

# CIRCUIT BREAKERS: SECURING EUROPE'S GREEN ENERGY SUPPLY CHAINS

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## SUMMARY

- Implementing the green energy transition is a core EU goal and is urgent in light of rising global temperatures and new geopolitical realities.
- China is a core player in green technologies, which potentially creates European over-dependence on China-based supply chains and decisions made in Beijing.
- Europeans should rapidly reassess their green energy supply chains and take steps to selectively reduce their China exposure, through both strengthened domestic policies and by working with key partners and allies.
- It is, however, neither possible nor desirable to completely cut China out of these supply chains.
- European policymakers will instead need to strike a balance between managing China-related risks and continuing to work with Chinese suppliers where necessary, especially as they seek to fast-forward the EU's transition to a low-carbon economy.

# Introduction

In April 2022, Italy's first offshore wind farm went into operation at the port of Taranto, powered by turbines produced by Chinese firm MingYang. This marked a first win for the Chinese wind champion in Europe's offshore market. Just a few months prior, the largest wind farm in Croatia opened in the coastal town of Senj, constructed and run by Chinese company Norinco International. This too was equipped with turbines imported from China. These were produced by Shanghai Electric, another of China's champions in the wind sector and among the top ten companies globally in the sector.

European countries are investing heavily in the green transition. But projects such as the Italian and Croatian wind farms have taken on new relevance and urgency as Europe deals with the war in Ukraine and works to reduce its energy dependence on Russia. Both projects, however, illustrate the challenges ahead for the European Union in ensuring a future that is both green and energy-secure. In the Taranto project, a European turbine-maker's failure to deliver products on time provided an opening for its Chinese competitor. At Senj, Norinco International, which is providing both capital and hardware, is not only a Chinese state-owned industrial giant, but also a major defence company and supplier of weapons and equipment to the Chinese People's Liberation Army.

Though Europe's oil and gas dependence on Russia is the more immediate chokepoint, its reliance on China for the energy technologies of the future poses a similar problem. China has become a global player across a wide range of green technologies, which makes it indispensable for the green transition that the EU is pursuing. As with Russia, this creates risks of over-dependence on an authoritarian power. Compared to Russia, however, China is a far bigger non-market economy and has much greater sway over global technology markets.

Navigating this situation will require European policymakers to make hard choices. This policy brief reviews some of the major supply chain risks linked to green energy technologies, especially as they relate to China. It proposes the following approaches to guide policymakers' actions:

- **Reassess the geopolitical risks that affect supply chain resilience.** European policymakers need to make green energy supply chains more resilient to any further deterioration in relations with China.
- **Right-size China exposure.** Securing Europe's green energy supply chains will come at a cost – but it is possible to address security concerns without resorting to full-scale reshoring.

- **Prioritise business-friendly policies.** Europeans should work to enhance the competitiveness of domestic firms. Their policies should aim to ensure that those European industries that emerge from the transition are globally competitive in the long term.
- **Uphold high environmental and ethical standards to achieve long-term sustainability.** Any effective green energy policy will require adherence to high standards of sustainability and ethics that fit with the EU's values.
- **Work with partners.** Building resilient green energy supply chains will demand an unprecedented degree of cooperation with like-minded partners.

## Current risks in green energy supply chains

Green energy technologies will play a crucial role in reducing Europe's dependence on fossil fuel imports from Russia and other autocratic countries. However, supply chains for such technologies are also vulnerable to disruption.

<b>Risks to green energy supply chains</b>	
<b>Risk</b>	<b>Detail</b>
<b>Critical minerals risk</b>	Many green energy technologies rely on scarce minerals that must be extracted and processed. This creates risks of supply disruption due to operational difficulties, monopolistic behaviour, or political or military flare-ups.
<b>Critical component risk</b>	Green energy technologies often rely on complex equipment and devices with critical parts sourced from a limited number of suppliers. Disruptions that affect the supply of these critical components could have an outsized impact on the entire supply chain.
<b>Geographic concentration risk</b>	In several green energy technologies, the manufacturing of intermediate and/or finished products is concentrated in a few countries. This creates risks that geopolitical tensions between the producer and key buyers, or operational disruptions in the manufacturing country, could limit access to these technologies.
<b>Know-how risk</b>	In instances where the production of green energy equipment has largely moved overseas, there are risks that the know-how to manufacture these technologies cheaply and at scale is lost to key buyers – making it much harder to cope with supply disruptions.
<b>Cyber security risks</b>	Though cyber security concerns are not unique to green energy technologies, the rapid development of these technologies, and the interconnected nature of the new energy infrastructure, has made cyber security a key risk.

These risks to supply chains affect different renewable energy technologies in different ways. Future efforts to mitigate supply chain risks should start with a comprehensive mapping of supply chains. But some risks in key industries are already known.

- **Solar:** In the solar industry, critical minerals risks are least acute because the raw materials that form the bulk of most solar panels, particularly silica, are globally abundant. However, due to substantial government investment and low input costs, much of the solar photovoltaic manufacturing chain today is geographically concentrated in China. In polysilicon production, seven of the top ten manufacturers are Chinese, with US, EU, Japanese, and South Korean companies accounting for only 22 per cent of the global total. China accounts for 97 per cent of global ingot and wafer production. Though Western companies are the leaders in next-generation solar technologies such as cadmium-telluride thin-film solar, the production of these panels currently makes up only a small percentage of the global solar panel market and requires rare minerals such as tellurium, of which China accounts for 62 per cent of global refining activity and 21 per cent of reserves.
- **Wind:** In the wind industry, critical minerals risks are high. Wind turbines, especially those used for offshore wind farms, typically require rare earths such as neodymium, which is predominantly mined and refined in China. In many segments of the supply chain, European and other Western manufacturers remain competitive. The EU, for instance, is the global leader in exports of wind turbine generator sets. In other segments China is more dominant, accounting for more than half of the world's wind turbine manufacturing and assembly plants.
- **Energy storage:** The energy storage industry, which is important to both power grids and electric vehicles, presents high exposure risks across the supply chain. The production of batteries requires minerals such as cobalt, nickel, and lithium – commodities that are subject to different vulnerabilities. For example, the price of nickel doubled after the West implemented a new set of sanctions on Russia, which accounts for 20 per cent of global nickel refining capacity. China accounts for more than 60 per cent of lithium and cobalt refining, and for more than 60 per cent of the global production of cathodes, anodes, separators, and electrolytes – all of which are components of battery cells. China also accounts for nearly 80 per cent of global battery cell manufacturing capacity.
- **Green hydrogen:** The green hydrogen industry is at an earlier stage of commercialisation than the solar and wind sectors. As its supply chains have not yet solidified, it is difficult to fully map the risks they involve. However, some key components of green hydrogen production systems require rare minerals such as platinum and iridium, the largest deposits of which are in Russia and South Africa. This is true of electrolysers – which consume energy to split water into oxygen and hydrogen – and fuel cells, which generate energy by reacting oxygen and hydrogen. European companies are still highly competitive in the electrolyser industry, but China has invested massively in the sector, which could create challenges similar to those in the solar industry.

# Key approaches to addressing supply chain risks in green energy sectors

Given the central role that green energy technologies will play in Europe's economic transition, and in light of rising geopolitical tensions, China's growing dominance in core segments of these supply chains merits attention. The main question facing European policymakers is not whether, but how, they should respond. Five approaches could serve as a start to guide their action.

## Reassess geopolitical risks affecting supply chain resilience

The first step towards improving green energy resilience is for the EU and its member states to conduct a thorough and realistic assessment of risks across supply chains. With green energy technologies accounting for a growing share of Europe's energy supply, it is time to treat them as an integral part of its critical infrastructure – and assess vulnerabilities accordingly. This should involve a review of all relevant technologies, as well as all current and potential vulnerabilities at all stages of the supply chain, to anticipate and mitigate potential disruptions. As with other kinds of critical infrastructure, vulnerabilities to cyber-attacks should receive due consideration, including in relation to trustworthy vendors, collateral vulnerabilities, and deliberately installed vulnerabilities. The question of cyber security must be addressed speedily for both existing infrastructure and future installations. An outage of the KA-SAT satellite network following the Russian invasion of Ukraine led to the loss of maintenance and remote control access of 5,800 wind turbines in Germany with a total of 11GW of power generation capacity. The United States has conducted assessments of clean energy technology supply chains to help focus policymakers' attention on the areas of greatest concern. In its own analysis, the EU has emphasised Europe's resilience in critical raw materials and has commissioned research on vulnerabilities and disruptions, particularly with regard to the covid-19 pandemic. But it has so far not integrated the conversation about the holistic challenge of dependencies in the green energy supply chain into its broader strategic communications.

Future assessments should also cover geopolitical risks in each link in the supply chain. Conflicts and great power competition are already affecting European energy security – and will continue to do so. Geopolitical considerations have received too little attention in traditional assessments of risks to green energy supply chains, but the war in Ukraine and the heightened threat of military escalation in east Asia are a reminder of how essential it is to understand these factors.

Europeans should reassess these risks in relation not just to Russia but also, crucially, to China. China has become a key player in green energy value chains and, in recent years, it has displayed increased willingness to use economic sticks to achieve political goals. It has taken coercive economic actions against its neighbours (such as Japan, South Korea, and Australia) and against Europe (such as the Nordic states and Lithuania). In these instances, Beijing has sought to force these states to change their policies on matters of political concern to the Chinese Communist Party. China may well resort to similar behaviour again in the future, with implications for green supply chain security. Besides this, the war in Ukraine further challenges the long-held assumption on the part of European policymakers that China's and Europe's interests are too intertwined to lead to massive disruptions in times of conflict. The war underlines the need to treat exposure to China on a similar level to exposure to Russia, given the nature of the Chinese regime and the assertiveness of its foreign policy in the past few years.

Europeans will therefore need to reassess how much exposure to China they are willing to tolerate. Recent developments should lead policymakers to reduce this exposure while increasing it with friendly economic partners. This does not mean cutting out China completely; no country has the financial means or planning ability to eliminate all current and potential vulnerabilities in their supply chains. But it will mean selectively maintaining some supply chain exposure to China in areas where security concerns are least acute, and strategically building up local and friendly supply chains where vulnerabilities are more pressing.

## **Right-size Europe's exposure to China**

European policymakers will need to balance supply chain concerns with economic realities. Limited budgets mean that policymakers will have to be smart and selective about how to address supply chain vulnerabilities in a way that preserves Europe's economic future.

Total reshoring is too costly an option. The creation of new, full energy value chains at home will not address all of Europe's vulnerabilities – far from it. This option may appear politically attractive given its potential to create jobs and stimulate local economic activity. However, it is also unrealistically expensive, given that it would involve luring back foreign (especially China-based) supply chains. Major reshoring efforts would require European governments to create strong incentives (including grants, subsidies, and preferential procurement) and disincentives (regulations, standards, and trade barriers). Both would result in higher costs for taxpayers, businesses, and consumers, and could delay the green transition. For this reason, European countries should only adopt this approach for the most critical and at-risk parts of the supply chain, prioritising areas where they already have a competitive advantage thanks to a high concentration of skills, access to cheap energy or critical materials, or proximity to related industries.

European policymakers should also diversify their sources of supply. They can use targeted incentives and disincentives in the form of direct subsidies, tax breaks, quotas, and standards to support domestic and allied producers and buyers of green energy goods. This approach has the advantage of increasing sources of supply while keeping prices down through at least partial relocation to lower-cost destinations.

In a slightly more targeted variation of this approach, policymakers could focus their efforts on encouraging ‘friend-shoring’, by incentivising producers and making efforts to harmonise norms and standards with like-minded partners. Stockpiling is also an option for certain goods and materials. This could be particularly effective for storable critical raw materials in the production chain and could take place either nationally or jointly with like-minded partners. Additionally, preferential purchase agreements for key inputs in the value chain are another option short of stockpiling.

A combination of these options will likely be necessary to enhance Europe’s security as much as possible while contending with economic reality. Policymakers will need to be strategic and selective, adopting different approaches for different levels of dependence and choosing measures appropriate to the sector or supply chain segment. They should identify the most important items and issues and prioritise them. Tools could include European carbon emissions standards, which can help reward domestic, allied, or otherwise friendly firms for making their manufacturing processes more environmentally friendly. However, these approaches will not be able to kick-start new factories on their own – cheap financing will be the key to this, either for new domestic plants or friend-shored facilities. While subsidised or guaranteed loans will be helpful for spurring new economic activity, decision-makers will also need to adopt policies that reduce operational costs for an extended period of time, especially where the plants in question are in high-income countries. In some cases, reshoring may be less attractive than other approaches, such as smart procurement agreements or plurilateral stockpiling efforts.

As they fine-tune their approach, European countries will, as noted, want to avoid removing China from the supply chain completely. Certain forms of production are so centred on China that Europe will need to rely on Chinese producers to some extent if it is to implement the green transition. Otherwise, Europe will risk significant supply disruptions and price hikes. This is true in terms of both goods and knowledge: the know-how required to manufacture inexpensive and high-quality batteries at scale, for example, is now largely concentrated in Chinese firms.

In managing this transition, European policymakers might therefore want to consider a two-track

strategy. Given the huge demand for low-carbon energy goods and services created by its green transition policies, Europe could continue to rely on China for a significant part of its imports, potentially the lower-tech, cost-effective, and commoditised goods needed to equip its economy. Alongside this it could promote goods and services made domestically or by its allies for newer or higher-value technologies, or for inputs requiring trustworthy vendors due to cyber security and other risks. This dual approach would come at a cost but would be less expensive than seeking to replace all Chinese goods and services.

## **Prioritise business-friendly policies**

The private sector will be a key force in ensuring a green and secure energy future, accounting for the bulk of innovation and investment in Europe's green transition. At the same time, policies that shore up supply chain security will necessarily be disruptive. While this is unavoidable, policymakers will need to work to create policies that are predictable, realistic, fair, and tailored, to foster a robust market for green energy technologies.

Policymakers should strive for policy predictability and continuity. Mitigating supply chain risks will take years and will need significant public and private investment. Firms are more likely to invest substantially in this undertaking if they can trust that the business environment for green energy will remain stable and predictable in the long run. This will require policymakers to work towards achieving stability of demand (through measures such as long-term programmes of public procurement, emissions objectives, and consumer subsidies) and of incentives (through measures such as durable standards, subsidies schemes, and tax incentives). Green energy policies, regulations, and incentives schemes should be set at the EU level where possible to avoid misalignment or competition among member states. A timeframe of a minimum of five to ten years for applying these policies, regulations, and incentives schemes would allow businesses to plan their investment and restructuring.

All these policy options will take time to work, partly because businesses need to adapt. This is particularly true for diversification and reshoring. Many green energy industries are complex and capital-intensive and rely on an ecosystem of suppliers and university-based research and innovation capacity, making them difficult to move. For example, building a silicon plant for solar photovoltaic production can take up to two years. Europe will also need to develop some of the requisite skills and knowledge, which will be a slow process that demands support through research and development funding, education, and training. Moving too quickly could unnecessarily damage these industries



and delay the green transition.

“Level playing-field” policies can go a long way towards boosting European competitiveness. This is particularly true with regard to China, but it is not limited to this. It is more challenging to address market distortions at the global scale, but at least in its large and attractive home market the EU has the ability to regulate conditions for all actors more decisively. The EU is currently developing tools such as regulations to address distortions caused by foreign subsidies, and an international procurement instrument to ensure fair bidding in public procurement. These policies will help ensure that foreign players (at least in the European market) are competing fairly. Similarly, the EU will have to apply carbon emissions standards equally to all players, as well as any form of carbon border adjustment mechanism.

Decision-makers should work with experts and business leaders to identify the best policy approach for each core technology and value chain segment. In the end, every industry faces different supply chain challenges, requiring a flexible set of solutions for each. For example, in the case of solar, the energy costs of producing polysilicon in Europe are prohibitively high. Policymakers may consider introducing targeted subsidies to bring down energy prices for these manufacturers. The wind and green hydrogen industries might benefit more from research and development support, given that their production levels in Europe are still resilient; for them, much of the challenge will be in maintaining domestic firms’ technical edge. Battery manufacturers will welcome European and allied efforts to secure supplies of critical inputs. In all these areas, proactive European policies should involve large-scale public procurement or efforts to build a common and mutually open market within a coalition of like-minded countries.

## **Uphold high environmental and ethical standards**

The security of Europe’s supply chains will depend on their overall sustainability in the environmental, social, and political dimensions. Therefore, policies to secure green energy supply chains will need to align with key European interests and values, especially as regards ecological stability, climate neutrality, and labour and human rights standards. In many cases – such as funding new solar manufacturing capacity in Europe – these goals will be complementary. In other instances, however, there may be trade-offs – for example, when imposing barriers on certain green goods imports because of security concerns.

European policymakers have a variety of tools available to promote the rapid, ethical, and secure deployment of green energy value chains. Upcoming tools such as the EU’s Due Diligence Law will be

able to guarantee a minimum level of labour and environmental standards for green energy products sold in the EU. Public procurement rules at the EU level, including standards on carbon content, can also set high requirements that European and other friendly countries' firms are well suited to meet. Adherence to these labour and environmental standards is not only a moral and ethical obligation but will boost the competitiveness of domestic firms in the long run.

Yet Europe will have to ensure that, in upholding strict sustainability standards, it does not limit its ability to procure the goods and services necessary for a rapid green transition. Some level of flexibility might therefore be needed in the short term for certain high-demand green goods. Here, the EU could again adopt a dual-track approach, setting higher standards for publicly procured goods than for privately procured ones. This could help ensure the supply of sufficient, low-priced inputs for the private deployment of green energy equipment. The EU could also consider a 'grace period' for like-minded emerging economies to raise their environmental and labour standards. This too could ensure a sufficient supply of lower-priced inputs, and also incentivise and facilitate friend-shoring. In the process, the EU should consider providing funding and other support to partner emerging economies that invest in improving their domestic environmental standards and low-carbon production capacity.

Building secure supply chains will also require a just transition. The green transition will not only be a colossal economic, ecological, and geopolitical challenge but will also bring about a massive social transformation. Governments in Europe and elsewhere are eager to argue that it will create high-paying skilled jobs – but this will only happen if they put in place durable strategies and policies that take account of this social component. For example, short-sighted incentives to invest only in Europe could quickly fail in light of rising energy prices or a lack of supporting infrastructure. Any effective plan will need to build resilient domestic supply chains and focus on long-term employment and skills.

## **Work with partners**

Building secure, cost-effective, ethical, and sustainable supply chains will demand a high level of cooperation among like-minded countries. Russia's war on Ukraine has demonstrated G7 countries' capacity to work together when absolutely necessary. Similar levels of coordination would go a long way towards ensuring the green transition does not create new critical dependencies, especially in relation to overreliance on authoritarian states. However, such coordination will require new mechanisms and much greater urgency if it is to lead to quick and decisive action.

Building alignment around green energy technologies will not be easy, as all countries want to reap

the economic benefits of leadership in this key growth sector. But Europe, the US, Japan, and other like-minded countries start off with areas of relative consensus. This can help them build momentum. They can begin by openly sharing and comparing concerns and vulnerabilities, clarifying preferred national approaches, laying out upcoming policies, and eventually building a common understanding of one another's positions and actions. The EU-US Trade and Technology Council will be a useful forum for these discussions. The G7 and OECD may also be able to foster partnerships on secure green supply chains. The newly created EU-India Trade and Technology Council could also be a venue for exchange on the long-term prospects of the green energy supply chain.

A second crucial step will be to develop common green energy standards. This is to ensure companies from like-minded economies do not face unnecessary barriers in friendly markets, and are able to scale up their operations quickly and efficiently. A large harmonised market is a crucial precondition to European and partner companies becoming competitive globally in green energy sectors.

The same purpose will be served by granting companies from like-minded countries fair and equal access to domestic public procurement programmes. Western governments are already drawing up plans for large-scale public investment in the green transition. This could create significant business opportunities for European firms and enterprises in partner countries, incentivising them to consider long-term investments that meet Europe's goals for securing its green supply chains. Similarly, special subsidies and other government support should be made available to any firm from partner countries. Partners might also consider establishing joint programmes to secure key inputs, including co-investment in mines or factories, joint procurement agreements from key supplier countries, or a G7 agreement on friend-shoring.

Finally, Europe's like-minded partners might consider deepening engagement and investment in joint research, development, and training programmes. This would help beef up domestic firms' competitiveness in the green energy sector and avoid duplicative programmes in different partner countries.

## **Conclusion: How to use the current momentum to get the green transition right**

European policymakers face a daunting challenge in securing green energy supply chains amid systemic rivalry with China and a war on their immediate border. The increasingly dire warnings

issued by the Intergovernmental Panel on Climate Change make this even more urgent.

This policy brief has set out five core approaches that can serve as a starting point not only for guiding the debate among policymakers in Europe and beyond, but also for fostering a broader public discussion about the difficult choices ahead. In many cases, getting the green transition right will require a delicate balancing act that needs public support if it is to succeed. There are no easy answers, but an honest conversation about the limitations of reshoring is just as important as a critical assessment of the areas in which it is most important for European companies to be competitive in the future.

The war in Ukraine is an inflection point that has generated a willingness among European partners to take steps that under other circumstances would have needed a decade. This momentum has already driven an alignment between G7 partners that was previously inconceivable and that can now be used to speed up bureaucratic processes, secure member state buy-in at the EU level, and quickly progress regulation that has been in the pipeline for months, if not years.

Businesses are currently feeling the strain of the geopolitical turmoil in their operations. They are open to greater exchange with policymakers about how to create the conditions to bring some critical production back to Europe or other destinations. It will be possible to incentivise investors to put their money into more long-term, profit-yielding activities in green energy innovation if government commitment to the process is strong and reliable. But, despite this urgency, the most sensible approach is for European decision-makers to right-size their exposure to risks emanating from China, rather than trying to eliminate any and all links to Chinese companies in the supply chain.

The good news is that Europe not only has a key role to play in many of the important industries of the future, but it also has a powerful group of partners to work with. The green energy industry's enormous potential for growth can offset some of the effects of reduced access to the Chinese market in these areas. Adopting the correct measures to enhance the security and resilience of green energy supply chains will improve Europe's competitiveness and prosperity in the long term.

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