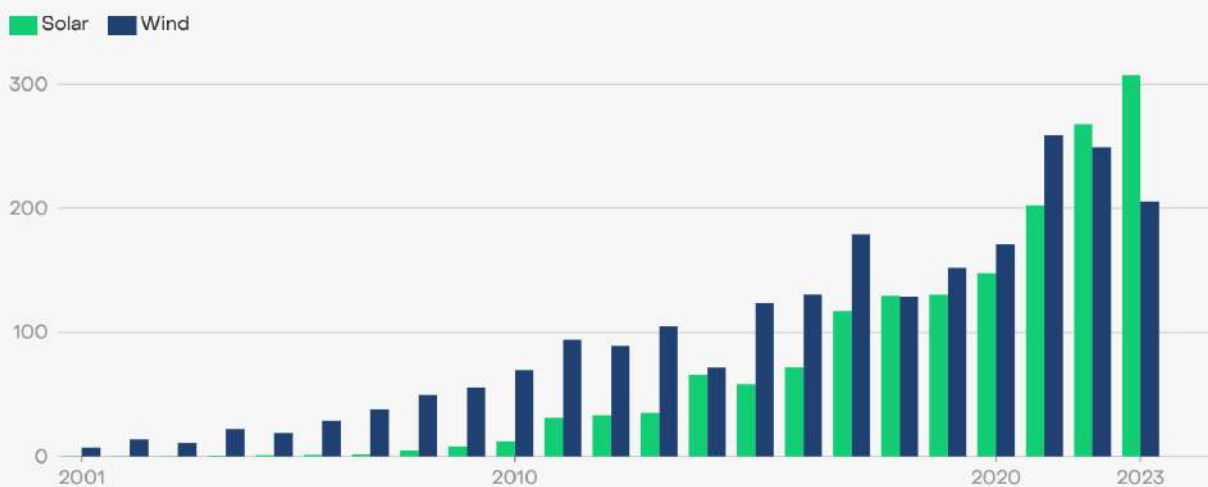
Source: Annual electricity data, Ember

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Despite reaching new record highs, the absolute growth in wind and solar (+513 TWh) was below expectations and slightly smaller than in 2022 (+517 TWh). This was mainly due to lower–than–expected wind growth, which was 18% lower compared to the 249 TWh increase in 2022.

The US was a key contributor to the wind slowdown, experiencing a fall in wind generation for the first time since at least 2001 (–9.1 TWh, –2.1%). Low wind conditions kept load factors close to the lowest levels seen in the past five years, while capacity additions slowed before an anticipated uplift from the Inflation Reduction Act. These were likely short–term factors, bringing confidence in a return to growth levels similar to those from 2020–2021.

Solar generation growth was also lower than expected, lagging behind record high capacity additions (+36%) in 2023. The biggest reasons (further examined in Chapter 2.2) are the higher share of capacity additions in areas like China which experienced lower sunlight in 2023, and the underreporting of solar generation in some countries. When correcting for temporary factors – underreporting, sunniness and the timing of additions – the 2023 increase in generation could have been as high as 29% instead of 23%, bolstering our confidence in a larger increase in 2024.

A record fall in global hydropower generation led to a five–year low

Following a record annual fall (–88 TWh), global hydropower generation fell to a five–year low of 4,210 TWh. Although it remained the largest source of clean power globally, its share in the world's electricity mix dropped 0.6 percentage points to 14.3% – the lowest level since at least 2000 and just 1 percentage point above wind and solar. This occurred despite the construction of new dams, with 7 GW of hydro capacity added in 2023 according to IRENA.

Droughts affected hydro output in different regions, including Asia (–5.9%) and North America (–7.4%) – especially Mexico which saw a fall of 42%. Meanwhile, EU hydro generation recovered only partially from the 2022 multi–decade low (+14%).

China saw the largest absolute drop in hydro of 59 TWh (–4.5%), with the fall concentrated in the first half of the year as generators were instructed to save water for the winter period to avoid power shortages. Other Asian economies were even more severely affected, with hydro generation falling 15% in India and 20% in Viet Nam.
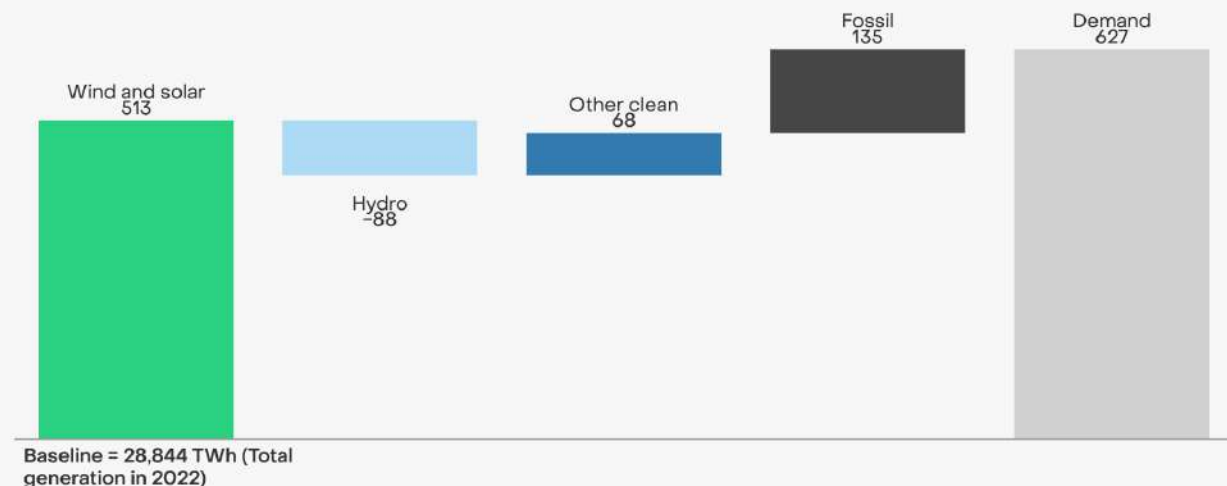
Nuclear remained the same

Nuclear provided 9.1% of global electricity in 2023, unchanged from the previous year. Global nuclear power generation increased by a marginal 46 TWh (+1.8%) to 2,686 TWh, recovering less than 40% of its fall in 2022 (−123 TWh, −4.4%). The partial recovery of French nuclear power from 2022 contributed strongly (+41 TWh), together with restarts in Japan's nuclear fleet (+26 TWh). Elsewhere in the world, new reactors in Finland, the US and China came online and helped offset the effect of voluntary early closure of reactors in Germany and Belgium.

Bioenergy showed a small increase

Global bioenergy electricity generation increased by 21 TWh (+3.1%), mainly due to growth in China (+28 TWh, +15.6%), while in OECD countries it fell by 8.9 TWh (−2.6%). As a result, its share in the global mix remained at just 2.4%. The risk of emissions, plus wider social and ecological impacts, constrains the use of bioenergy for decarbonising the power sector (see Chapter 4.7).

Wind and solar power grew most in 2023, but other clean electricity sources underperformed

Annual change in electricity generation (TWh)

Wind and solar 513 · Hydro −88 · Other clean 68 · Fossil 135 · Demand 627

Baseline = 28,844 TWh (Total generation in 2022)

Source: Annual electricity data, Ember

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1.2 Demand growth was below trend but clean growth still fell short

Demand growth was lower than usual in 2023, but despite this, clean growth was not able to meet all of the increase and so fossil generation grew marginally to meet the shortfall.

Demand growth was below trend

In 2023, global electricity demand increased by 627 TWh (+2.2%), the equivalent of adding the entire electricity demand of Canada (607 TWh). This brought total global demand to a new record high of 29,471 TWh. Nevertheless, 2023's growth rate was lower than the 2.5% average growth of the past decade (2012–2022).

China remained the main engine of global electricity demand growth. China's rapid growth (+606 TWh, +6.9%) was just 21 TWh lower than the net global increase. India's growth (+99 TWh, +5.4%) was the next largest contributor.

China was the main driver of global electricity demand growth, while the EU and US saw sharp falls

Change in electricity demand in 2023 (TWh)
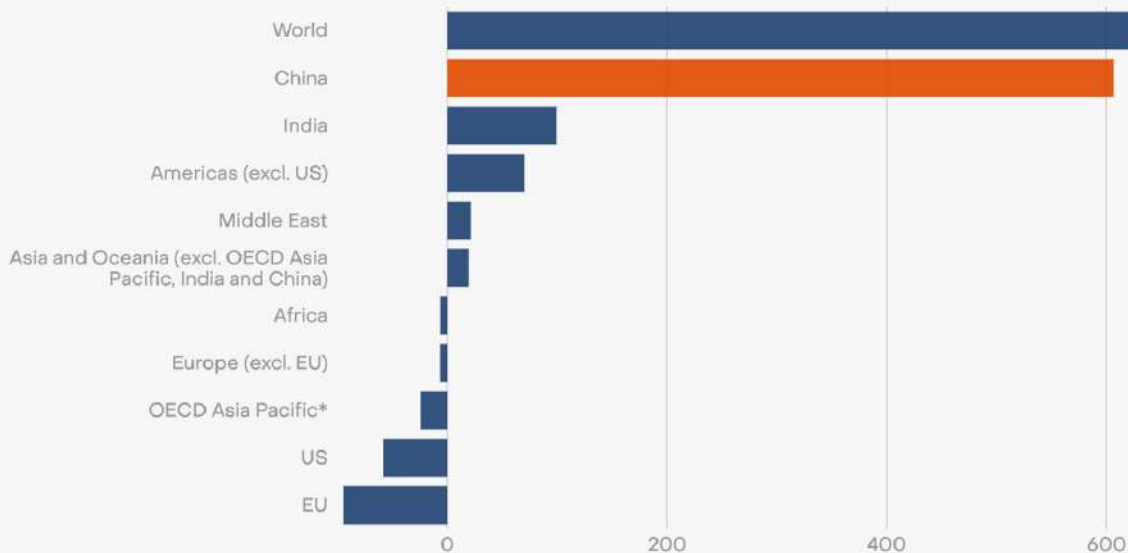
Source: Annual electricity data, Ember
*South Korea, Japan, Australia and New Zealand

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The increase in global electricity demand was limited primarily by a pronounced decrease in OECD countries. The largest demand falls were seen in the US (–1.4%) and the EU (–3.4%), amid milder weather and – mainly in the case of the EU – a temporary downturn in industrial activity and demand reduction measures. Demand also fell in Japan (–1.9%) amid economic headwinds in the manufacturing sector and demand reduction measures.

Demand growth is expected to accelerate going forward as electrification picks up speed alongside growing pressures from technologies like AI and greater demand for cooling (as explored in Chapter 2.3), raising the question of whether clean power growth will accelerate fast enough to meet it.

Wind and solar met most of the electricity demand rise

Wind and solar rose by 513 TWh, slightly less than in 2022 (+517 TWh) but they met 82% of the 2023 global electricity demand growth, compared to 77% in 2022. The higher share was due to the smaller demand increase in 2023 (+627 TWh) compared to 2022 (+674 TWh).

Growth in wind and solar met 82% of the global electricity demand rise in 2023

Annual change in electricity generation (TWh)

■ Wind and solar ■ Other clean ■ Fossil ■ Demand
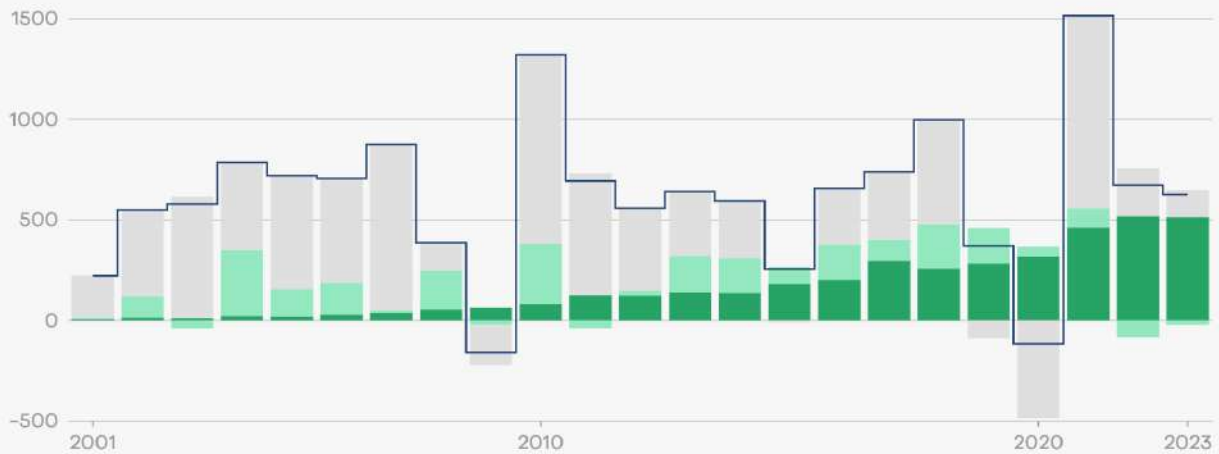
Source: Annual electricity data, Ember

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Despite their lower–than–expected growth, solar and wind were the powerhouses of newly added clean electricity. In aggregate, all other clean electricity sources fell – small rises in bioenergy and nuclear were not enough to counter the large fall in hydro generation caused by extensive droughts. Together, all clean sources met 79% of the increase in electricity demand, creating a shortfall that was met by fossil generation.

1.3 Carbon intensity fell, but emissions narrowly hit another record high

2023 marked another major leap forward in reducing the CO2 intensity of global power generation, reaching a new record low of 480 gCO2/kWh, down 1.2% from 486 gCO2/kWh in 2022, as the share of clean sources reached a record high.

However, absolute fossil generation increased 135 TWh (+0.8%) to meet the remainder of demand growth not met by clean sources, with small increases in coal and gas. As a result, global emissions rose by 1% (+135 million tonnes of CO2) in 2023, reaching 14,153 million tonnes of CO2 – a record high.

2023 came very close to becoming the first year of a new era of falling power sector emissions. As clean electricity growth continues, we have growing confidence that in 2024, it will rise above electricity demand and lead to a fall in emissions (as explored in Chapter 2.1).

Small increases in coal and gas

Global coal generation increased by 1.4% from 10,288 TWh in 2022 to 10,434 TWh in 2023, but its share in the global electricity mix fell by 0.3 percentage points from 35.7% to 35.4%. Although it is a relatively small decrease it is a positive sign of the progress in the global energy transition. As explored below, coal generation is in rapid decline in mature economies, while coal increased mainly in four emerging economies hit by droughts in 2023.

Global gas generation increased only slightly (+53 TWh, +0.8%) and its share in the mix fell 0.3 percentage points to 22.5%. The increase in the US (+115 TWh, +6.8%) was more than 2.5 times the growth recorded at the global level, but was largely offset by sizable falls in the EU (−86 TWh, −16%), the UK (−25 TWh, −20%) and Japan (−27 TWh, −7.4%), where falling demand and rising clean power pushed out both coal and gas. The EU has now seen gas generation fall for four years in a row.

Droughts and high demand drove coal rises in key emerging markets

The hydro deficit in 2023 was a major factor behind the increase in fossil generation at a global level. 95% of the coal generation rise occurred in four countries that were severely affected by droughts, while also having above–average demand growth, in part boosted by heatwaves and greater cooling requirements. Coal generation increased by 319 TWh (+5.9%) in China, by far the largest contributor, followed by India (+100 TWh, +7.3%), Viet Nam (+24 TWh, +23%) and Mexico (+12 TWh, +55%).
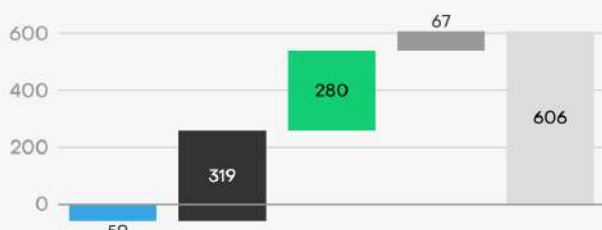
In China and India, lower hydro accounted for 18% and 26% of the rise in coal, respectively. The rest of the coal increase in these two countries was to meet the shortfall in additional electricity demand. In Viet Nam, lower hydro accounted for 81% of its coal rise and the country struggled to meet the rise in demand, experiencing rolling black–outs. In Mexico, both coal and gas generation had to increase to meet the hydro shortfall.

95% of the global rise in coal generation in 2023 occurred in four countries that were severely affected by droughts

Annual change in electricity generation, 2023 (TWh)
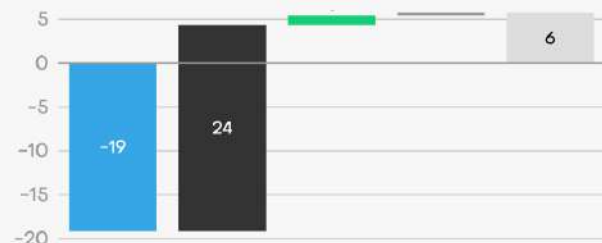
Legend: Hydro, Coal, Wind and solar, Other, Demand

China: Hydro −58, Coal 319, Wind and solar 280, Other 67, Demand 606

India: Hydro −26, Coal 100, Wind and solar 30, Other −5, Demand 99

Viet Nam: Hydro −19, Coal 24, Wind and solar, Other, Demand 6
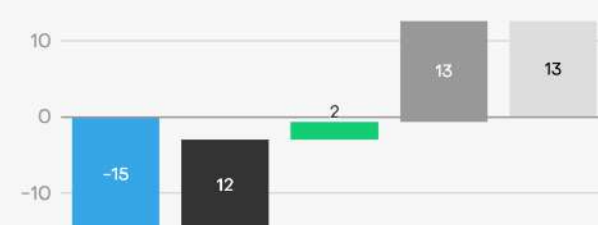
Mexico: Hydro −15, Coal 12, Wind and solar 2, Other 13, Demand 13

Source: Annual electricity data, Ember
'Other' includes gas, bioenergy, other renewables, other fossil generation and net imports; the majority of Mexico's 'Other' generation is from an increase in gas power

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Coal generation and emissions fell strongly in many mature economies

The increase in coal generation in key emerging markets was partly offset by large falls in mature economies. 86% of the fall in global coal generation came from OECD economies. The largest falls were registered in the US (−156 TWh, −19%), the EU (−113 TWh, −25%) and Japan (−22 TWh, −6.3%). Demand reduction and clean power generation contributed to these coal falls. In Europe, this was mainly thanks to wind and solar. In the US, it was coal to gas switching, while in Japan nuclear was the main contributor.