



Clean Energy Market Monitor

November 2024

International
Energy Agency



INTERNATIONAL ENERGY AGENCY

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Abstract

As clean energy technologies become more integral to the energy system and energy markets, tracking their evolution with more granularity becomes more important. In March 2024, the IEA initiated a new publication series, the [Clean Energy Market Monitor](#).

This November edition of the Clean Energy Market Monitor provides an update in terms of technology deployment trends for selected clean energy technologies for the first half of 2024.

In addition, it gives clean energy equipment price evolutions up to the second quarter of 2024 for solar PV, electric vehicle batteries, stationary storage batteries, and wind power.

It analysis the financial performance of a selected sample of clean energy companies, in order to provide a snapshot of current market trends.

Finally, it provides insights into CO₂ emissions trends for the electricity sectors of the countries covered by the IEA's [Real-Time Electricity Tracker](#).

Acknowledgements, contributors and credits

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Executive summary

The IEA released the first edition of the [Clean Energy Market Monitor](#) in March 2024. This publication series aims to present up-to-date data regarding clean energy trends to inform policy and market analysis. As clean energy becomes more and more integral to the energy system and energy markets, timely understanding of clean energy market trends becomes more important. This November edition of the Clean Energy Market Monitor expands on the indicators presented in the March edition. In addition to data on clean energy technology deployment for the year-to-date, this edition includes analysis of the financial performance of a snapshot of listed clean energy firms, CO₂ emissions in a subset of electricity systems for which the IEA collects near real-time data, and analysis of equipment price trends of selected clean energy technologies.

The data do not support the narrative of slowing clean energy transitions, although some regions and sectors have seen recent wobbles. In the first half of 2024, solar PV additions rose 36%, electric vehicle sales increased 25%, while wind power capacity additions have kept pace with the record deployment seen last year. However, heat pump sales have fallen back by around 10%. Solar PV continues to be a standout performer: additions increased one-third in China in the first half of 2024 compared to the same period last year, while additions in the United States grew by nearly 80%. Several major markets, notably China and the United States, often see a surge in new capacity additions for wind and solar PV towards the end of the calendar year as developers aim to complete projects.

Clean energy transitions show signs of accelerating in emerging market and developing economies outside China, as some advanced economies see setbacks in some sectors. Progress on clean energy transitions remains too concentrated in advanced economies and China, but there are some signs that this is changing. In the first half of 2024, emerging market and developing economies, excluding China, saw a 100% increase in electric vehicle sales, with the share in total sale reaching around 5%, comparable to the level seen in the developed Asia region. India saw a substantial increase in solar PV capacity additions (+90%). However, clean energy technology deployment levels in some advanced economies, notably in Europe, were lower. Heat pump sales in Europe fell almost 50% in the first half of the year, and EV sales only grew 3%.

Ample manufacturing capacity and in some cases weaker-than-expected demand are putting pressure on the financial performance of some companies, while pushing down clean energy equipment prices and providing opportunities for faster transitions. Net profit margins in integrated

solar PV manufacturers in China fell from around 13% in the first half of 2023 to around -5% in the first half of 2024, even as equipment prices for solar PV fell to new record lows. However, the picture is not one-sided. China's battery manufacturers saw profit margins strengthen even as manufacturers outside China struggled. Overall, clean energy equipment prices have overcome the uptick seen in the post-Covid period, as tangled supply chains, rising interest rates, and high commodity prices put pressure on equipment prices. The IEA's Clean Energy Technology Equipment Price Index is down by 22% compared to the post-pandemic peak.

Electricity sectors continue to decarbonise, but extreme weather has pushed up electricity demand and prevented a sharper decline in electricity sector emissions in 2024. The IEA has released a new tracking product: the [Real-Time Electricity Tracker](#). This tool tracks in close to real-time the CO₂ emissions from the electricity sectors of countries accounting for around half of global electricity generation. In the countries covered by this tracker, cumulative CO₂ emissions were over 1% lower by mid-October than the same period last year. In the United States, total electricity generation emissions from January to October remained broadly stable compared to 2023, as an increased availability of renewables mitigated the demand surge from an extremely hot summer. In India, both electricity demand and emissions are around 5% higher for the year-to-date, compared to 2023. Electricity sectors in the European Union crossed a milestone with renewables accounting for around half of total generation between January and October. Meanwhile, coal and gas generation combined fell to a record low share of 23%. Wind and solar PV accounted for around 30% of total electricity generation in the European Union on a year-to-date basis.

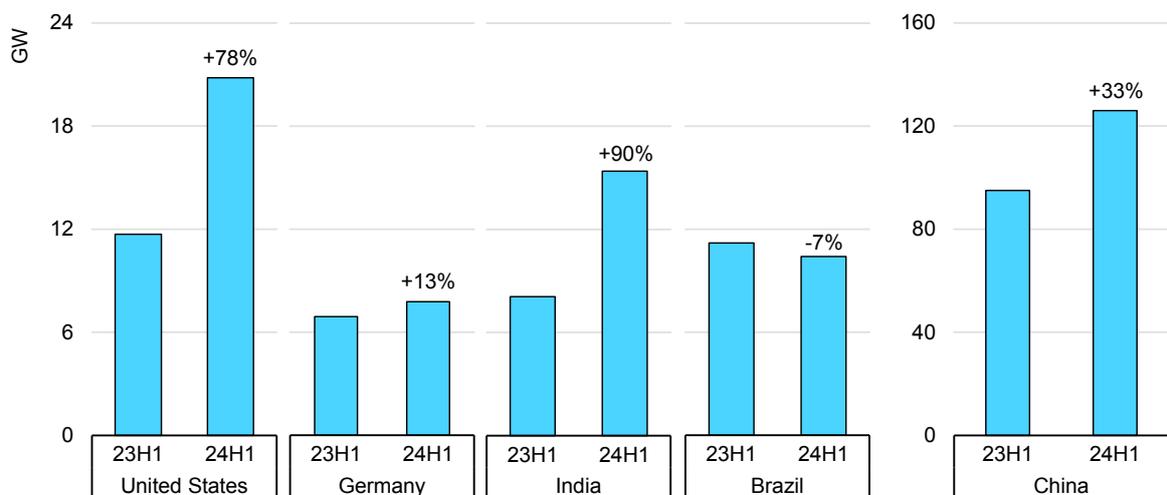
Clean technology deployment trends

Solar PV

In the first half of 2024, combined solar PV capacity additions in Brazil, China, Germany, India and the United States are 36% higher than the same period last year. China installed almost 130 GW of solar PV from January to June 2024, one-third higher than in 2023. Despite this, growth in new capacity has slowed as additions more than doubled in 2023 compared with 2022. The rapid rollout of solar PV in China can be largely attributed to the fall in module prices, which have more than halved over the last year, improving the cost competitiveness of large-scale utility-scale projects. Lower equipment prices have also favoured distributed solar PV systems, helping residential and commercial customer to save on their electricity bills.

In the United States, solar PV capacity additions surged nearly 80% in H1-2024, adding 20.8 GW. India posted a 90% increase in the same period, adding 15.4 GW. Changes in the net metering policy scheme in Brazil resulted in a slowdown in distributed applications with capacity additions falling by slightly over 5%. Capacity additions in major European markets showed continued momentum, with Germany posting a 15% increase in the first half of the year (7.8 GW) and Italy a nearly 45% increase (3.3 GW).

Solar PV capacity additions for selected regions, first half year of 2023 and 2024

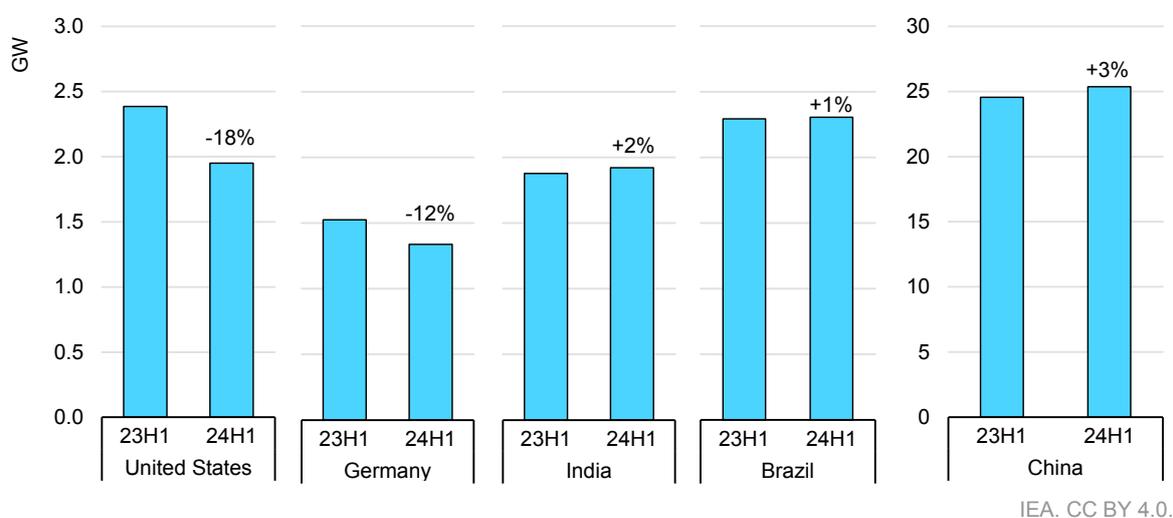


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Wind power

New capacity additions for wind varied between different markets. In China, growth in new capacity was stable, rising around 3% versus H1-2023. Additions in the United States fell from 2.4 GW in H1-2023 to 2.0 GW in H1-2024, due to a lull in the project pipeline as wind developers awaited confirmation of tax credits extensions under the Inflation Reduction Act. Additions in Germany were down slightly due to differing auction schedules this year compared to last year. Capacity additions in major emerging markets, namely Brazil and India, remained in line with 2023 levels.

Wind capacity additions for selected regions, first half year of 2023 and 2024



Electric cars

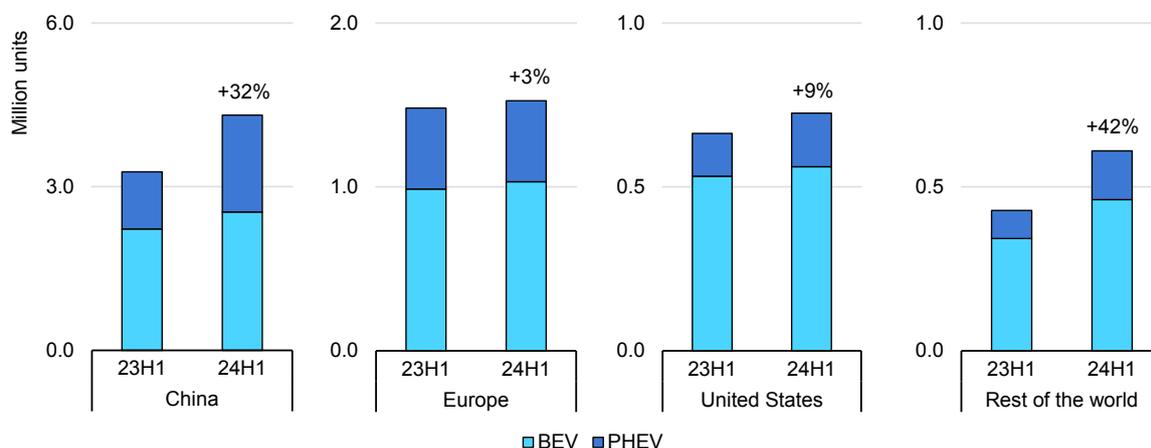
Over first half of 2024, global electric car sales have increased by around 25% compared to the same period last year. In terms of market share, EVs are nearing 20% of total car sales in the first half of 2024. This supports the IEA’s preliminary assessment in the [Global Electric Vehicle Outlook](#) that the market share of electric cars will surpass 20% in the whole year of 2024.¹ In 2023, the EV market share in total car sales was 18%.

Of the 7 million electric car sales sold globally in the first half of 2024, a significant share was sold in China, solidifying its position as the global leader in the sector. Sales in China surged by over 30%, and by late June, nearly one in two cars sold was electric. Plug-in hybrids (PHEVs) grew by around 70%, while battery electric vehicles (BEVs) saw an increase of around 15%. The rise in plug-in hybrids was largely driven by the popularity of extended-range electric vehicles (EREVs) in China. This momentum has continued, with electric car sales in China surpassing 1 million for both August and September, pushing market shares in both months above 50%.

¹ Electric cars include pure battery electric vehicles (BEV) and plug-in electric hybrids (PHEV).

This was supported by a decline in EV prices, and a trade-in policy incentivising the replacement of older, less efficient cars with new vehicles and subsidies of 20 000 RMB (USD 2 770) for new energy vehicles (NEVs). As of mid-September, over 1 million older cars applied for the trade-in scheme.

Electric car sales for selected regions, first half year of 2023 and 2024



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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. Annotation is the percentage increase of the year-on-year H1 electric car sales.

Sources: IEA analysis based on EV Volumes, ACEA.

In North America, electric car sales continue to rise steadily, increasing by around 10% in the first half of 2024 compared to the same period last year. The market share of EVs approached 10% of all cars sold in the first six months of 2024. New model entries and incentives are supporting this growth. Electric car sales in the United States are also following similar trends.

Europe, on the other hand, saw more modest growth in EV adoption, with electric car sales growing around 3% in the first half of 2024 versus the same period in 2023. This trend is largely due to the phase-out of incentives in Germany and the absence of more stringent CO₂ emission standards for 2024. However, the United Kingdom stands out in the region, with a notable 15% increase in electric car sales, but the significant drop in Germany meant that overall sales growth in Europe remained flat. Other strong performers in Europe include Belgium and Netherlands. Outside of Germany, EV car sales grew 6% in Europe.

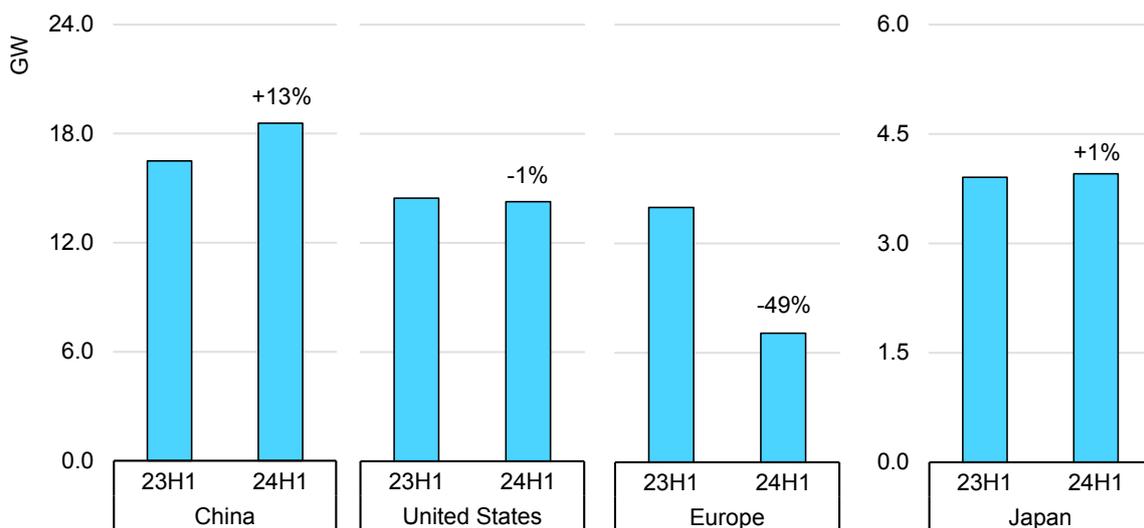
Although starting from a low base, the rest of the world saw a sharp acceleration in electric car deployment, with sales rising over 40%. Markets such as Brazil, Indonesia and Mexico have seen growth rates 270%, 160%, and 140%, respectively.

Additionally, there is a growing global trend toward plug-in hybrids (PHEVs), largely driven by China, though this is not the case in all markets. Worldwide, the share of PHEVs in total electric car sales has increased to over 35%, up from 30% in the same period last year. This highlights ongoing consumer concerns about range anxiety and insufficient charging infrastructure.

Heat pumps

In the first six months of 2024, global heat pump sales fell by 10% compared to the same period last year. However, the global trend was notably influenced by a sharp decline in heat pump sales in Europe, partially offset by rising sales in China and stable trends in the United States and Japan.

Heat pump sales for selected regions, first half year of 2023 and 2024



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Note: Data for Europe includes sales in Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Portugal, Spain, Sweden and Switzerland.

Sources: IEA analysis based on data from [ChinaOL](#); The [Air-Conditioning, Heating and Refrigeration Institute](#); the [Japan Refrigeration and Air Conditioning Industry](#); and the [European Heat Pump Association](#).

China was the only major market where heat pumps grew, chalking up a robust 13% increase in H1 2024 and consolidating China’s role as the largest domestic market and the largest exporter of heat pumps. In China, heat pumps are already a common solution in central provinces with hot summers and cold winters, where they provide both heating and cooling. Heat pumps have also been actively promoted in the 14th Five Year Plan [for buildings](#), and they are also gaining in popularity in colder regions of northern China, where they have been part of the coal-to-electricity subsidy programs over the past decade as part of the fight against air pollution.

In the United States, heat pump sales fell slightly by only 1%, but their market share continued to grow as they keep outpacing sales of gas-fired units, which fell further by 4%. In 2023 and 2024, the US Department of Energy awarded over USD 250 million under the Defence Production Act to expand manufacturing capacity for heat pump units and components in the United States, highlighting the central role of heat pumps in improving energy security. Tax credits and rebates for consumers to install heat pumps have also been approved as part of the Inflation Reduction Act and are starting to reach consumers, with tax credits of up to USD 2 000 and rebates of up to USD 8 000, the latter for low-income households and enough to cover up to 100% of the capital cost of average household units.

The outlook for heat pumps in the United States seems positive in the short term: they are already widespread in regions with very cold climates, such as Maine, a state with a housing stock of slightly more than 700 000 housing units, where [more than 100 000 heat pumps have been installed since 2020](#). In addition, around 70% of US households already use central heating and/or cooling systems, meaning that a large proportion of the US building stock could be converted to heat pumps simply by replacing the existing equipment at the end of its life, without the need for major renovations of the heating and cooling system.

In Japan, sales of heat pump water heaters in the first six months of 2024 were down by around 3% compared to the same period in 2023, but early market data for the third quarter show double-digit growth, suggesting that this segment – which experienced seven consecutive years of growth up to 2022 – may be back on track for growth after the slump in 2023. The air-to-air segment, typically used for both heating and cooling, grew by around 5% in the first half of 2024, reaching its highest level since 2021, in a highly saturated market where purchases are typically to replace existing units.

In Europe², heat pump sales fell [by almost 50%](#) in the first six months of 2024. If this trend continues in the coming months, installations in 2024 would be back to pre-pandemic levels, a far cry from the record levels seen in 2022. In France, Europe's largest market, air-to-water heat pumps declined [by nearly 50%](#), while air-to-air systems dropped by 15%. In Germany, Europe's second largest heat pump market, sales fell by [more than 50%](#) in the first half of the year to the lowest level since 2021. Heat pump installations in new buildings increased by nearly 10% in 2023, but overall there were 6% fewer buildings constructed. In addition, the number of new residential building permits granted in 2023 was 40% lower than in 2022, which, together with the [wave of building project cancellations](#) in recent months, suggests that additional downward pressure on the German heat pump market could come in late 2024 and 2025. The third largest market, Italy, [also saw complex trends](#) over the first half of 2024: while air-to-air units continued increasing (3% to 15% depending on the type of unit) mostly driven by the cooling market, the installations of air-to-water units recorded a decrease of almost 25%, compared to the first half of 2023. On the positive side, largely driven by the Boiler Upgrade Scheme, installations of certified heat pumps in the United Kingdom reached 250 000 units and sales were up around [40% year-on-year](#) in the first half of 2024, and by the end of September cumulative annual installations had already exceeded those for the whole of 2023. Overall, natural gas prices in Europe have mostly declined from their peaks in 2022, and in most countries the price consumers pay for electricity is [2-4 times higher than the price of gas](#), making new installations less financially attractive

² Data for Europe, reported by the [European Heat Pump association](#), includes sales in Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Portugal, Spain, Sweden and Switzerland, which together accounted for 85% of the European heat pump market in 2023.

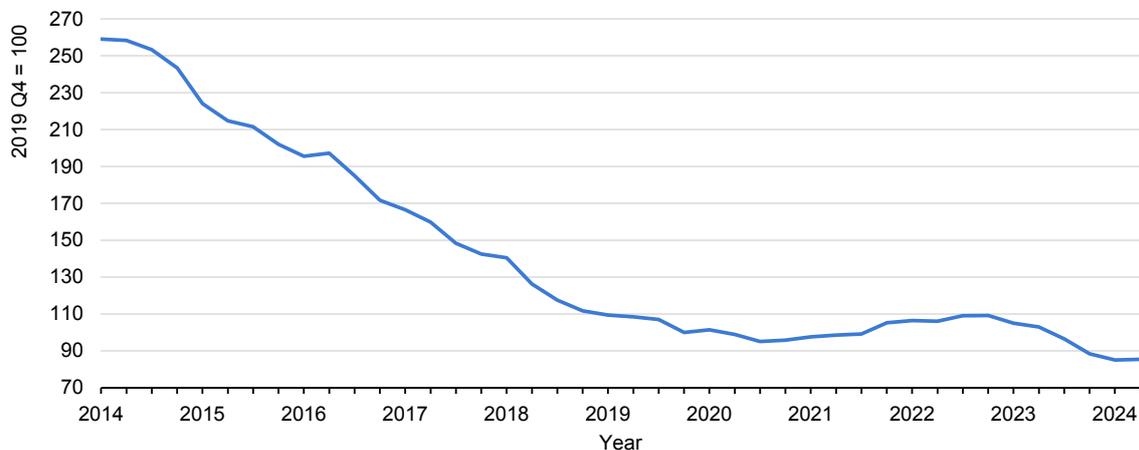
Clean energy equipment price trends

The last several editions of the IEA’s [World Energy Investment](#) report have presented an annualised global Clean Energy Equipment Price Index. This captures trends in the prices of solar PV panels, EV batteries and utility-scale battery storage, and wind power. In this edition of the Clean Energy Market Monitor, we downscale this index to a quarterly frequency.

Clean energy equipment prices have resumed their downward trend

The overall Clean Energy Equipment Price Index fell around 17% in Q2-2024 compared to the same period last year. Compared to the post-pandemic peak, the overall index is down by 22%. The increase in equipment prices after the pandemic, caused by supply chain disruption, commodity and energy price increases, and the generalised uptick in inflation, has therefore reversed.

IEA quarterly Clean Energy Equipment Price Index, 2014-2024



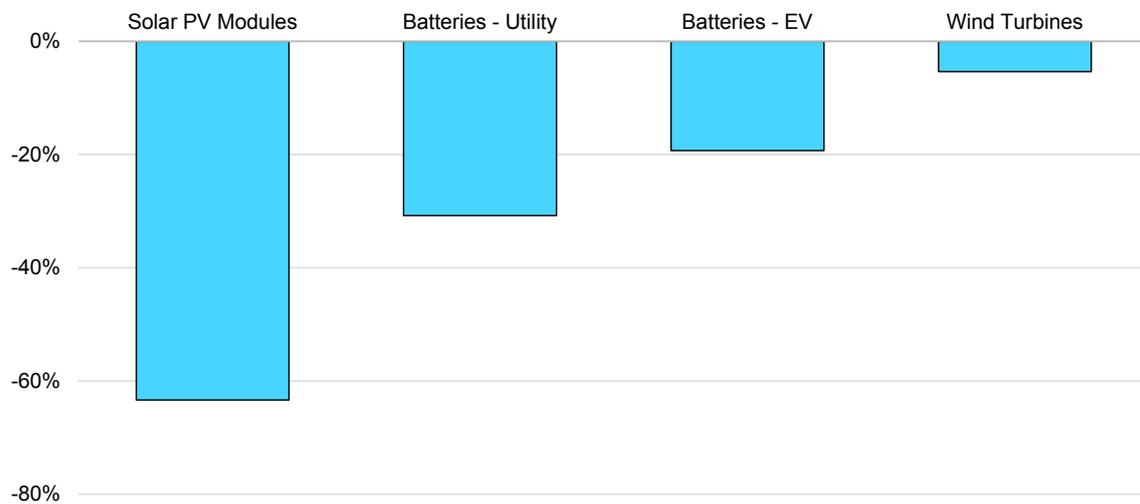
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From Q2-2023 to Q4-2023, equipment prices of wind turbines fell about 8% in aggregate. However, over the following six months between Q4-2023 and Q2-2024, wind power equipment prices saw a slight increase of about 3%. This puts total change over the past year at about a 5% decrease. However, wind power equipment prices remain below the post-pandemic peak.

Between their post-pandemic peak in 2021 and Q4-2023, the equipment prices of solar PV modules decreased by more than 50%. By Q2-2024, they had dropped a further 20%. In total, the equipment prices of solar PV decreased by almost two-thirds since their post-pandemic peak.

The equipment prices associated with grid-scale battery storage decreased by around 25% from the peak in 2022 to the end of 2023. By Q2-2024, these prices had decreased about 9% further, yielding a total decrease of more than 30%. The equipment prices of the lithium-ion batteries that power EVs showed a higher level of stability than their grid-scale counterparts. In Q2-2024, EV battery equipment prices were down almost 20% from their post-pandemic peak in 2022.

Changes in clean energy equipment prices from post-pandemic peak to Q2-2024



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Financial performance of selected clean energy technology companies

This section presents financial metrics for a selected group of listed companies in the clean energy technology space. It covers the top ten integrated solar PV manufacturers, battery manufacturers, the leading EV manufacturers, and wind power developers. The data is presented for firms headquartered in China and those headquartered outside China (“rest of the world”). The second group is almost entirely composed of firms headquartered in advanced economies.

As China’s clean technology sector continues to scale up, concerns on excess capacity in some sectors show up in a wobble in profit margins

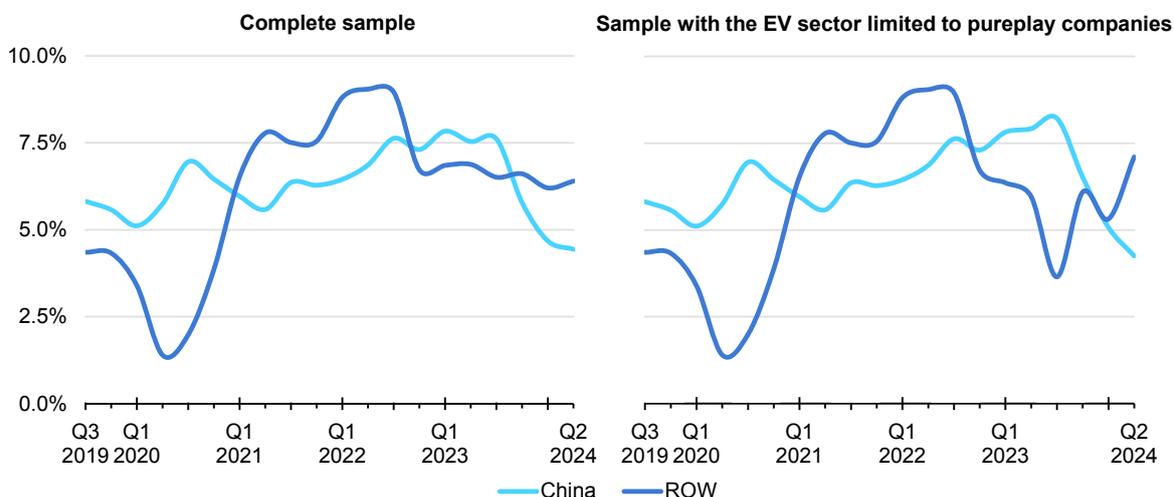
This section presents an aggregated picture of profit margins across the companies tracked in this sample. While aggregating across sectors masks important differences between sectors and regions (see below), the aggregate picture provides a useful snapshot of market and policy dynamics across the clean energy technology space. Due to the large size of automobile manufacturers relative to the other companies in the sample, we present an aggregation that includes all automobile manufacturers in the sample (i.e. the larger EV manufacturers in the world), and an aggregation with only the pureplay EV manufacturers.

Following the Covid-19 pandemic, profit margins slipped substantially in firms headquartered outside of China, as activity and sales plummeted. The picture was entirely different within China, which kept production and economic activity humming through the Covid shock. The world then saw a period of commodity and energy price inflation, fuelled by supply chain disruptions, a strong resurgence of demand, and the effects of the Russian invasion of Ukraine on energy and commodity markets. During this period clean energy companies were able to maintain pricing power, this led to a period of strong profit margins in clean technology sectors. Aggregate profit margins picked up substantially in firms headquartered outside China and ticked up for Chinese companies as well. For companies headquartered outside China, aggregate profit margins peaked around 9% in mid-2022.

Subsequent to this, rising interest rates, and easing supply chains and commodity prices, led to an easing of profit margins. In China, recent quarters have seen a notable slippage in profit margins, as excess capacity, fierce competition and

falling prices have impacted some sectors. Aggregate profit margins for Chinese firms have dropped by about three percentage points over the past three-quarters.

Net profit margins in selected listed clean energy firms, 2019-2024



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Note: Three-quarter trailing rolling average of aggregate net profit margins. ROW = Rest of the world.

Troubles in China’s solar PV sector are not matched by the same picture in EVs and batteries

This section presents the sector level data underlying the aggregate profit margins for the battery, EV, solar PV, and wind power sectors.

Batteries

Despite concerns of excess capacity in battery manufacturing, China’s manufacturers posted strong profit margins in the aggregate. In the first half of 2024, profit margins increased to around 11.5%, up from 9.5% in the same period of last year. There is a notable concentration in China’s pureplay battery manufacturing market, with CATL accounting for over 80% of gross revenues in the companies sampled here. CATL has seen average margins of 12% in the last six-quarters compared to average margins of around 1% in the next largest listed firms in this sector.

For companies headquartered outside China, the picture is somewhat different in recent quarters. Net profit margins in the first half of the year slipped by nearly six percentage points compared to the same period of last year. Non-Chinese manufacturers have struggled with slower than expected EV sales growth in some markets, falling battery and materials prices, and increased competition and excess capacity in the global battery manufacturing market.

Electric cars

Similar to China's battery manufacturing sector, in the aggregate China's EV manufacturing firms appear to be showing resilience against excess capacity in the sector. Aggregate profit margins of the firms operating in this sector strengthened somewhat in the first half of 2024, compared to the same period last year. However, compared with benchmarks outside of China, they remain relatively low. BYD, China's largest "pureplay" EV manufacturer, saw its H1-2024 profit margin strengthen to 4.5%.

Over that same time period, net profit margins from the top EV manufacturers outside China saw a decline in their profit margins by around two percentage points. This sample contains large companies which are not pureplay EV manufacturers. Within the sample, Tesla is the closest to a pureplay EV manufacturer (it also has business lines in charging, stationary storage and solar PV). Tesla's net margins saw a decline of about half, falling from almost 11% to about 5.5%.

Integrated solar PV manufacturers

Meanwhile, in China's solar PV sector, aggregate data shows a decrease in net margins of almost 18 percentage points, with profit margins falling to nearly -5% in the first half of 2024. Excess capacity and fierce competition led to substantial price pressure (see section above on clean energy equipment price trends), resulting in pressure on profit margins. Outside of China, integrated solar PV manufacturers saw profit margins remain relatively low but stable. However, industry associations and governments have highlighted the [extremely challenging situation](#) in the global solar PV manufacturing market, driven in particular by excess capacity in China.

Wind

Chinese companies operating in the wind energy sector saw stable profit margins in the first half of 2024. China has largely avoided the supply chain disruptions, commodity price inflation, high interest rates, and policy uncertainty that have affected the wind power industry outside of China. A jump in capacity installations in China in 2023 was also important in absorbing some of the excess manufacturing capacity that has emerged in this sector.

Outside China, wind power companies staged a modest recovery, with net margins increasing from almost -1% in early 2023 to upward of 4% in early 2024. Outside China, the wind sector suffered from higher interest rates, supply chain disruptions, policy uncertainty on demand and auctions, and commodity price inflation.

Profit margins by clean energy sub-sector, first half year of 2023 and 2024



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Note: ROW = Rest of the world.

CO₂ emission trends from the electricity sector in 2024

Global temperatures have been exceptionally high in 2024, making it [almost certain](#) that 2024 surpasses 2023 as the hottest year on record. From January to September, global population-weighted average of cooling degree days increased by more than 8%, leading to a surge in electricity demand for cooling and putting strain on power systems in many regions.

The International Energy Agency [tracks near real-time CO₂ emissions](#) from electricity generation across more than 50 countries, covering approximately half of global electricity production. Generation data is gathered from the information published by transmission system operators, so electricity from small/scale distributed generation and auto-producers may not always be captured. Despite these gaps, the dataset provides an important indicator of near real-time trends in the electricity sectors of the countries covered. Among the 20 largest electricity producers, the tracker does not include China, Canada, Saudi Arabia, Indonesia, Iran, and Viet Nam.

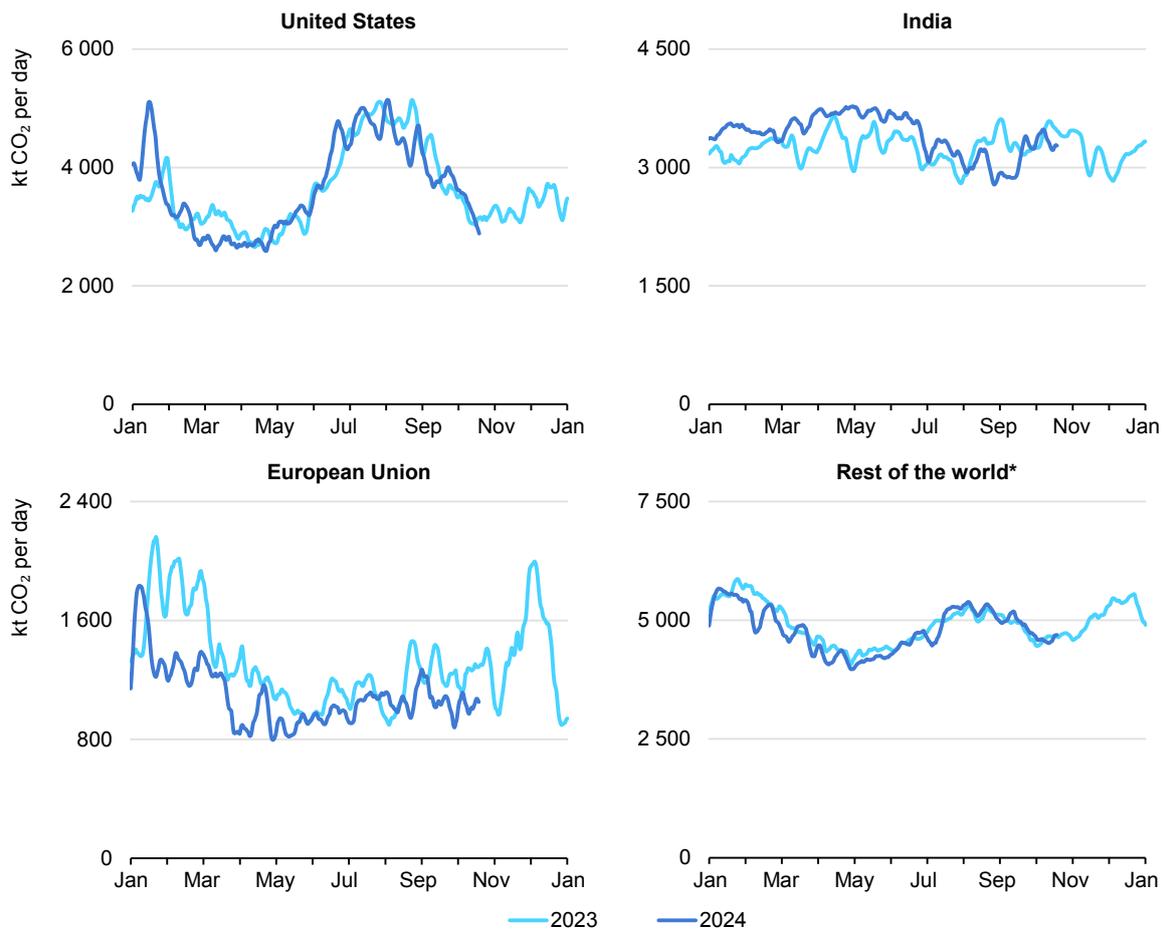
This section presents data from the IEA's real-time electricity emissions tracker, and unless otherwise specified data presented here pertain only to the countries covered by the tracker.

From January to mid-October 2024, CO₂ emissions from electricity generation in the countries covered by the IEA's real-time tracking tool fell by over 1% compared to the same period in 2023, despite a 2.5% increase in total electricity generation. This represents an improvement in the CO₂ intensity of electricity generation by nearly 3.5%. A key driver of this progress is the growing contribution of renewable energy, with its share in the electricity mix rising by two percentage points and generation increasing by 8% compared to the same period in 2023. Nuclear power generation, supported largely by a recovery in the European Union, also increased by over 2% in 2024, though its overall share in the electricity mix remained stable.

In the United States, electricity demand surged in January 2024, driven by colder temperatures compared to the same month in 2023. This spike in demand coincided with reduced availability of low-emissions electricity sources. Wind generation fell by 11%, hydro by 5%, and nuclear by 3% year-on-year. In response, coal and natural gas plants ramped up production to fill the gap, with coal-fired generation increasing by 24% and gas by 17%. Overall electricity generation in January rose by 9%, but the shift towards more carbon-intensive electricity sources led to a 20% increase in emissions. Despite the challenging

start to the year, emissions normalised at 2023 levels in the following months. Although June 2024 was the [second warmest on record in the past 130 years](#), driving a sharp rise in electricity demand for cooling, the increased availability of wind, solar, and hydro power helped temper the impact on emissions. Overall, total electricity generation emissions from January to October remained broadly stable compared to 2023.

Average daily CO₂ emissions from electricity generation, 2023-2024



IEA. CC BY 4.0.

Notes: *Rest of the world refers to the rest of the countries covered by the tracker. European Union does not include Cyprus and Malta. The graphs display 7-day moving averages.

In India, both electricity generation and associated emissions grew by 5%, as the CO₂ intensity of generation remained stable. Driven by economic development, population growth, and record-high temperatures, electricity generation increased by nearly 8% year-on-year from January to July. However, the 2024 monsoon season brought significant improvements compared to the drought conditions of 2023, [with above-normal precipitation levels](#). The 2023 drought had sharply raised electricity demand for agricultural pumps, but the stronger monsoons in 2024 resulted in a nearly 3.5% reduction in electricity demand year-on-year during

August and September. As a result, despite the jump in the first six months of the year, the annualised growth in total generation and emissions started to slow as the year progressed into the second half.

In 2024, the reduction in EU emissions from electricity generation remained close to the record 20% decrease achieved in 2023, confirming the rapid pace of the power sector's transition in the region. Between January and October, emissions fell by 16%, despite an overall increase of more than 2% in electricity production, resulting in an 18% improvement in carbon intensity. This progress was primarily driven by a 14% rise in renewable energy generation and a 4% increase in nuclear power output. Notably, 45% of the total increase in renewables came from higher hydroelectric power generation. Nearly three-quarters of electricity was generated from low-emission sources, with 25% coming from nuclear and almost 50% from renewables. Wind and solar alone accounted for almost 30% of the electricity mix reached on a year-to-date basis. In contrast, the share of coal in the energy mix dropped to below 11%, marking a historic low, while natural gas declined to less than 13%, its lowest level in a decade. For the first time, wind and solar power together generated more electricity than coal and gas combined since the start of the year, putting the European Union on track to achieve a new historic milestone in its energy transition in 2024.

International Energy Agency (IEA)

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