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POLICY BRIEF

LAST GASP: SECURING EUROPE'S WIND INDUSTRY FROM DEPENDENCE ON CHINA

Luke Patey, Byford Tsang

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SUMMARY

- Incoming Chinese competition is an ominous sign for one of Europe's last clean technology hopes—wind turbine manufacturing.
- China has already eradicated Europe's solar industry. It also dominates the supply chains of many components and raw materials crucial for wind turbines.
- At this rate, the decarbonisation of the EU's power generation sector could become yet more dependent on Chinese renewable technology.
- Europe can still save its wind industry. But policymakers will have to take more decisive action to ensure fair competition in Europe for domestic and foreign firms alike.
- They also need to ensure predictable, long-term demand and work with like-minded partners to build resilient supply chains that can weather future shocks.

Headwinds

Europe's wind turbine manufacturers were industry pioneers. Their cutting-edge technology still dominates in the EU, and it captures a large slice of the pie in the United States and in many emerging markets. But Europe's wind industry is in trouble. After years of rapid growth at home, Chinese manufacturers are expanding overseas and encroaching on markets European companies have long led, including in the heart of Europe itself.

The EU has launched initiatives to support Europe's manufacturers as they grapple with incoming competition from Chinese firms. But without more decisive action, Europe's wind sector could fall prey to the "second China shock". The first of these upheavals happened after China joined the World Trade Organization (WTO) in 2001 and flooded rich economies with cheap consumer goods, contributing to a decline in manufacturing jobs—particularly in the US. The second round could well be more consequential for Europe: this time, it is high-value sectors at risk.

China's growth in advanced manufacturing stems from tightly integrated local supply chains, abundant resources and access to world-class engineering talent. But it also benefits from Beijing's massive and diverse range of state support. This means Chinese firms enjoy baked-in advantages over their Western competitors as they hit the global market—notably, the economies of scale China's vast closed market brings and abundant supplies of low-cost products. Chinese competition has already eradicated Europe's (also pioneering) solar industry. And China dominates supplies of many components essential in wind turbine manufacturing. The danger for the EU is thus not only that decarbonisation leads to deindustrialisation through a loss of European jobs and exports; the bloc will also face a new kind of energy security risk: dependence on Chinese renewable technologies.

The EU and European governments need to work with Beijing on trade and climate. But they will only expose themselves to geopolitical leverage if they fail to balance this necessity with China's status as Russia's "no limits" partner and what NATO has labelled a "decisive enabler" of Russia's war on Ukraine. Disruptions to energy supplies, once rare, have become recurring features in a world increasingly shaped by geopolitical rivalry. Recent history lays bare how over-dependencies in energy, trade and security—on any single source—can, and will, be weaponised by foreign powers. As Europe reduces its dependence on Russian fossil fuels, it would be an act of cognitive dissonance if it did not manage the risks of dependence on clean energy technologies from China.

The second Trump presidency has already made matters worse. The 2022 US Inflation Reduction Act (IRA)—landmark legislation designed to boost domestic clean technology

manufacturing—created new opportunities in the US market for European investors and manufacturers. But these opportunities may disappear, for instance, under Trump's "One Big Beautiful Bill Act". This, as well as tariffs and a volatile trade war, means European wind developers have found their access to the US market is in jeopardy and their financial health squeezed when they are already warming up to buying Chinese wind turbines overseas and in Europe.

Europe can, and should, save its wind turbine manufacturing industry. This policy brief aims to guide European policymakers and industry figures in this process. First, the paper underscores the potential of Europe's wind turbine manufacturing industry to continue to thrive, but also some of the problems it faces—including supply chain dependencies on China. It then examines how Beijing's industrial policy created such immense scale in its homegrown wind turbine manufacturers that they can undercut European firms as they expand into the global market, potentially also undermining Europe's energy security.

Ultimately, the brief argues that Europeans should focus on three overarching policy goals to ensure Europe's manufacturers keep their place in the world's energy transition:

1. make Europe the world's most (genuinely) competitive market for wind energy—including for Chinese companies;
2. ensure that market enjoys predictable long-term demand;
3. develop diverse, resilient supply chains and a robust industrial base that can weather future shocks.

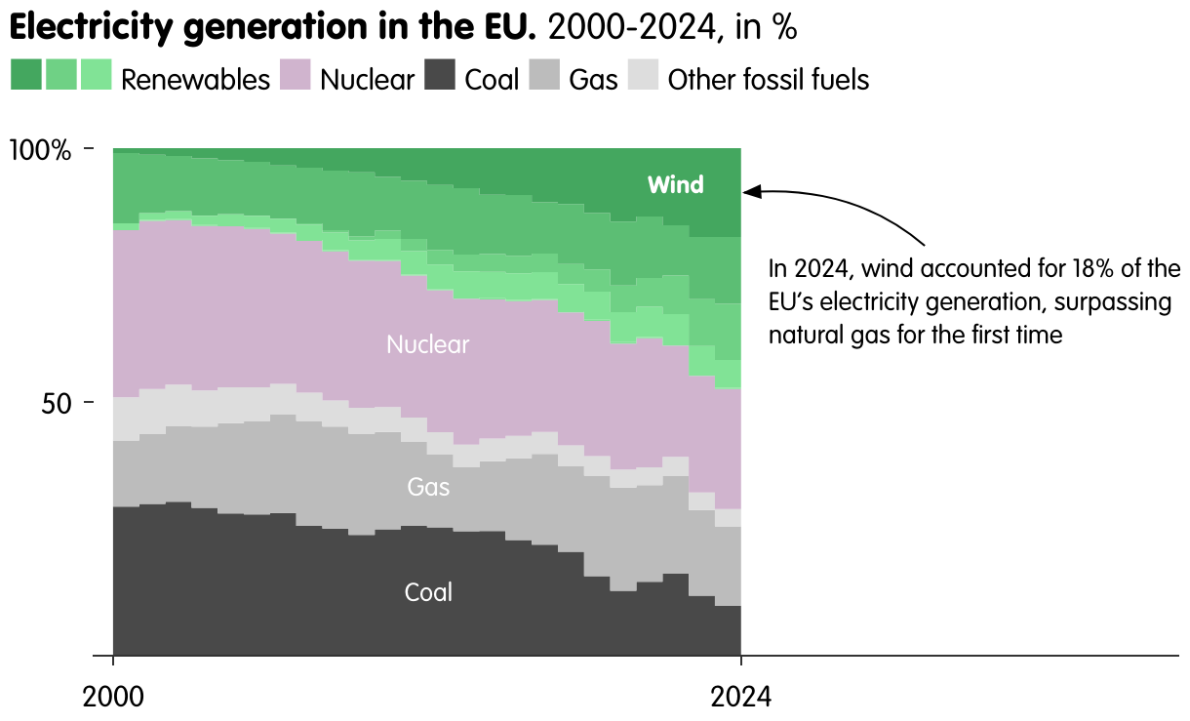
Europe's big clean breeze

In 2024, European wind turbine manufacturers play a large role in making—especially assembling and installing—almost all turbines on the continent. This dominance, and the industry's notable manufacturing capacity, means it is a significant jobs creator among renewable sectors in Europe.

The industry's strong position in Europe is underpinned by decades of global leadership and technological competitiveness from manufacturers, suppliers, and collaborating research centres and universities. The global strength of European wind turbine manufacturers brings more than economic and energy security benefits: it also contributes to Europe's strategic autonomy—ensuring that some decisions about the world's energy transition are "made in Europe" too.

At home

The green transition in Europe is highly dependent on wind power. In 2024 wind surpassed natural gas in power generation for the first time, accounting for 18% of the EU's electricity mix. If the EU meets its targets, wind is set to supply over a third of the bloc's electricity needs by 2030 and half of its power demand by mid-century. Wind is already helping wean Europe off Russian gas, and it will play a key role in shielding the continent from the volatility of global fossil fuel markets. Wind power and Europe's wind industry are therefore central pillars of European energy security. And the European wind market holds great potential and opportunity.



Yearly electricity generation, in terawatt hour (TWh).

Source: Ember

Yet, political polarisation and the "greenlash" of recent years mean future demand for wind power is not guaranteed. Renewables are cheaper than fossil fuels, but it takes time and investment for people to feel that saving in their pockets. Governments, meanwhile, are also feeling the pinch following the covid-19 pandemic and Russia's war against Ukraine. A key economic benefit of and social licence for net-zero policies is green jobs. The implementation of the EU's European Green Deal could create 2.5 million of these by 2030. But these jobs are not an inevitable result of the energy transition. In 2024 alone the European car industry cut

88,000 jobs amid its shift to electric vehicles. The 2025 bankruptcy of Swedish company Northvolt, once Europe's best hope as a battery manufacturing champion, has cast doubt on the future of the continent's battery industry.

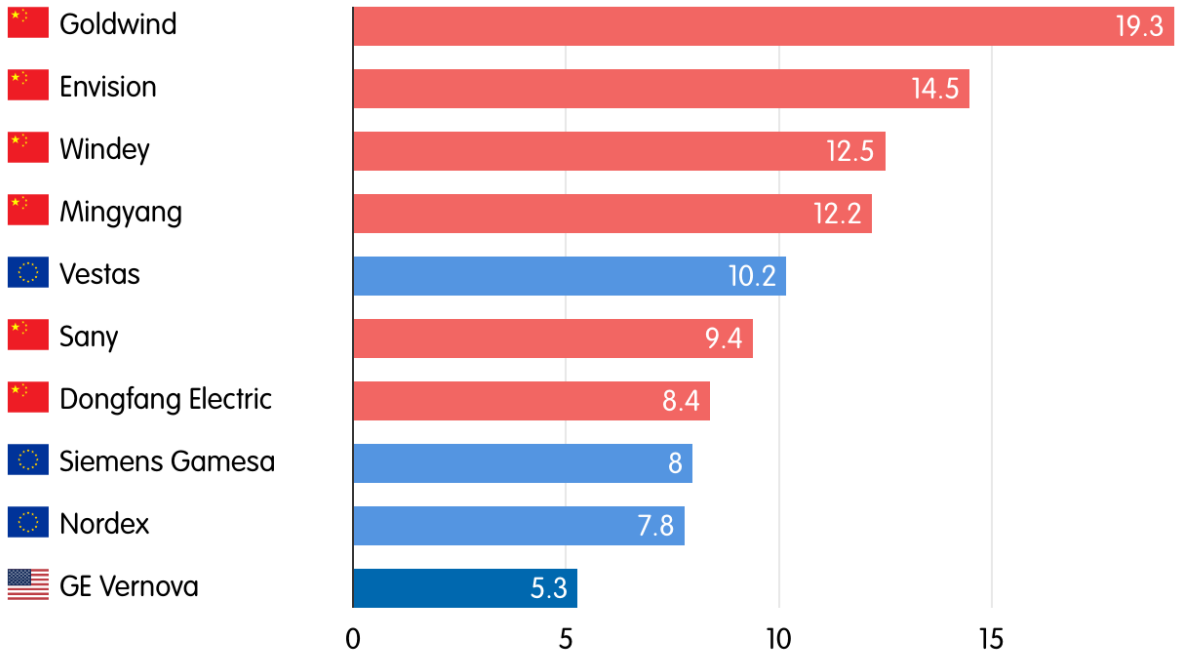
Europe's wind turbine manufacturing industry—the world's second largest after China—is far more promising. Including Norway and the UK, it employs 370,000 people, primarily in Germany, Spain, France and Denmark. By 2030, the workforce in just the EU could grow to 936,000, accounting for 16% of the potential new green jobs. Unlike the solar industry, in which most of the job potential comes from the installation of the technology, manufacturing accounts for the majority of the jobs in wind—with demand set to grow. These jobs will not all necessarily disappear as Chinese competitors enter the European market, particularly if they decide to produce components locally. But Europe will lose technological sovereignty if it does not ensure its manufacturers survive.

And abroad

The past 15 years have seen the Chinese market replace that of the EU as the epicentre of the global wind industry. In 2010 China became the country with the largest single wind market in the world. It took just five more years for the country to overtake the EU's then 28 member states combined. And it has shown no signs of slowing down since then: by 2024 the Chinese market accounted for 70% of new wind installations, an increase from over 60% of the world total in 2023.

Indeed, 2024 was the first year on record that Western wind turbine makers did not rank in the top three wind turbine suppliers. Chinese manufacturers Goldwind, Envision, Windey and Mingyang accounted for four of the top five largest wind turbine producers in the world. Goldwind alone brought online over 19 gigawatts (GW) of wind turbines. This is nearly 16% of the world's total and enough to power the whole of Belgium (on a very cold day). At over 10GW, the Danish company Vestas took fifth place.

Top ten global wind turbine makers. 2024 commissioned capacity, in GW



Source: Bloomberg
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For now, this remains largely due to Chinese manufacturers dominating in their colossal home market. European wind turbine manufacturers still lead in almost every other part of the world. Indeed, wind is one of the few remaining clean technology sectors in which European companies—Vestas, as well as German-Spanish firm Siemens Gamesa and Germany's Nordex, for example—maintain a sizable global market share. Besides their dominance in Europe, they also enjoy a strong position in the US and a solid presence in other markets. In 2024, Vestas alone held close to one-third of the global market share outside China.

The EU also enjoys enduring leadership in innovation and technological development. This is despite China's gains on this front. Since 2009 China has consistently filed more wind patents than any other individual country and EU member states combined. These inventions, however, tend not to be protected outside the Chinese market; nor do they hold significant economic or strategic value for their owner ("high value" patents). Between 2019 and 2021, the EU remained the global leader by some distance on numbers of high-value patents, with Denmark and Germany taking first and second place. (The US was third, and China fourth.) Patenting specifically for offshore wind technology focuses on new technologies such as floating foundations. This has followed a similar pattern to onshore and offshore inventions

combined: in 2023 China led in overall numbers of patents but lagged behind Germany, Denmark and the US for international filings.

But innovation in the wind sector is moving beyond blades, rotors, gearboxes and other key components. To improve the efficiency of turbines and wind farm management, manufacturers are developing energy storage and hydrogen conversion, as well as digital technologies such as AI, big data analytics and machine learning. This next wave of technological advances presents opportunity for Chinese manufacturers to close the innovation gap with their European competitors as they expand overseas, just as they have in other clean technology industries.

Gathering clouds

The European wind industry's production base and trading partners remain limited in size and scope. European manufacturers are shut out of the massive Chinese market, yet depend on China for supplies of many crucial components and raw materials. Europe's manufacturers have also faced unpredictable demand thanks to the battle for seemingly ever-larger turbines; improving, but still often lengthy and complex, permitting processes in Europe; and tender auction designs that promote a "race to the bottom". This is not to mention the "Trump effect". Combine all that with Chinese giants expanding overseas, and the next five years will be decisive for Europe's turbine manufacturing industry.

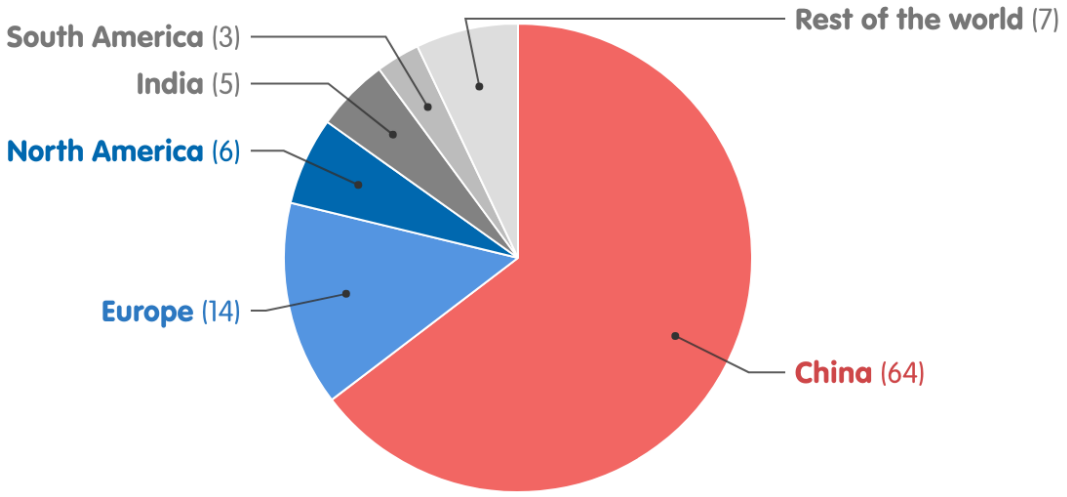
Supply chains

The security and economic benefits Europe is set to gain from renewables will be undermined if the continent becomes dependent on one source for clean technology—whether that is China or anywhere else. Solar energy, for example, provided around one-tenth of the EU's electricity needs in 2024. But 95% of solar panels installed in Europe are imported from China, which also dominates the production of polysilicon (a critical component of solar cells). In 2023, Europe made up 14% of the world's wind turbine value generation. This is, however, mostly in design engineering and assembly. To protect jobs and mitigate supply chain risks, the EU will have to hold onto this—but also expand its manufacturing base and diversify its suppliers.

China, meanwhile, accounts for over 60% of the global manufacturing value in wind turbines. China dominates key components such as gearboxes, generators, power converters and castings. It also controls the production of subcomponents and raw material extraction necessary to make turbines, such as 90% of permanent magnet manufacturing and 62% of

global rare earth mining.

Value generation along the wind supply chain. In %, based on USD 2023



Source: GWEC
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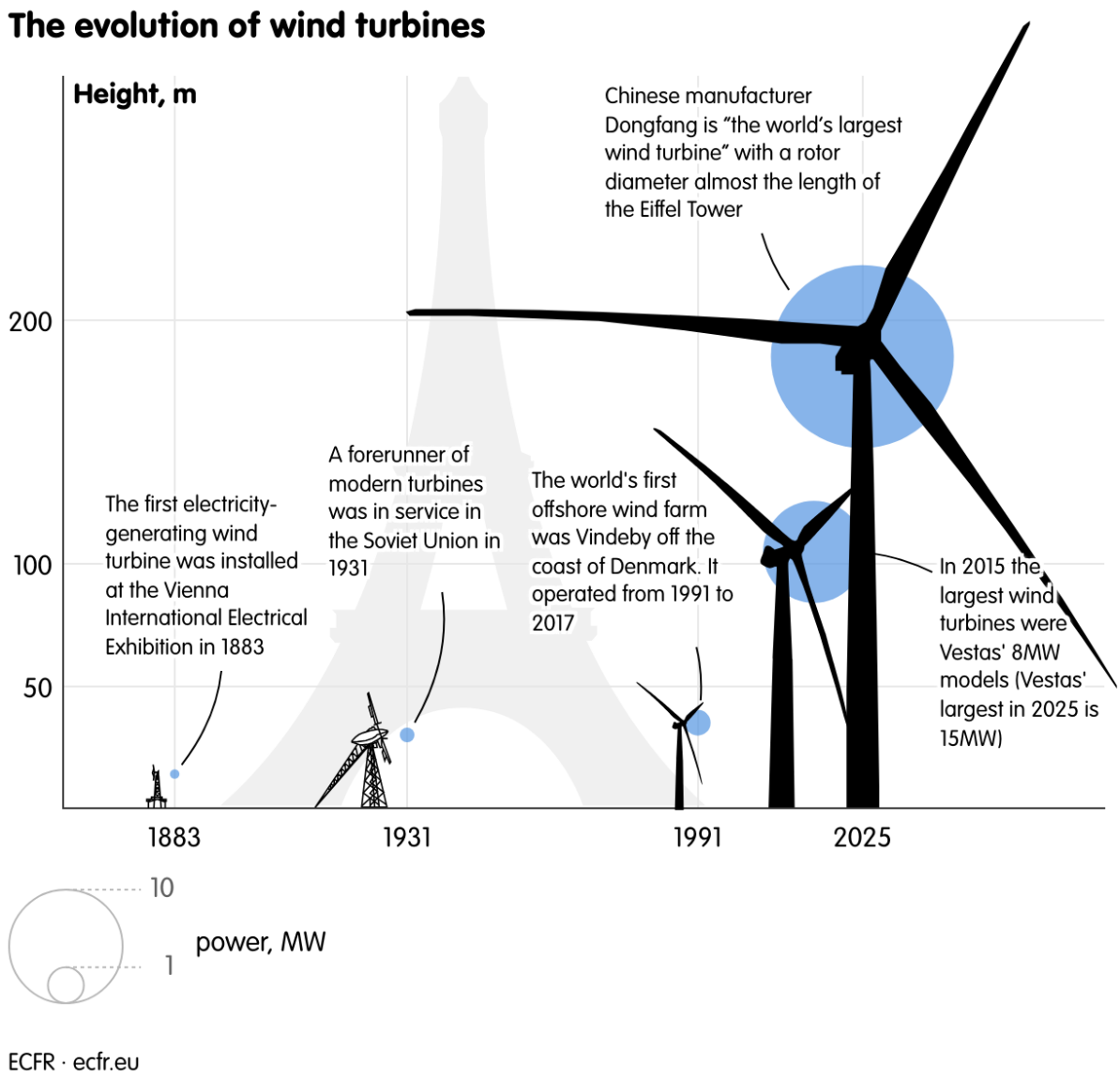
European countries are making some progress in developing their domestic rare earth processing and magnet making industries. France and Norway, for example, have begun developing their rare-earth processing capacity; Estonia is in the early stages of magnet manufacturing. But the need for these critical minerals and magnets will only grow. All offshore wind turbines require rare earth magnets (as do up to 30% of onshore turbines). And offshore wind installations are expected to make up 50% of the EU's total by 2030, up from 31% currently.

Such dependencies mean the EU faces strategic risks in reaching its renewable energy targets. Supply disruptions in China would not immediately upset Europe's energy system like a Russian gas embargo. But decisions about the cost and pace of the EU's green transition could become contingent on policy choices made in Beijing. After all, China has increasingly used export controls to maintain its dominance in clean energy supply chains. As early as 2020 Beijing reportedly placed informal high-grade graphite (a mineral crucial in the production of lithium-ion batteries) restrictions on Sweden, home to the bankrupt Northvolt. It made these restrictions official for all exports of high-grade graphite in December 2023. In early 2025, China imposed controls on tellurium, tungsten and indium—critical materials for solar cell production.

Unpredictable demand

The accelerating energy transition has triggered a race for seemingly ever larger, more powerful wind turbines. European manufacturers are very much in this race. But Chinese firms lead in the development and prototyping of the world's largest offshore wind turbines, with Dongfang testing a model whose rotor blades span 310m in diameter—nearly the height of the Eiffel Tower.



The sheer scale of these turbines and their components necessitates costly upgrades to factories, vessels and ports. The arms race in turbine size also means products more quickly go out of date. This forces manufacturers to invest heavily in research and developments (R&D), straining cash flows. European industry figures have warned that Europe's infrastructure is not ready for much larger turbines. They instead favour expanding the production of existing models as a more sustainable approach in which the goalposts are more static.

Moreover, the EU is having to overcome regulatory hurdles to that add to the uncertainty. Europe's wind manufacturers have been stymied, for instance, by longstanding problems with permitting for new wind farms and connection to the grid. The EU and member states

have begun to address this through initiatives to simplify the permitting process and make it more efficient. Moreover, in recent years some European governments have applied "negative bidding" in their tenders, where the investor essentially pays for the right to develop a project. While this proved attractive to some member states, high costs and supply chain disruptions since the covid-19 pandemic have since turned many European investors against this approach: Denmark's large offshore tender in late 2024 received no bids, for example. When investors do pay, the extra costs end up being passed on to turbine manufacturers, suppliers and customers. Negative bidding also favours low-cost, high-scale Chinese competitors, despite the potential risks to economic and energy security.

And Trump

The second Trump administration complicates things further. Since his return to the US presidency, Donald Trump has launched an aggressive and volatile trade war that threatens to upend the international trading order. Trump's tariffs have elicited a response from China. In April, for example, Chinese authorities imposed restrictions on rare earth elements and permanent magnets. This did not only affect the US, but also European importers.

Trump has also sought to roll back support to clean technology manufacturing, increasing uncertainty for European wind companies in the US. Democrat-led and even some Republican states continue to support clean energy incentives under the IRA, which may keep onshore wind development moving forward. But offshore wind projects, which were already facing delays and cancellations, will likely be hit by federal regulatory shifts that hinder their progress even more. In face of such risks, analysts warn of a "wait and see" attitude among European investors. This uncertainty, and potential loss of US revenues, is nudging EU wind developers towards engaging more closely with cheaper Chinese wind turbine manufacturers in European and overseas markets.[1]

China's global hurricane

There is good reason for Europe's wind industry to fret over incoming Chinese competition. Chinese wind companies not only provide competitive and innovative products, but thanks to China's competitive domestic wind market and subsidised manufacturing positions all along the supply chain, a Chinese-made turbine costs at least 30% less than those made by European and American companies. This means Chinese manufacturers could be on track to dominate another global industry, undercutting European incumbents in markets such as India and very possibly in Europe itself.

First China

Historically, Chinese wind manufacturers were dependent on Western pioneers. Technology transfer took place through commercial licensing, joint technology development and acquisition deals. But, as with solar panels, China's subsidies and protectionist policies over the last three decades have given Chinese companies a significant boost, shutting European competitors out of China. In 2005, for example, Siemens Gamesa enjoyed a one-third stake in China's wind market; by 2010, that had shrunk to a mere 3%. This exclusion has played an important role in shaping today's challenges for European wind turbine manufacturers, as it denied European firms the opportunity to benefit from the economies of scale that China's wind industry giants now enjoy.

China's leaders started their localisation drive for the wind sector as early as 1996, when they introduced local content requirements, mandating that wind farms include a minimum of 20% Chinese-made parts. This rose to 50% in 2003 and 70% by 2005. They also prioritised wind farms that used local content for permits and then connection with the grid. The aim of this drive was not only to ensure Chinese companies captured a larger part of the profits from the wind turbine supply chain, but also to "import, digest and absorb" advanced technologies to enable "self-development of wind energy intellectual property".

Western wind turbine makers, in turn, found good reasons to encourage their foreign suppliers to set up shop in China. One key disadvantage foreign bidders experienced was that Chinese government tenders in the wind power sector often focused on initial turbine price but not life-cycle cost. And, to access the Chinese market and receive government funding, foreign wind turbine manufacturers had to form joint ventures with local Chinese companies and transfer wind turbine technology. As they did this, their market share in China was increasingly squeezed by policies that favoured Chinese domestic firms. In 2009 Beijing dropped its 70% local content requirement to signal to Western governments that China was a competitive market. But European manufacturers have reported they were still rejected after that due to requirements for Chinese-made parts.

The Chinese government also introduced subsidies that targeted Chinese-owned wind turbine manufacturers. For instance, the "Special Fund for Wind Power Equipment Manufacturing" offered grants "to Chinese-funded and Chinese-controlled" wind equipment manufacturers that also used components made in China. But Beijing cancelled this fund in 2011 after the US challenged it at the WTO on the basis that it amounted to unfair subsidies. By that time, however, Chinese manufacturers already dominated their domestic market. Now, non-Chinese turbine manufacturers barely register in China's wind industry. While European and

American wind turbine manufacturers still account for about 10% of turbine production in mainland China, most of these products are exported. Just 0.2% are made for the Chinese domestic market. Western manufacturers are thus producing in, but not for, the world's largest wind market.

China's wind turbine manufacturers, meanwhile, benefit from tightly integrated local supply chains, abundant upstream resources such as rare earths, and access to world-class engineering talent. But intense price wars and the end of some government incentives have slashed the profit margins of Chinese wind turbine manufacturers. This, and a turbine surplus of around 20GW in 2024, has intensified Chinese manufacturers' search for more profitable opportunities abroad.

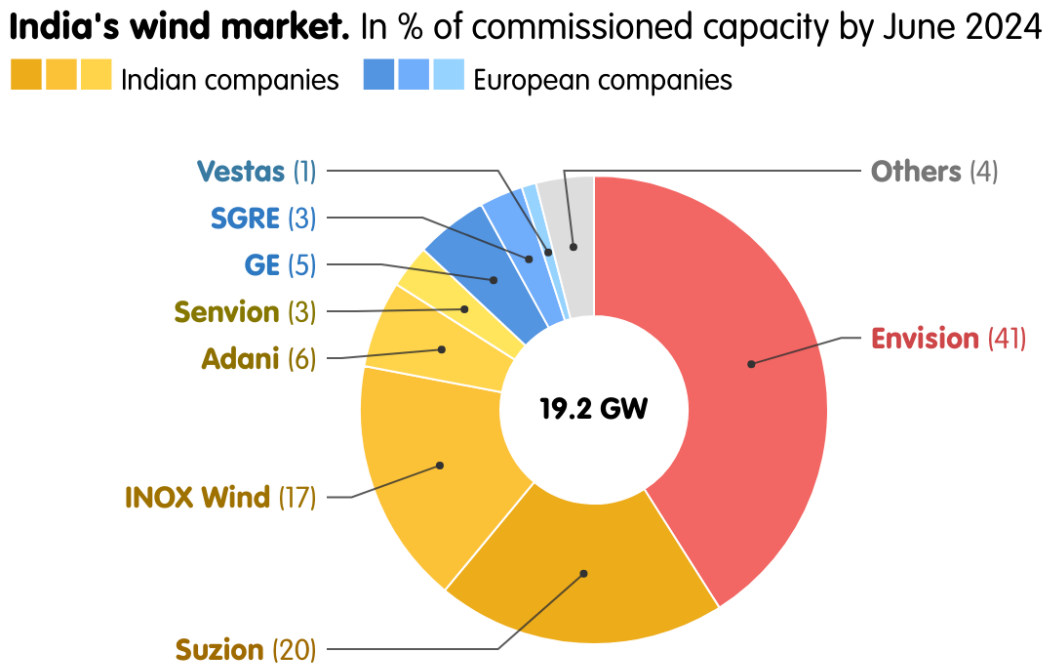
Then emerging markets

Most of the world's wind power is generated in China, European countries and the US. But new markets have begun to emerge over the past couple of decades. European wind turbine makers maintain a strong position in most of these emerging markets, though industry insiders fear that the wind industry outside China is reaching a tipping point. [2] In the years that followed the covid-19 pandemic, Western wind turbine makers faced persistently higher costs due to supply chain disruptions and inflation. Most companies responded by turning to their home markets where they can sell fewer products at a higher price (and did not bid for less profitable tenders in emerging markets). On top of these sector-wide difficulties, Siemens Gamesa suffered serious product quality problems.

This does not mean a Chinese takeover of the world's wind industry is guaranteed. The vast majority of new installations by Chinese companies remain in China. But they are advancing overseas. In 2023 Chinese wind turbine makers won overseas orders for 7GW in capacity—more than the previous three years combined. This is equivalent to 15% of the market outside China. They already enjoy a big slice of Central Asian markets, and have overtaken European firms in the Middle East and Africa. Now, Chinese wind turbine manufacturers are displacing their Western competition in larger emerging markets too.

India has become the largest wind market outside China, European countries and the US. Even before the pandemic-related supply chain disruptions, Vestas and Siemens Gamesa had built a presence in India as a de-risking option from China. Nordex exploited its Indian production in 2024 for exports to Europe. But some Chinese wind turbine manufacturers are also expanding their footprint in the Indian wind industry. In recent years, Envision has opened a casing factory in Maharashtra and a blade factory in Tamil Nadu, in addition to developing partnerships with Indian and foreign suppliers.

Indeed, India is a prime example of how quickly the tables can turn on European manufacturers. For years, Siemens Gamesa and Vestas often held nearly half of the annual Indian wind market. But the 45% market share they held in 2019 has collapsed, with China's Envision rising to become the dominant firm with a 41% share, roughly the same as local manufacturers Suzlon (20%), Inox Wind (15%) and Adani Green (7%) combined. Another Chinese company, Sany, is also increasing its share.



Source: MEC+ and GWEC India
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This marks an abrupt sidelining of Western wind companies. (By March 2025, owing to its broader financial struggles, Siemens Gamesa was in the process of selling much of its India business.) The sheer scale Chinese wind turbine manufacturers command at home makes their international offerings cheaper than foreign and Indian wind companies. According to

Indian wind-industry insiders, Chinese firms also provide fixed rather than variable price contracts because their sizable stock largely shelters them from price fluctuations. [3] Indian wind turbine manufacturers have called for "fair play" in face of a foreign "invasion" of the wind sector (including by Western manufacturers).

Brazil is another battleground. Although Vestas and Nordex currently lead with about 70% of the Brazilian market, China's Goldwind has opened a turbine plant in the country, positioning itself for rapid growth across Latin America thanks to greater ease in transporting massive components.

And finally, Europe

The EU market could be next. By 2022 Mingyang turbines were already in action off the coast of Italy; Croatia had an onshore farm complete with turbines manufactured by Shanghai International. Chinese manufacturers see many such opportunities in the thriving EU market, where a record 16GW of new capacity was installed in 2024. Given Chinese manufacturers only took roughly 1% of the EU wind market that year, they have a long way to go. But the rapid ascent of Chinese manufacturers in solar, telecommunications and other clean technology and digital industries should provide ample cause for concern among European leaders and wind manufacturers.

Chinese turbine manufacturers are engaging European investors and taking steps to establish a stronger presence and production base in Europe. European investors have also been attracted by the low-cost advantages of Chinese wind turbine makers for their projects outside Europe, particularly since many Western manufacturers downsized their global ambitions after the covid-19 pandemic. French, Danish, Italian and other European investors have already chosen Chinese wind turbine makers for projects in emerging markets—including on the EU's doorstep. In 2023, for example, Windey won close to 1GW of deals in Serbia from the Italian company Fintel Energia.

Chinese manufacturers see these projects as a way to demonstrate their products' performance and reliability to European and international developers. [4] Once the Chinese turbines have built up a two- to three-year track record of performance in overseas projects, wind analysts argue, European investors will be better placed to assess whether Chinese manufacturers compete as well in practice as they seem to on paper. [5] European developers are not blind to demands for a secure green transition in Europe. But others in the industry fear that, if these "test projects" go well, Chinese manufacturers will win more and larger EU-based wind energy projects and their European counterparts will suddenly find themselves with shorter order books and shrinking share prices. [6]

Indeed, in 2024 European investors chose Mingyang to supply turbines for offshore wind projects in the North Sea and the Mediterranean. As part of a collaboration with energy developer Renexia, Mingyang has also signed a deal to build a turbine factory in Italy. Moreover, a division of Goldwind plans to open a factory in Spain, and the company has joined a host of other Chinese players bidding for new offshore projects in France. Still, Chinese wind turbines remain largely unproven in European markets. And the rapid rollout of new and larger Chinese models has raised concerns among some investors.

The potential damage

The EU has started the damage limitation. Among the raft of initiatives is the flagship 2023 Wind Power Package that aims to strengthen domestic manufacturing and stimulate local demand through strategic public procurement. This initiative covers permitting reform and auction design, but also finance and skills to help Europe maintain its "first mover" advantage in wind and fill all those future jobs. The 2024 Net Zero Industry Act and 2024 Clean Industrial Deal also aim to boost domestic manufacturers and demand. These efforts are starting to bear fruit. Besides the EU's record installations in 2024, over 30 new wind turbine manufacturing facilities had been announced across the continent by the end of the year. EU financial instruments, including the European Investment Bank (EIB) and the Innovation Fund are now supporting wind manufacturing projects in Europe.

Moreover, the European Commission has taken a more proactive stance on unfair trade practices. In 2024 it launched an investigation into wind projects involving Chinese turbine suppliers suspected of benefiting from market-distorting subsidies. This year it also introduced provisional duties on imports of epoxy resins, used in wind turbine blades and other products, from China and other Asian countries. Back in 2021 it imposed anti-dumping measures on Chinese steel wind towers. One component supplier, however, said EU tariffs are leading Chinese companies to relocate to other markets, like Turkey, to produce there and

circumvent the levies.[7]

Without more decisive action, the expansion of Chinese turbine manufacturers will have serious market-distorting effects in the EU's wind industry and could imperil its energy security.

Economy

Chinese wind turbine makers can offer European customers multiple years of deferred payment—generous conditions European wind companies simply cannot match because they are beholden to bottom lines. Chinese manufacturers' edge is also bolstered by direct government subsidies in the form of income-tax concessions, grants and below-market borrowing rates, which amount to about 4% of the firm's revenue on average. OECD wind turbine manufacturers on average receive subsidies amounting to about 1% of their revenue.

The presence of Chinese wind turbine manufacturers in the European market does not necessarily mean European jobs will disappear, if they decide to produce components locally. However, the economic value of Chinese investments will largely depend on Beijing's policy decisions. China's government, for instance, has instructed car companies investing in Europe to retain advanced electric vehicle (EV) technologies within China. It has also encouraged the use of "knock-down kits" (pre-assembled, domestically produced components for final assembly abroad) as a means to safeguard economic activity and intellectual property in China. Similar dynamics are evident at EV manufacturer BYD's plant in Hungary, which relies on importing battery cells and steel from China. This limits its economic benefit for the country and hampers the development of local supply chains.

Security

The contribution of wind power to Europe's energy security is based on a well-functioning and secure wind industry. China already dominates supply chains in solar and in components crucial to the wind sector. If the EU seriously considers China a "systemic rival" then it will have to counter security risks all along the renewables supply chain. This includes wind turbines, which remain its best hope to avoid hyper-dependency on China.

The European defence and intelligence communities have raised concerns over the presence of Chinese wind turbines in Europe. A German defence ministry think-tank has advised against the development of wind farms using Mingyang turbines. And the British departments of defence and energy security reportedly objected to the inclusion of Chinese manufacturers in a wind farm tender in Scotland.

Wind farms—especially offshore installations—rely on remote monitoring and control systems (given their locations). Indeed, manufacturers can typically shut off their turbines anywhere in the world within an hour. Such vulnerabilities, whether they are deliberately embedded or not, can be exploited by hostile actors or firms under state pressure. China's 2017 National Intelligence Law, for instance, compels all companies to cooperate with the country's intelligence services. Off-site access could be exploited as a point of entry, to disguise an attack as maintenance through software updates. Such breaches could create a voltage depression that destabilises the grid, or, in the worst-case scenario, cause serious physical damage to turbines. Beijing, in turn, recently ensured one Western manufacturer could no longer remotely control its China-based turbines. [8]

This remote access also means wind farms are vulnerable to cyberattacks, regardless of where the technology comes from. On the day Russia invaded Ukraine, German wind turbine maker Enercon lost remote access to 5,800 turbines after a Russian-linked cyberattack on a communication satellite. While an attack on Europe's power systems would likely only happen in a moment of extreme geopolitical tension, as it could be interpreted as an act of war, that does not negate the risk altogether. The US has accused a Chinese state-backed group of cyber actors, Volt Typhoon, of infiltrating critical infrastructure to map vulnerabilities that could be exploited in the event of a military conflict. This includes America's energy systems.

How to keep the wind in Europe's sails

Europe faces mounting demands on its political and financial capital: higher defence spending, the economic aftershocks of the so-called Trump tariffs, and intensifying industrial competition from China. Among all this, European policymakers would do well to prioritise the wind sector. Strengthening European wind manufacturing is not just about corporate market share; the sector will also play a crucial role in the continent's economic prosperity, energy security and strategic autonomy.

In saving Europe's wind industry, policymakers and industry figures should focus on three overarching goals: first, making Europe the world's most (genuinely) competitive market for wind energy; second, ensuring that market enjoys predictable long-term demand; and third,

developing resilient supply chains and a robust industrial base capable of weathering future shocks. To achieve these goals, policymakers should consider the following recommendations.

Forging the world's most competitive wind energy market

Restore fair competition

The aim of trade defence measures is to ensure business in Europe takes place on a level playing field and involves fair competition for all firms, domestic and foreign. It is not to exclude Chinese firms from the European market. EU policymakers should therefore aim to offset the distorting effects of Beijing's state support to its wind industry overseas. This will enable the EU to keep its market open to Chinese trade and investment that meets fair competition criteria, meaning European manufacturers benefit from competition and investors retain access to the best technology worldwide.

In 2024, for instance, the EU imposed tariffs on Chinese EVs, and the ensuing row may very well lead to agreements on pricing and local production. This shows how trade defence measures can potentially be an effective lever in negotiations to restore fair competition. Europe's wind market may not be the largest, but policymakers should aim for it to be the most pro-competition in the world.

Insist that foreign investment creates significant local value

Member state governments should ensure that foreign direct investment (FDI) brings about growth in wind manufacturing in Europe as well as local value creation. This means they need to prevent their wind industries becoming mere assembly hubs for Chinese components.

European governments should adopt a coordinated approach to negotiating, vetting and conditions for FDI in wind and other clean technology. They should focus these efforts on safeguarding local interests and prioritising local supply chains, workforce development and technology transfer, while maintaining fair competition for European and foreign firms. As part of this, the European Commission should include greenfield investments in renewable energy manufacturing, such as factories for wind turbines and their components, in its ongoing update of the EU FDI Screening Regulation (which enables the commission to advise member states on foreign investment).

But, as member states negotiate deals and apply screening mechanisms, governments must keep in mind that Chinese companies operate within the framework of Beijing's broader

geopolitical and foreign policy goals. Beijing has already said that Chinese companies should favour investment in EU countries that oppose tariffs on electric vehicles and freeze projects in member states that support them. This includes those companies operating as private enterprises. In March 2025, for example, Hong Kong-based conglomerate CK Hutchison attempted to sell its stakes in Panama ports likely to avoid any Trump-related business complications. This attempt, however, was abruptly halted following intervention from China's regulator, underscoring the fact that private firms remain subject to Beijing's strategic considerations and control.

Ensuring predictable demand for long-term investment

Pause the "battle for the biggest"

European governments and industry should explore setting standards on turbine size through the European Commission's high-level forum on European standardisation. They should also adjust tender auction designs to avoid systematically favouring ever-larger models. This will help prevent the goalposts constantly moving (and expanding) and mitigate the challenges of giant untested turbines. To ensure measures such as these do not stifle innovation, the wind industry should also develop predictable timelines for when new standards would allow increases in turbine size.

Prevent a "race to the bottom" in tender auctions

Member states that still use uncapped negative bidding should heed the call in the EU's Wind Power Package to avoid such auctions. They should instead shift towards models that offer more predictable returns and lower financing costs for developers, such as long-term power purchase agreements that guarantee stable prices and predictable cash flow for developers.

Governments should also set out a plan for a stable pipeline of wind energy auctions or tenders to provide developers and investors with greater certainty on volumes and revenues. The North Seas Energy Cooperation has provided a useful model for such coordination, where governments align on long-term planning of offshore wind growth and collaborate on joint projects.

Developing resilient and secure supply chains

Support domestic production

The EU and European countries need to develop domestic wind production to lower

dependencies on single sources. While it is not feasible for them to remake a fully integrated wind industry supply chain, this reduction is achievable over time.

This would not necessarily involve excessive amounts of new financial support through one-off state-aid or grants. European wind turbine manufacturers and component suppliers, for example, have called for production-based incentive schemes to stimulate investment for the long term. The European Commission could test how this would work without developing unfair competition between member states. [9]

But the EU and member states should ensure such support helps relieve critical dependencies. Crucially, the EU and its member states need to overcome their reliance on China for permanent magnets. The Critical Raw Materials Act and the Net Zero Industry Act set targets and simplify permitting to encourage investment in developing a rare-earth supply chain for technologies that require such materials. Some important European magnet makers have already been attracted by the benefits offered by the IRA in the US. But Europe has building blocks of its own to exploit.

The EU should bolster the development of new rare earths processing under way in France and Norway, as well as Estonia's and other nascent magnet manufacturing sectors. The bloc should do this by leveraging state aid and EIB financial support for critical raw materials to facilitate guaranteed purchases between these new rare earth production efforts and wind industry end users.

The EU will also need financial protections against any Chinese monopolistic pressures the European processing and magnet industries may face. The EU should also support the efforts of its Japanese, Australian and South-East Asian partners to develop new mine and separation capacities for the earlier stages of the permanent magnet supply chain. This would enable all involved to diversify their trade.

Foster alternative supply chains

In parallel with new domestic production, the European wind energy sector needs alternative supply chains for components for which it is currently dependent on China. This will help ensure fair competition, and sustainable and resilient growth in the sector. Europeans should focus on such critical components as gearboxes, generators and power converters, which are at risk of concentration in China. Policymakers and industry figures should collaborate with partners that share the EU's goals of developing home-grown clean technology industries, reducing dependence on China, and building resilient and competitive supply chains. The EU would be well placed to share its expertise on permit reform and grid connectivity with third

markets facing similar challenges.

India stands out as a promising candidate for such collaboration. Its potential as a manufacturing base suffers due to swings in annual domestic demand and high wind turbine costs compared with China. But India's large and fast-growing wind energy market offers one of the most attractive low-cost destinations outside China, boasting an industry ecosystem and policies that promote local wind turbine production.

The EU, UK and India should work together to ensure mutual market access for their respective wind technologies. They should also introduce safeguards against distortions caused by subsidised products or trade diversion. Such coordination is essential if industries in both Europe and India are to grow and remain competitive against China's clean technology giants. The EU-India Trade and Technology Council offers an established platform to advance this collaboration. The UK government should consider replicating its ongoing policy and research collaboration with China on offshore wind, for example UK-China Offshore Wind Industry Advisory Group, with India.

Take control of wind turbines

The EU and its member states should ensure that control of turbines and access to operational software can only originate from the EU countries. One way to implement this safeguard would be to include such requirements in the pre-qualification criteria for renewable energy auctions under the Net Zero Industry Act and through national auction frameworks. Lithuania, for example, has passed legislation that bans access to management systems of solar and wind farms by companies from countries that pose a threat to national security. The law prohibits these entities from remotely managing key operational functions, such as adjusting electricity output or turning systems on and off. This could provide a model for other member states.

Over the horizon

If the EU wishes to continue playing a role in promoting the green transition and expanding clean technologies worldwide, it must first take command of its green future at home. European governments must identify where Chinese wind turbine manufacturers have gained competitive advantages through state support. Europeans should then aim their policy interventions at closing these gaps through trade defence measures, regulations and incentives.

But it cannot stop there. Overseas markets are crucial for European wind turbine

manufacturers to remain competitive in the long term. It will be vital for the EU and member states governments to foster and deepen international partnerships that can help them maintain resilient supply chains, thereby assuring Europe's energy security and strategic autonomy.

About the authors

Luke Patey is a senior researcher at the Danish Institute for International Studies, focusing on geoeconomics and industrial competitiveness in green and digital technologies.

Byford Tsang is a senior policy fellow with the Asia programme at the European Council on Foreign Relations. He previously led the China programme at the international climate think tank E3G, where he advised policymakers on EU-China negotiations on climate and energy issues.

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[1] ECFR workshop, held under the Chatham House rule, Berlin 2025.

[2] Authors' interviews with wind industry insiders, online, February 2025.

[3] Authors' interview with wind industry insiders, online, February 2025.

[4] Authors' interview with Chinese manufacturer, online, February 2025.

[5] Authors' interview with European investors, online, April 2025.

[6] Authors' interview with industry insiders, online, November 2024.

[7] Author interview with European supplier, online, May 2025.

[8] Authors' interview with Western manufacturer, online, April 2025.

[9] Author interviews, online, November 2024 and May 2025.

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