



WIND POWER

KEY FACTS FOR 2024

- Although wind power capacity additions broke a new record in 2024, the increase over 2023 was marginal as numerous challenges slowed growth.
- Europe is not on track to achieve regional targets and capacity additions in North America failed to meet expectations, but installations rose in some emerging markets and several countries saw positive policy developments.
- In the offshore sector, installations slowed in China and Europe largely due to construction and grid-connection delays; however, contracts representing a record amount of additional capacity were awarded globally in 2024.
- Challenges to manufacturers and developers included policy instability, increasing costs and risks, permitting and grid related issues, intense competition and rising public opposition in some key countries.

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Wind energy met
>10%
 of global electricity
 demand and 25% or
 more of demand in
 at least 10 countries.



MARKET DEVELOPMENTS AND TRENDS

An estimated 116.8 GWⁱ of new wind power capacity was connected to the world’s grids in 2024, which is a record, although it represents just a marginal increase (0.2%) over 2023.¹ Onshore installations grew 3.1% to 109 GW, while offshore additions decreased by 27.5% compared to 2023.² China again dominated the global market, accounting for 68.3% of additions; not including China, global additions fell 9.6%.³ Cumulative capacity in operation increased 11.2% to 1,135.4 GW.⁴ (→ See *Figure W-1*.)

The wind industry had another challenging year and deployment was slowed by several factors, including political and policy instability, increasing costs and risks, permitting and grid-related challenges, and rising opposition in some key countries.⁵ However, installations increased in some emerging markets and several countries saw positive policy developments.⁶ In addition, the use of merchant contracts and private power purchase agreements (PPAs) has become increasingly important for market growth, accounting for 5% of additions in 2024.⁷

New wind farms reached full commercial operation in at least 55 countries in 2024 (the same number as in 2023), and two emerging markets (Kazakhstan and Uzbekistan) surpassed 1 GW in total capacity.⁸

Installations increased in Asia (due to China) and doubled in Africa and the Middle East (Egypt and Saudi Arabia), but decreased significantly in the Americas (Brazil, Canada and United States) and in Europeⁱⁱ.⁹

For the 17th consecutive year, Asia was the largest regional market, representing 75.7% of new grid-connected wind power capacity (up from 70.3% in 2023 and 55% in 2022).¹⁰ Most of the remaining installations were in Europe (nearly 13%), North America (4.7%) and Latin America and the Caribbean (4.1%).¹¹ The top five countries – China, the United States, Germany, India and Brazil – together accounted for 81% of annual installations.¹² (→ See *Figure W-2*.) The list of the 10 leading countries in terms of cumulative capacity remained the same, but with some shifts in rankingsⁱⁱⁱ.¹³

i

Data reflect wind power capacity that was newly connected to the grid during 2024 and in operation by the end of 2024. Accounting for decommissioning, net additions amounted to an estimated 114.9 GW in 2024. Including more than 9 GW of capacity that was mechanically installed in China, India and the United States, but not grid-connected, global wind power additions in 2024 were closer to 127 GW. “Mechanically installed” refers to capacity that is in place and ready to produce electricity but not officially connected to the grid. See endnote 1 for this section.

ii

Annual installations declined relative to 2023 in most countries in Europe. See endnote 9 for this section.

iii

The top 10 countries for cumulative capacity at the end of 2021, 2022 and 2023 were China, the United States, Germany, India, Spain, the United Kingdom, Brazil, France, Canada and Sweden. In 2024, China, the United States, Germany and India remained in the lead, followed by Brazil (overtaking Spain and the United Kingdom), the United Kingdom, which also overtook Spain, and France, Canada and Sweden.


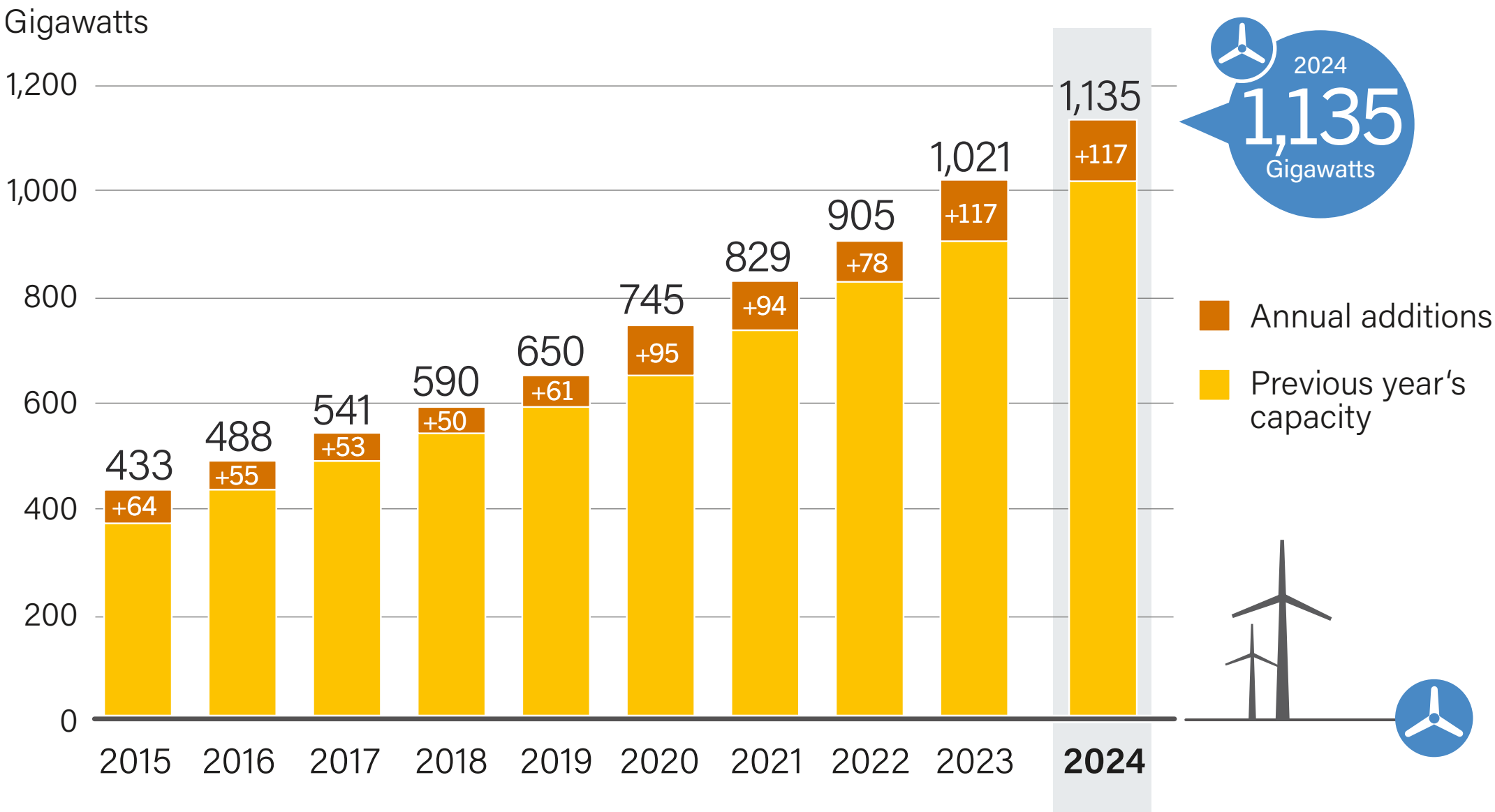


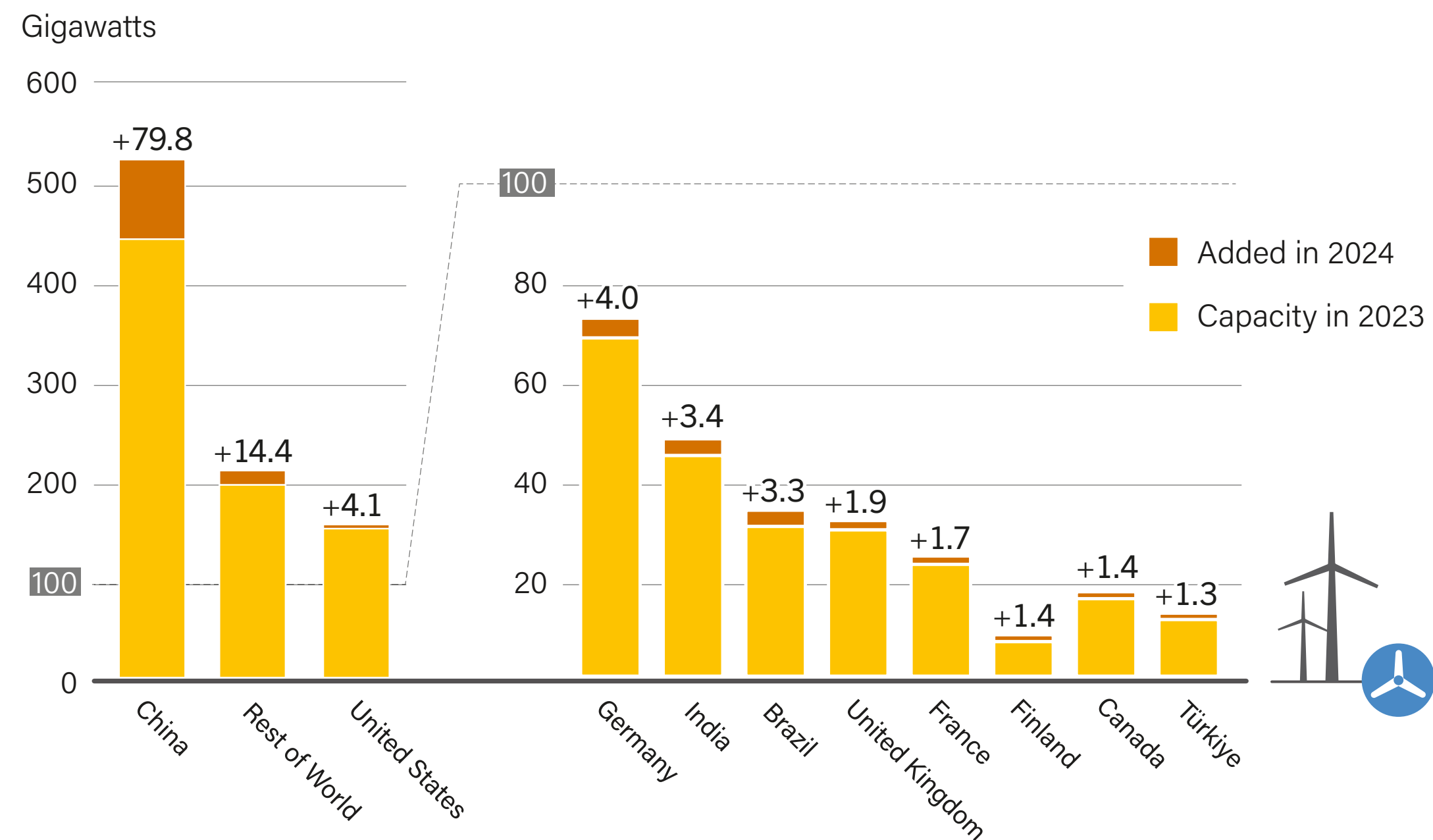
FIGURE W-1
Wind Power Global Capacity and Annual Additions, 2015-2024



Note: Data reflect grid-connected capacity only. Annual additions are gross while year-end totals account for decommissioning. All capacity data are rounded to nearest GW.

Source: See endnote 4 for this section.

FIGURE W-2
Wind Power Capacity and Annual Additions, Top 10 Countries and Rest of World, 2024



Note: Data reflect grid-connected capacity only. Numbers above bars are gross additions, but bar heights reflect year-end totals. Net additions were lower for China (79.5 GW), the United States (3.8 GW) and Germany (3.3 GW) due to decommissioning.

Source: See endnote 12 for this section.

Several countries – including at least nine countries in Europe plus Uruguay (38%) – generated at least one-quarter of their electricity with wind energy in 2024.¹⁴ Denmark (56%) continued to lead in terms of the share of wind in total generation, and wind energy accounted for 19% of EU output, the same as in 2023, despite a 1.4% increase in the region's electricity demand.¹⁵ By one estimate, wind energy met more than 10% of global electricity demand.¹⁶

China connected a record 79.8 GWⁱ (79.5 GW net) of new wind power capacity to the grid, as provinces pushed to meet renewable energy targets by the end of 2025.¹⁷ China alone accounted for 68.3% of the global wind power market, up from 65% in 2023 and 48.5% in 2022.¹⁸ At year's end, an estimated 520.6 GW of wind power capacity was operating in China, nearly 46% of the global total.¹⁹ Wind generation accounted for an estimated 10% of China's electricity production in 2024 (up from 9.2% in 2023).²⁰

Installations in the **United States** fell for the fourth consecutive year to the lowest level since 2014, but the country held on to second place for gross additions and for cumulative capacity.²¹ Almost 4.1 GW was added (3.8 GW netⁱⁱ), bringing total capacity to 154.8 GW.²² Although 2024 had been expected to be a slow year due to long interconnection queues and delayed guidance for rules on federal tax credits, installations were lower than expected because inflation, high interest rates,

equipment shortages and a near-doubling of turbine delivery times all delayed commissioning for several projects.²³ Despite these challenges, the pipeline of onshore projects grew slightly (1%) and PPA deals increased 31% over 2023.²⁴

Close behind the United States, **Germany** added more than 4 GW (3.3 GW net) of wind power capacity in 2024, a 5.2% increase over 2023, for a year-end total of 72.7 GW.²⁵ Germany saw a record year for permitting and auction results, owing to government interventions to remove barriers to deployment.²⁶ New wind installations are also driven by Germany's energy-intensive industries (e.g., steel and chemicals), which rely on renewable energy to decarbonise and remain globally competitive.²⁷



ⁱ The Chinese Wind Energy Association reported that 86.9 GW was mechanically installed during 2024, up from 79.4 GW in 2023, for a year-end total of 561.5 GW. See endnote 17 for this section.

ⁱⁱ This figure is net of the 0.3 GW of onshore wind power capacity that was decommissioned in 2024.

Germany's

government interventions helped to remove barriers to deployment.



India rose one spot to place fourth for additions.²⁸ Following a 52% rise in installations during 2023, deployment increased a further 21% in 2024 to 3.4 GW, bringing total capacity to 48.2 GW.²⁹ This rapid market growth has been attributed to policy reforms, government incentives and increased investment in domestic turbine manufacturing, combined with rising demand for wind energy to fulfil renewable purchase obligations.³⁰ However, due to project cancellations as a result of grid-connection delays and problems with land acquisition, additions failed to meet expectations.³¹

By contrast, **Brazil** saw annual wind energy investment, installations and generation all plummet in 2024.³² After four years of ranking third in the world due to strong growth driven by PPAs, Brazil dropped to fifth place.³³ Additions fell 31% to 3.3 GW, for a cumulative total of 33.7 GW.³⁴ Technical, regulatory and economic challenges forced companies to postpone or cancel investments in new projects, while major manufacturers closed factories or exited the market.³⁵ Transmission infrastructure development has not kept up with wind capacity expansion; as a result, forced curtailment of generation resulted in a 10% decline in output in 2024, causing significant financial losses and reducing investor confidence.³⁶

As a region, **Europe** again placed second in terms of capacity additions and accounted for all remaining top 10 countries, with the exception of **Canada** and **Türkiye**.³⁷ However, the region's additions fell 16% from 2023, to 15 GW (net 13.7 GW), most of which was installed onshore (83%), bringing total capacity to 271.1 GW.³⁸ The main drivers of deployment were the continued pursuit of energy independence and the region's goal to decarbonise industry.³⁹ However, deployment slowed down due to grid bottlenecks, permitting issues and challenging financial conditions.⁴⁰

After Germany, the top countries in Europe for capacity additions were the **United Kingdom, France** and **Finland**, ranking sixth to eighth globally.⁴¹ At year's end, Germany continued to lead in Europe for total wind power capacity, with 72.7 GW, followed by the United Kingdom (31.6 GW), which passed Spain (31.2 GW), France (24.4 GW) and Sweden (17.2 GW).⁴²

Additions also were down (-20.2%) in the European Union in 2024, despite increases in some of the top markets, with new grid-connected capacity of nearly 12.9 GW (net 11.5 GW) raising the total to 231 GW.⁴³ Annual installations remained well below what is needed to achieve EU targetsⁱⁱ for 2030.⁴⁴

i An exception was Goldwind (China), which opened a new manufacturing facility in Brazil during 2024. See endnote 35 for this section.

ii The REPowerEU strategy calls for 425 GW of wind power capacity by 2030. See endnote 45 for this section.

OFFSHORE WIND

Four countries in Asia, three in Europe and one in North America together added 7.9 GW of offshore wind power capacity in 2024, resulting in a global total of 83.1 GW.⁴⁵ Additions fell 27.5% from 2023, to the fourth highest of any year to date.⁴⁶ Offshore turbines accounted for 6.7% of new grid-connected wind power capacity in 2024 and represented 7.3% of the total installed capacity at year’s end.⁴⁷

For the seventh consecutive year, **China** led the expansion of the sector, accounting for more than half of global installations (4 GW) despite a 36% decrease from 2023 due to project delays.⁴⁸ Elsewhere in **Asia**, Taiwan (0.9 GW) ranked second for added capacity, followed by Japan and the Republic of Korea (each with 0.1 GW).⁴⁹

Following a record year for offshore wind installations in 2023, capacity additions in **Europe** declined 31.3% to 2.6 GW in 2024, mainly due to construction and grid-connection delays.⁵⁰ All additions were in three countries (down from seven in 2023): the United Kingdom (1.2 GW), Germany (730 MW) and France (658 MW), which increased its offshore operating capacity by 78%.⁵¹ At year’s end, Europe’s offshore wind power capacity totalled 36.7 GW.⁵²

The **United States’** offshore capacity in operation, while relatively small, increased more than four-fold from 42 MW to 174 MW with the commissioning of the country’s first large-scale project.⁵³ Momentum appeared to be growing during 2024, but developments stalled in early 2025 due to policy changes under the new administration.⁵⁴

By the end of 2024 (as in 2022 and 2023), 19 countries (13 in Europe, 5 in Asia and 1 in North America) had at least some offshore wind capacity in operation.⁵⁵ China led in total capacity (41.8 GW), followed distantly by the United Kingdom (15.9 GW), Germany (9.1 GW), the Netherlands (4.7 GW) and Taiwan (3 GW).⁵⁶ Asia (mostly China) was home to 55.7% of total offshore capacity.⁵⁷



Offshore wind power capacity additions fell

27.5%

from 2023.

POLICY AND INVESTMENT LANDSCAPE

The top **policy mechanisms** supporting installations in 2024 remained “grid parity”ⁱ in China and auctions and tenders in most other countries; tax credits drove the US market, and feed-in tariffs (FITs) played a role in some countries.⁵⁸ For future onshore capacity, China approved 92.8 GW under the grid parity mechanism and, elsewhere, auctions and other procurement mechanisms led to the awarding of contracts for projects totalling 53.5 GW, double the volume awarded in 2023, mostly in Europe and India.⁵⁹ Offshore wind also saw a record year for approvals, with contracts totalling more than 50 GW awarded, mostly in Europe and China.⁶⁰

Countries around the world increased the ambition of wind power targets in 2024, driven by energy security and economic growth goals, as well as rising electricity demand, climate change and the cost-competitivenessⁱⁱ of wind energy.⁶¹ The year also saw positive legislative reforms in several countries: Australia increased regulatory support for offshore wind, while the state of Victoria adopted the country’s first offshore target; Brazil established

a regulatory framework for offshore wind; China adopted a law prioritising the development of renewables, enacted a policy to promote wind projects in rural areas and introduced a law requiring that municipalities benefit financially from local wind projects; India approved a funding scheme for the country’s first offshore projects; Saudi Arabia initiated geographical surveys to help fast-track wind power deployment and develop a domestic industry; and the United Kingdom enacted several reforms to achieve its 2030 wind power targets and lifted a nine-year de facto ban on onshore wind installations in England.⁶²

Following a 16% increase in 2023, global **wind power investment** fell 16%, to USD 194.8 billion, the lowest level since 2020.⁶³ By region, there were significant declines in the Americas (excepting Chile, Mexico), Europe (excepting Germany), and Asia-Pacific (excepting Australia, China, South Korea).⁶⁴ China accounted for nearly 50% of total global investment, followed by the United States (14.6%) and Germany (7.6%).⁶⁵

i Under grid parity, wind generation is remunerated at the same regulated price as coal-fired generation in each province.

ii Despite cost increases in recent years, wind power remains among the cheapest sources of electricity worldwide. Wind energy also can provide additional benefits. For example, a US government study found that the health and climate benefits of wind energy in the United States, plus its associated grid system value, far exceeded the levelised costs of wind energy in that country. See endnote 62 for this section.



INDUSTRY DEVELOPMENTS AND TRENDS

Numerous challenges continued to affect new installations, investor confidence, the health of the industry and its ability to scale production to meet future demand.⁶⁶ These included: macroeconomic challenges, including inflation and higher interest rates; ongoing fossil fuel subsidies; market frameworks that reward investment in fossil fuels; costly, complex and years-long planning and permitting processes; increasing trade barriers and tariffs, which threaten to disrupt global supply chains; and grid challengesⁱ, which slow installations or increase curtailment in many countries, threatening national renewable energy targets.⁶⁷

Even as materials and financing costs have risen for manufacturers and project developers, policymakers in many countries continue to focus on the pursuit of lower prices for wind-generated electricity.⁶⁸ Uncertainties due to stop-start government policies and unpredictable procurement cycles have created high demand volatility.⁶⁹ These factors, combined with permitting bottlenecks, have led to razor-thin or even negative margins across the industry and have rendered investment in the wind supply chain unviable.⁷⁰ In some key regions (Europe, Americas), investment in the supply chain has been insufficient to meet ambitious targets and expected demand beyond the next couple of years.⁷¹

China continued to dominate turbine manufacturing as well as the world's supply chains for critical components and raw materials.⁷² In 2024, six of the ten largest turbine manufacturers in the world were Chinese, and, for the first time, Chinese firms held the top four spots.⁷³ While they remained heavily reliant on their home market, China's biggest manufacturers also pursued sales growth overseas and opened new factories around the world.⁷⁴ Despite record installations and orders, however, intense competition and oversupply of components reduced profitability for Chinese manufacturers.⁷⁵

The results of these pressures and intense competition have been a race to the bottom for costs and a race to the top for turbine size in order to optimise project cost and performance.⁷⁶ The average turbine delivered to market in 2024 had a capacity of 5.5 MW, an increase of 9% over 2023; turbines announced for future installation were far larger, with the largest prototypes reaching 15 MW for onshore and 26 MW for offshore applications.⁷⁷

While rapid technological advances have improved turbine efficiency, they have increased cost pressures and created safety and reliability concerns, further increasing financial and technical risk.⁷⁸ Frequent design changes can increase uncertainty in production processes, disrupt learning curves and overburden supply chains.⁷⁹ An inability to progress to serial production means firms cannot recoup investments

in research and development.⁸⁰ Rapid innovation and limited time for testing also increase the risk of defects.⁸¹

This race for ever-larger machines also affects component suppliers, due to the short lifecycle of various components, as well as project developers, which must accommodate ever-larger models and might face quality issues, all of which increase costs.⁸² This is a problem particularly for offshore projects, where increasing turbine size requires larger installation vessels and ports that can accommodate them.⁸³

In some key markets – including Australia, Brazil, the United States, and across much of Europe – the rise of public resistance is also delaying or preventing project development.⁸⁴ Although some opponents of wind power have valid concerns, resistance is increasingly driven by misinformation and disinformation campaigns financed by fossil fuel groups. These campaigns exacerbate permitting delays and compound profitability challenges, while eroding public trust and affecting policy decisions.⁸⁵ To address or avoid opposition to wind energy, an increasing number of jurisdictions is establishing community energy laws, requiring community engagement in project planning.⁸⁶ In Germany, for example, where policies aim to align the interests of communities, industry and policymakers, communities are increasingly seeing economic benefits from local wind projects.⁸⁷

i Grid challenges include a lack of grid infrastructure, weak existing infrastructure and lack of access to existing infrastructure. See endnote 68 for this section.

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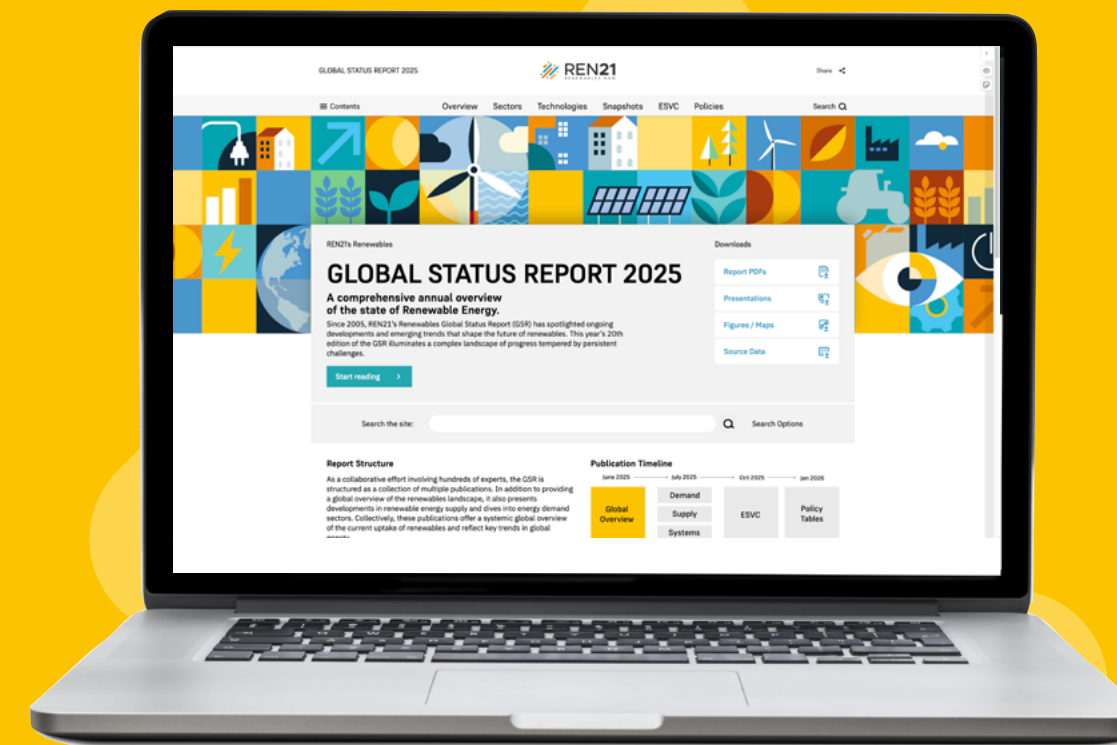
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