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DEALING WITH A RESURGENT CHINA

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De-risking while decarbonising: a green tech partnership to reduce reliance on China

Alicia García-Herrero

Heather Grabbe

Axel Källenius

Bruegel

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Abstract

Green tech is key for the world's decarbonizations. A single country, China, controls most of the world's production of solar panels and electric vehicle batteries, and some of the global trade in wind turbines. These supply chains are vulnerable to disruption, natural disasters and weaponization by China. Reshoring production of renewables seems to be the answer by major economies like the US or the EU to reduce dependence on China, but it is neither feasible nor economically efficient.

We propose a different solution, namely forming a green tech partnership, in which incentive-aligned countries would use coordinated specialization to produce green tech. This solution aim sat ensuring greater diversification of resources and production of renewables to reduce the risk of excessive reliance on a single provider, China. The aim is to supplement, not substitute, the Chinese supply chain, since both will be needed to meet rising global demand for green tech, including in China. Although such international coordination is difficult, the partnership would offer benefits to emerging economies rich in critical raw materials and/ or with moderate wages aiming at refining/manufacturing green tech.

The US and the EU should share technology and provide financing, as they will gain from reduced dependence on China but with cheaper sourcing than reshoring. China would have more room to use its clean tech to meet its own decarbonisation targets. The partnership could be organised through a combination of trade and investment agreements, together with tech transfer and financial agreements. Subsidies, or, preferably, a system of carbon pricing within the partnership, might be needed as well.

Key findings

- Trade in renewable energy goods is a global public good; all countries gain when others cut emissions, and all suffer from climate change if decarbonisation is delayed. Yet this trade depends on China, which controls most of the world's production of solar panels and electric vehicle batteries, and some of the global trade in wind turbines. These supply chains are vulnerable to disruption, natural disasters and weaponisation by China, which has already exercised its dominant position in some critical raw materials to put pressure on other countries.

- Part of the European Union and United States response to reduce reliance on China is reshoring production, but this is economically inefficient given their limited access to critical raw materials and high production costs. Moreover, Chinese firms are far ahead of the rest of the world in green tech manufacturing and innovation, and in extraction and processing.

- To reduce reliance on China, incentive-aligned governments and businesses should form a green tech partnership. This would produce green tech with the aim of decarbonising faster, while ensuring greater diversification of resources and improving security of supply. Each partnership economy would use its comparative advantage

within a new green-tech supply chain. The aim is to supplement, not substitute, the Chinese supply chain, since both will be needed to meet rising global demand for green tech, including in China.

- Although such international coordination is difficult, the partnership would offers benefits to many different countries. Emerging economies that are rich in critical raw materials and/or have moderate wages would gain economic development opportunities. The US and the EU should share technology and provide financing, as they will gain from reduced dependence on China and from sourcing than is still cheaper than reshoring. China would have more room to use its clean tech to meet its own decarbonisation targets.
- The partnership could be organised through a combination of trade and investment agreements, together with tech transfer and financial agreements, under some form of inter-governmental oversight. The dependence of all countries on China for green tech is so great that non-market incentives might also be needed, such as subsidies or, preferably, a system of carbon pricing within the partnership.

Contents

1. Introduction

To pursue decarbonisation as a global public good, greater alignment of the major eco- nomic powers is needed around a collective effort to accelerate the transition to renewable energy and electric vehicles. China wants to maintain its dominant position in global supply chains, while the US and European Union are focused primarily on increasing their own sup- plies of clean tech, rather than improving the overall security of supply for all countries.

We analyse two main risks to faster global decarbonisation. The first stems from the excessive concentration of green-energy supply chains in a single country. China dominates global supply chains for green-energy products, including solar panels, electric vehicle batteries and, to a lesser extent, wind turbines. The second risk arises from China's own clean-tech needs. China's decarbonisation targets are a vital global interest because it is the largest emitter of greenhouse gases. Given China's massive investment in production capacity for renewables, the risk that China might be unable to supply sufficient green tech to the rest of the world appears currently to be low, but this risk could grow, and supply disruptions that would slow down global decarbonisation remain a problem.

To address both risks, a 'green tech partnership' should be put in place. This would be a network of countries that take responsibility for different parts of the supply chain, according to their comparative advantage – in other words, through coordinated specialisation. It aims at creating a supplementary supply chain that would increase the production of green tech over and above that of China, while ensuring that extraction, refining and innovation are less concentrated in a single country.

In this policy brief, we first review Europe's dependence on China for decarbonisation goods and provide data on China's own needs for clean tech in the future, which will affect its export capacity. Next, we assess recent European and American attempts to reduce this reliance on China through the reshoring of production and seeking of bilateral deals with countries that can offer alternative raw material supplies. Neither the current situation of reliance on China nor the attempts at reshoring production are the best options for minimising the risks to global decarbonisation. We then set out our proposal for a green tech partnership.

2. How reliant is Europe on China for clean technology?

Clean-tech supply chains are complex and the input needs for clean tech are multi-faceted. These include reliable access to (i) critical raw materials, (ii) refining and processing capacity, (iii) low-cost manufacturing subject to limited tariffs and non-tariff barriers, and (iv) technological innovation to avoid resource bottlenecks and improve the efficiency of finished goods.

None of these needs can be met in the near term without China, neither within Europe nor globally. In this section, we present evidence on how reliant the EU is on China for clean tech, focusing on three sectors (solar panels, wind turbines and EV batteries), and on the four key components of each of these supply chains (extraction, refining, innovation and manufacturing).

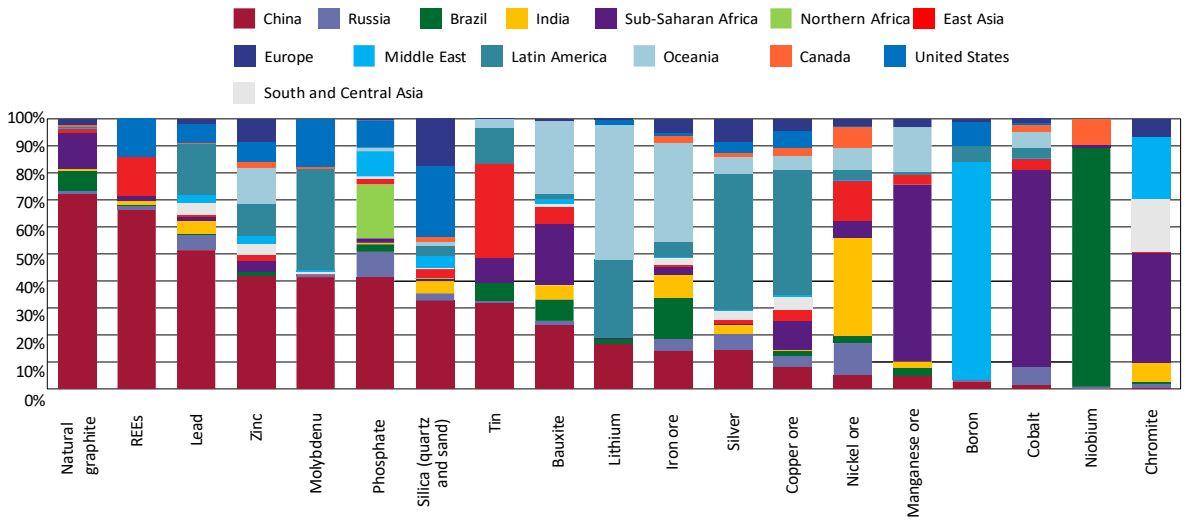
2.1. China dominates mining and processing of key renewable energy minerals

China's territory is rich in mineral resources, many of which are central to the production of clean-tech goods (Figure 1). Notably, China extracts 72 percent of the world's natural graphite and 66 percent of rare earth elements (REEs). On the whole, however, extraction of clean-tech minerals is dispersed across the globe, generally predicted by the location of deposits (Figure 2).

Furthermore, China dominates the processing of REEs, with a market share above 85 percent, and of silicon and cobalt, all of which are integral to the production of high-energy-density batteries, wind tur- bines and solar panels[1] (Figure 3).

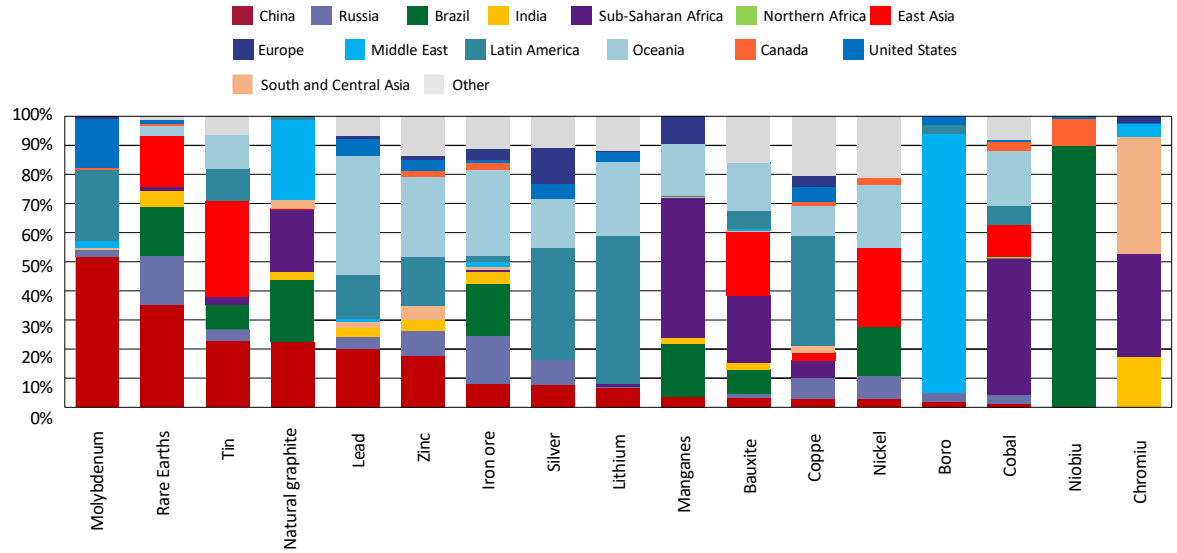
[1] Charlie Cooper, Antonia Zimmermann and Sarah Anne Aarup, 'China Leaves EU Playing Catchup in Race for Raw Materials', Politico, 10 March 2023, https://www.politico.eu/article/white-gold-rush-salt-lithium-batteries-raw- materials-chile-salar-atacama/

Figure 1: Global extraction of renewable energy minerals, % of total, 2019-2020



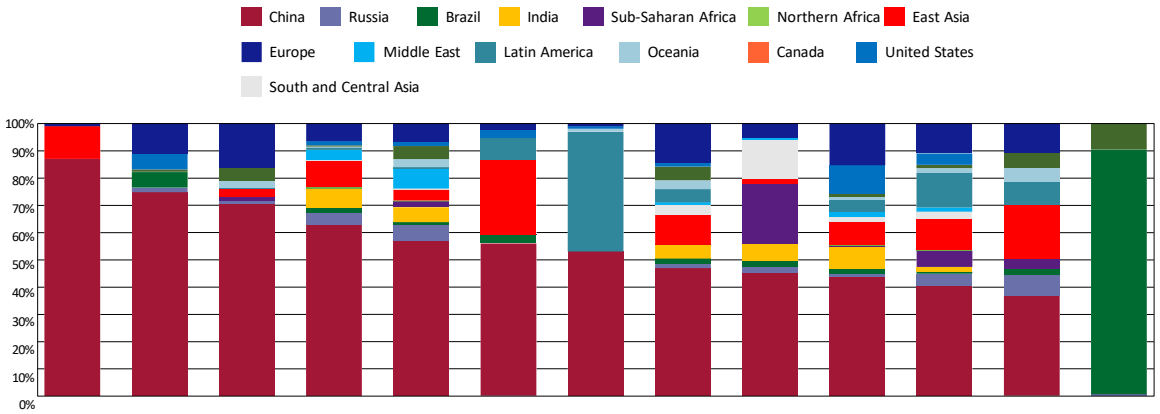
Source: Bruegel based on US Geological Survey.

Figure 2: Global reserves of key minerals for renewable energy goods (2022)



Source: Bruegel based on US Geological Survey.

Figure 3: Refining of renewable energy minerals, 2019-2020



Source: Bruegel based on US Geological Survey, IEA.

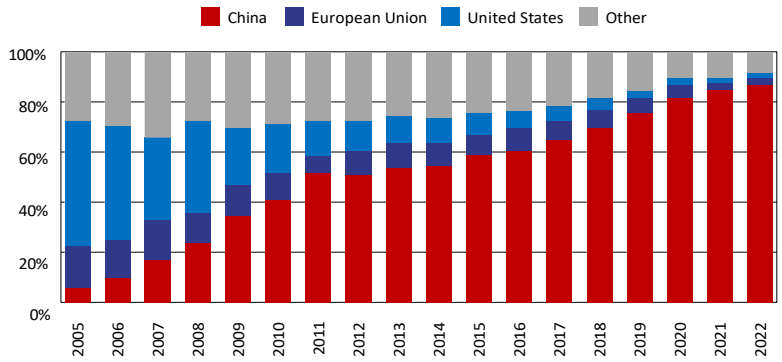
2.2. China is an advanced manufacturer of renewable energy goods

In the next sections we assess China's dominance of the manufacturing of three major types of clean tech: solar panels, wind turbines and EV batteries.

Solar panels

Chinese policymakers have succeeded in developing a leading solar PV industry that now holds a dominant share of the global market (Figure 4). Chinese solar panels are cheaper than the competition[2] – largely because of the country's command over raw material inputs – and are also the most efficient in terms of crystalline silicon panel technologies, which comprise the vast majority of the global market.

Figure 4: Share of solar panels all-components manufacturing



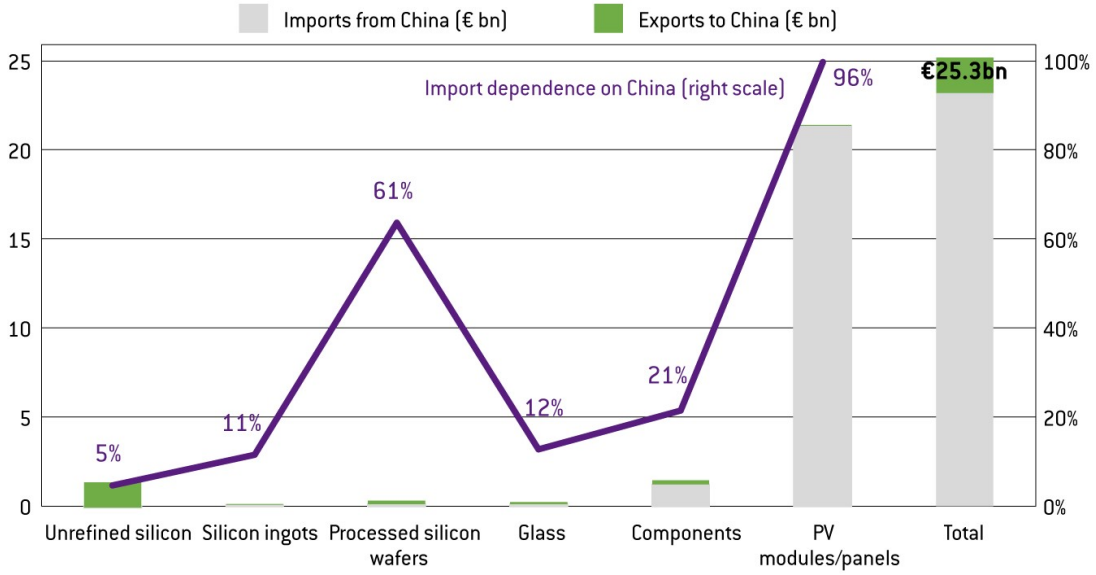
Source: Nataxis.

Chinese firms are the trusted suppliers of the European solar installation industry. More than 96 percent of EU imports of solar panels came from China in 2022, with a high degree of

[2] See Wood Mackenzie news release of 23 May 2023, 'China's solar exports booming, up 64% in 2022 despite global trade tensions', https://www.woodmac.com/press-releases/chinas-solar-exports-booming-up-64-in-2022-despite- global-trade-tensions/

dependence across the whole supply chain (Figure 5). Notably, the EU is a sizeable net exporter of unrefined silicon to China, where it is processed and fed into the domestically captured value chain. Total EU-China all-components solar PV trade was €25.3 billion in 2022. Overall, the value chain is dominated by China, with European exports of unrefined silicon accounting for barely 5 percent of the total.

Figure 5: EU dependence on China in the solar PV supply chain, 2022

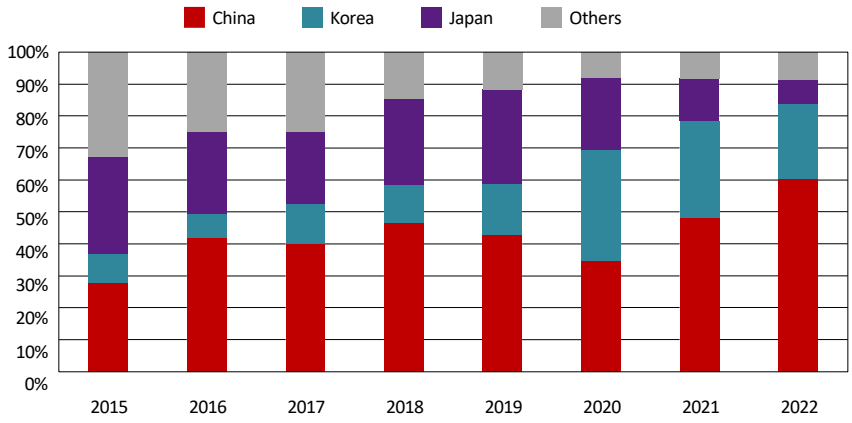


Source: Eurostat

EV batteries

Global EV lithium-ion battery production is principally located in China, Japan and Korea, with China having a 60 percent market share in 2022 (Figure 6). However, following major investments in EV battery factories in geographies including the EU and the US, manufacturing will become increasingly regionalised. Nevertheless, mineral extraction and refining may be harder to diversify and will likely remain centred on China in the near term.

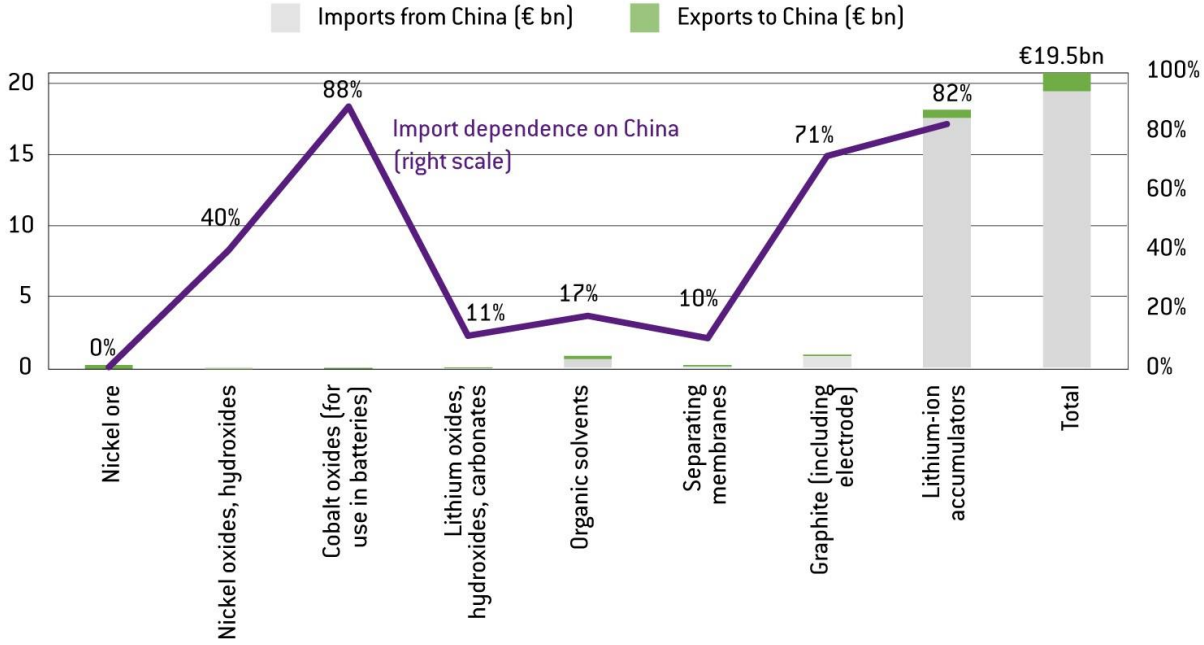
Figure 6: Market share of lithium-ion EV battery production by country



Source: Bruegel based on Natixis, SNE Research.

The EU's EV battery imports currently come mainly from China (Figure 7). Overall, 82 percent of finished lithium-ion accumulators imported into the EU in 2022 came from China. Moreover, certain inputs into the EV battery supply chain are also predominantly sourced from China, including cobalt oxides (88 percent) and graphite (71 percent). The EU is only a minor participant in this supply chain, both in terms of finished and intermediate goods.

Figure 7: EU dependence on China in the EV battery supply chain (2022)

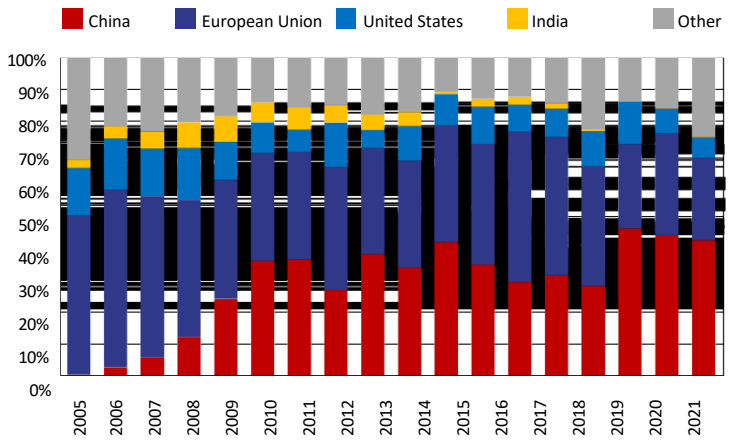


Source: Eurostat

Wind turbines

EU-China trade in finished wind turbines is low relative to that in intermediate goods, because of the high cost of transporting wind turbine blades and towers between Europe and China. This favours localised production and has resulted in a regional fragmentation of the market. Therefore, Europe's diminishing and China's growing global shares (Figure 8) do not reflect directly competitive dynamics among Chinese and European firms, but mainly the levels of investment in wind farms across the respective regions in which European and Chinese firms are active.

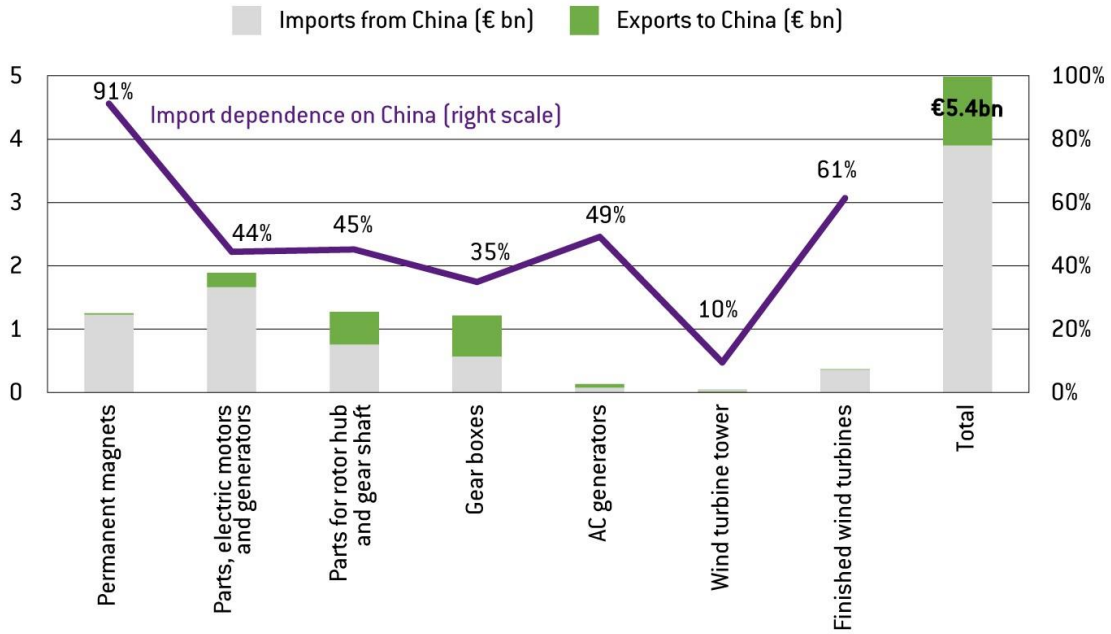
Figure 8: Shares of global wind turbine manufacturing



Source: Natixis

Though EU-China trade in finished wind turbines is low, there is a sizeable volume of trade in intermediate turbine components (Figure 9). While the EU's reliance on China is generally only moderate for most components, 91 percent of EU imports of permanent magnets came from China in 2022, a dependence that extends to many other technologies, including electric motors[3].

Figure 9: EU dependence on China in the wind turbine supply chain (2022)



Source: Eurostat

[3] Barry van Wyk, 'China's Wind Power Companies Are Giants, But They Aren't Going to Take Over the World—Yet', The China Project, 25 July 2023, https://thechinaproject.com/2023/07/25/chinas-wind-power-companies-are- giants-but-they-arent-going-to-take-over-the-world-yet/; Mary Hui, 'Why Rare Earth Magnets Are Vital to the Global Climate Economy', Quartz, 14 May 2021, https://qz.com/1999894/why-rare-earth-magnets-are-vital-to-the-global-climate-economy; David Piper, 'Applications of Magnets in Wind Turbines', Wind Systems Magazine, 15 March 2021, https://www.windsystemsmag.com/applications-of-magnets-in-wind-turbines/

2.3. China's increasing dominance of green tech-related innovation

Chinese researchers have rapidly increased their output of scientific publications on solar PV, wind turbine and EV battery technologies, surpassing the US and the EU in 2022 (Figure 10). However, the quantity of output tells little of its quality, and the extent to which this research is novel and what share of it is applied as opposed to basic is not reflected in this breakdown.

Figure 10: Chinese scientific publishing on renewable energy tech

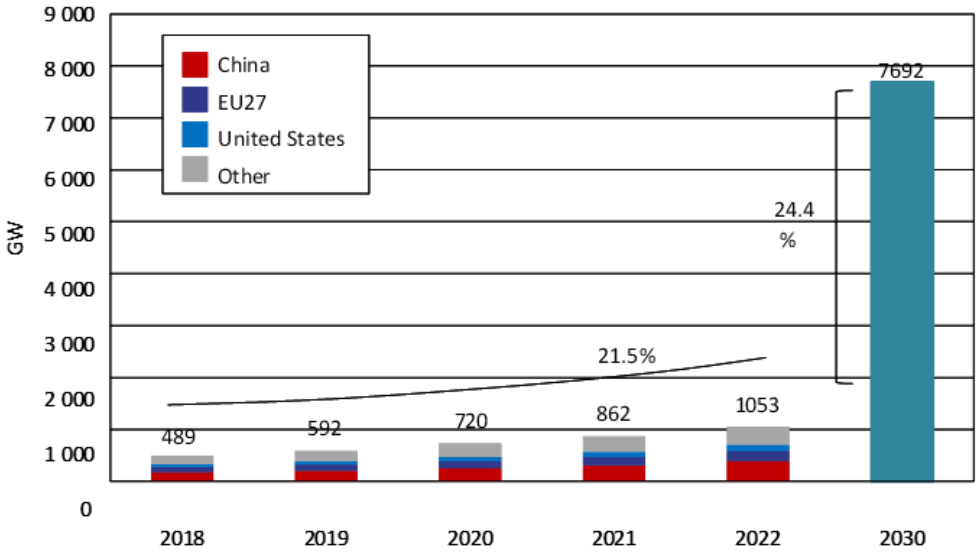
	Number of scientific publications - 2010			Number of scientific publications - 2021		
	1st	2nd	3rd	1st	2nd	3rd
Solar	EU	China	US	China	EU	US
Wind	China	EU	US	China	EU	US
Li-ion batteries	EU	China	US	China	EU	US
Heat pump	EU	China	US	China	EU	US
Carbon capture and storage	EU	US	China	China	EU	US

Source: European Commission presentation at Bruegel seminar on 21 June 2023. Reproduced with permission

3. Ballooning global demand for green technology, including in China

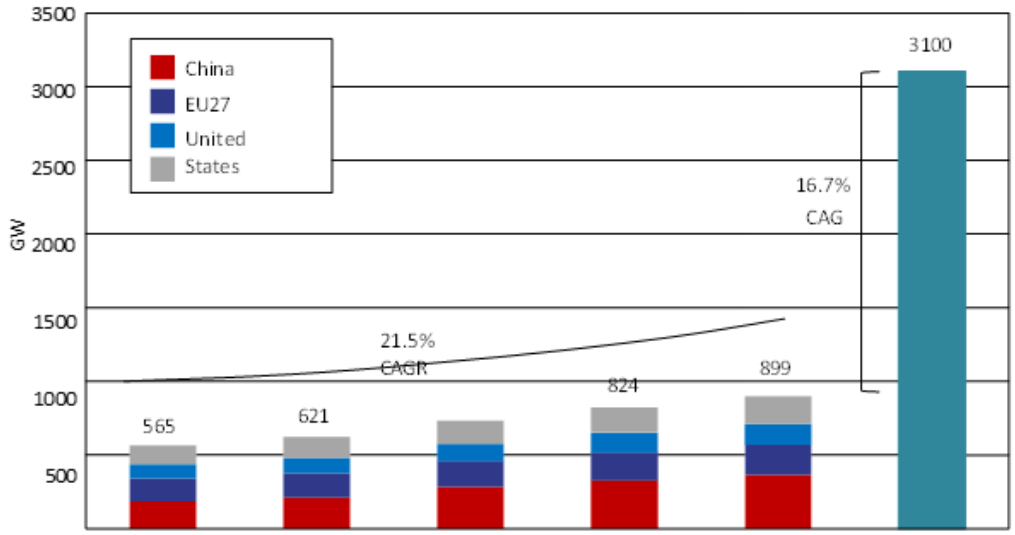
Global demand for green technology goods has and will continue to increase considerably to deliver the world's decarbonisation targets. The International Energy Agency projects six-fold and three-fold increases in installed solar panel and wind turbine capacity respectively, if targets for net-zero emissions by 2050 are to be met (Figures 11 and 12). It also projects EV battery demand to expand six-fold by 2030 under the sustainable development scenario outlined by the United Nations. (Figure 13) (IEA, 2020).

Figure 11: Solar PV installed capacity for net-zero, by region



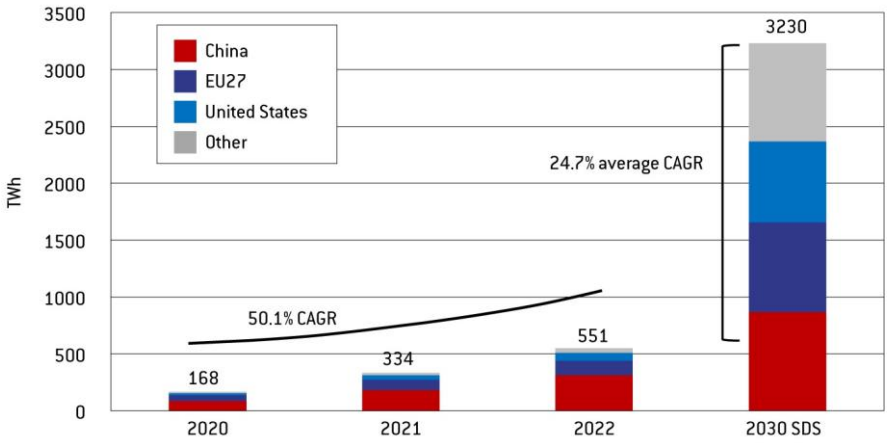
Source: Bruegel based on IRENA, IEA

Figure 12: Wind installed capacity for net-zero, by region



Source: Bruegel based on IRENA, IEA

Figure 13: Annual EU battery demand projections, by region



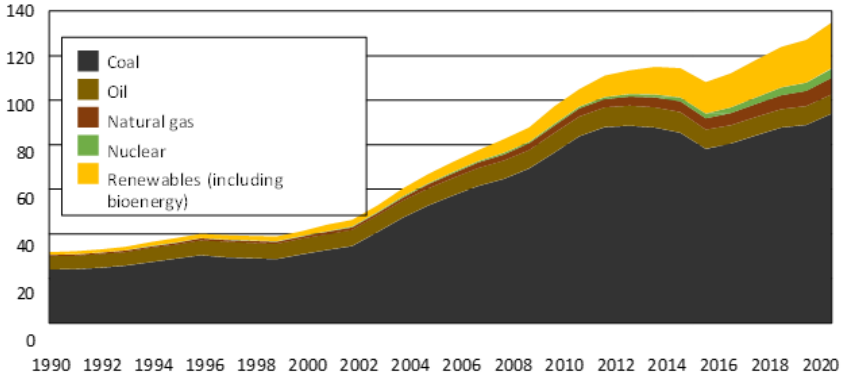
Source: IEA

3.1. China will need a massive increase in renewable energy capacity to meet its targets

While China has steadily cemented its dominant role as the largest exporter of green tech globally, the country's own decarbonisation needs are vast. It is the world's largest greenhouse gas emitter and has targets of peaking emissions in 2030 and reaching net zero by 2060.

Over the last two decades, China has addressed its rapidly growing energy needs by expanding its coal energy infrastructure (Figure 14). This expansion, which is still ongoing[4], will need to cease and ultimately be reversed through substitution by non-fossil power generation. This will require China to expand its renewables base on an enormous scale if its energy supply is to remain sufficient while emissions are being cut and if its decarbonisation targets are to be delivered on time.

Figure 14: China, total energy consumption by source

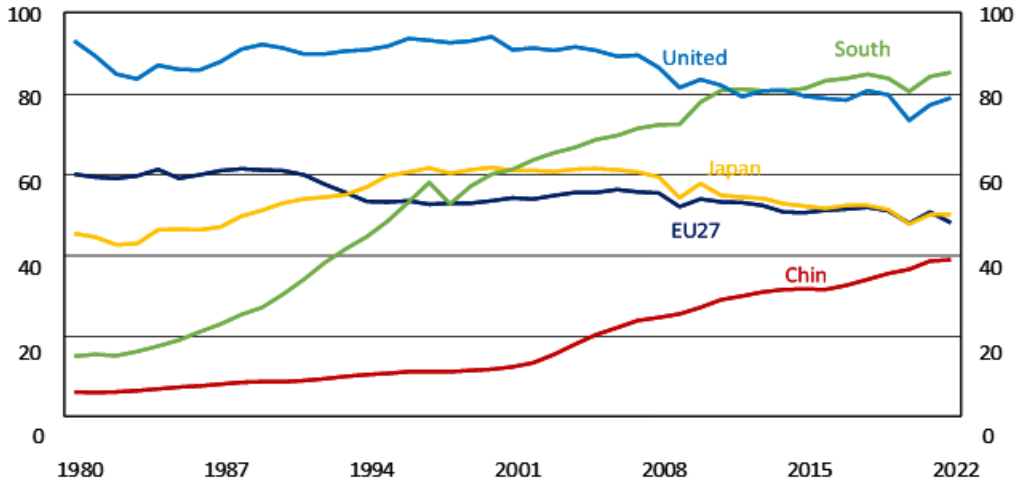


Source: China National Bureau of Statistics. Note: the unit of measurement is quad BTU (quadrillion British thermal units). One quad BTU is roughly equivalent to one exajoule (EJ) of energy. Global primary energy consumption was 617 EJ in 2019 (https://www.iea.org/reports/ world-energy-balances-overview/world).

[4] David Stanway and Muyu Xu, 'Analysis: China's New Coal Plants Set to Become Costly Second Fiddle to Renewables', Reuters, 22 March 2023, https://www.reuters.com/business/energy/chinas-new-coal-plants-set-become-costly-second-fiddle-renewables-2023-03-22/

China's renewable energy needs are highly dependent on how its per-capita energy demand develops over the next few decades. Assuming only a moderate increase in per-capita energy demand (Figure 15), the average annual installation needs for solar panels and wind turbines will easily exceed 400GW and 75GW annually, under the target set by China's Ministry of Ecology and Environment of 68 percent renewable primary energy by 2060[5].

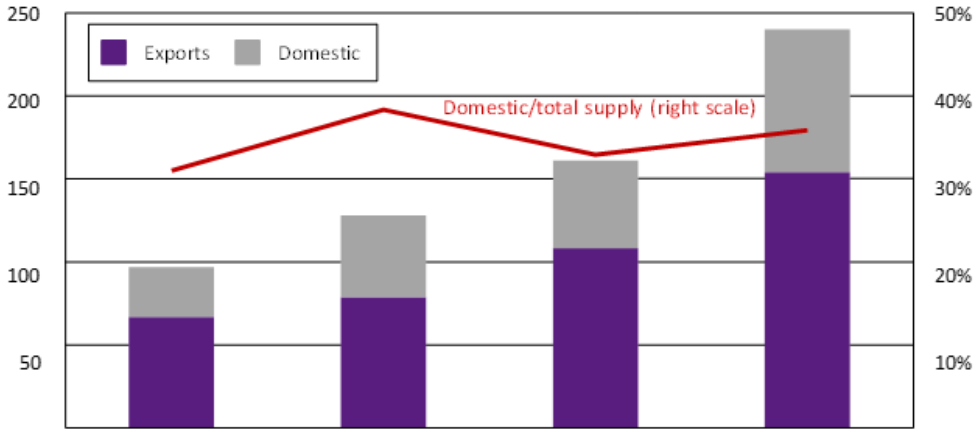
Figure 15: Primary energy consumption per capita, MW



Source: Energy Institute

Despite this, the Chinese solar PV industry remains predominantly geared towards exports, with only about a third of total supply installed domestically (Figure 16). This is despite China's large reliance on coal, phase out of which is a global priority. In a scenario in which China is pushed to install renewables even faster, for instance a climate crisis, there is a major question about whether China could remain the globally predominant supplier while addressing its domestic needs. The answer will depend on investment decisions made today, which are subject to a number of factors, including the return on investment in the various renewable sectors in China.

Figure 16: Chinese solar PV exports vs domestic installation, GW



Source: Source: Bruegel based on IRENA, Wood Mackenzie

[5] See https://climateactiontracker.org/countries/china/

Based on projections of Chinese capital expenditure in green-tech sectors, China should, in principle, manage to cover its own decarbonisation needs and maintain its highly lucrative export share. However, the ongoing deceleration of the Chinese economy makes it difficult to determine whether such substantial increases in capital expenditure will be feasible in the long run[6].

4. Mapping the risks of over-concentrated supply chains

Our analysis of the high reliance of the EU and the rest of the world on China for clean tech shows clearly why it is so difficult to reduce reliance on Chinese supply chains. In current circumstances, it is close to impossible for any country to achieve decarbonisation without importing a very large proportion of materials and finished products from China.

There are two different kinds of risk associated with the concentration of production: risks independent of the Chinese government and risks arising from decisions made in Beijing. Among the former, the effects of climate change itself in causing natural disasters and extreme weather events are increasingly important. The latter kind of risk may stem from active policy decisions or from shifts in economic and political priorities.

4.1. Types of risk created by over-concentrated supply chains

Many non-political and serendipitous risks could see exports from China impeded. These include climate-related disasters, pandemics or conflicts in mining regions (Van de Graaf et al, 2023). For example, in the summer of 2021, severe drought in Taiwan disrupted the delivery of semi-conductors to the rest of the world, causing sharp increases in chip prices[7]. This type of force majeure event can cause immense disruption to global trade, and are a much bigger risk if there is heavy concentration of supply chains in single countries.

Among the second group of risks associated with decisions made in Beijing, there are two broad categories: economic policy and political decisions. Among the former, China's own decarbonisation efforts figure most prominently. The country's domestic needs are considerable and will require a ramping up of production capacity and consistent pace of expansion of renewable energy infrastructure (section 3.1). At the moment, Chinese production is growing in response to increasing global demand. However, at some point, it might become difficult to meet the EU's demand for decarbonisation goods if China cannot invest enough to keep on growing the supply of renewables, or decides to put its own needs first or serve other trading partners with which it may have signed preferential agreements.

[6] García-Herrero and Kaellenius (2023) present different scenarios for China's energy demand and clean-tech production, with consequences for the rest of the world in terms of the ability to import the necessary amounts of renewables for decarbonisation.
[7] Sean Ashcroft, 'Timeline: Causes of the Global Semiconductor Shortage', Supply Chain Digital, 11 January 2023, https://supplychaindigital.com/top10/timeline-causes-of-the-global-semiconductor-shortage. Other examples include the Evergreen cargo ship blocking the Suez canal in July 2021 and the closure of rail freight lines through Russia after its invasion of Ukraine.

The second type of decision made by Beijing is retaliation. There are clear instances, some very recent, of potential green-tech relation from China. For example, the introduction by the Netherlands of export controls on semiconductor components (lithography machines) in 2023 provoked retaliation by China in the form of a stop to exports of gallium and germanium, which are essential inputs into high-end semi-conductors[8]. China previously leveraged its dominant position in the minerals supply chain in 2010 when it stopped rare earth element exports to Japan after a stand-off over disputed islands[9]. Finally, China's ambiguous position over the war in Ukraine, particularly the possibility of the EU imposing sanctions on Chinese companies exporting dual-use technology to Russia, could trigger retaliation.

Beyond potential exogenous shocks and actions taken by Beijing, a scenario could also arise in which national security concerns become even more important, for example around the Taiwan Straits. Economic priorities might then be re-arranged, potentially hitting EU sourcing of renewable technologies.

4.2. Responses so far

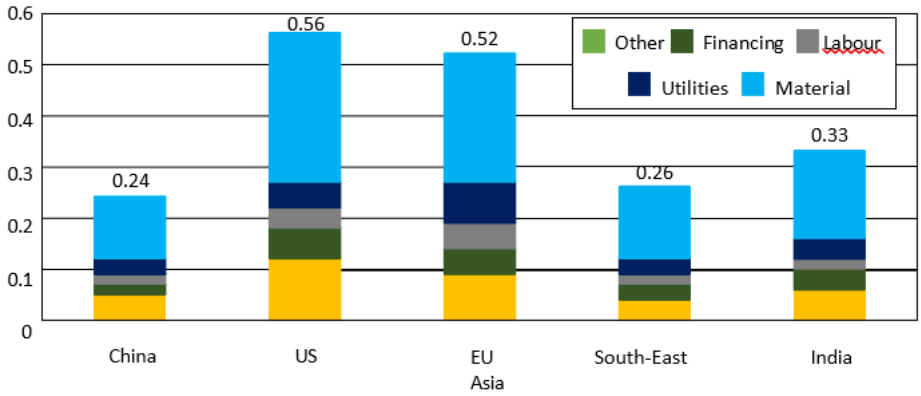
The EU's aim of "de-risking", or reducing its dependence on its relationship with China, as proposed by European Commission President Ursula von der Leyen in May 2023 (von der Leyen, 2023), has gained widespread support among European countries and from the Biden Administration (Yellen, 2023; Sullivan, 2023). Von der Leyen presented de-risking as distinct from de-coupling. One part of the policy is to diversify the sources of supply, as set out in the proposed EU Critical Raw Materials Act (CRMA, European Commission, 2023a), while the second is to reshore manufacturing to Europe, as set out in the proposed Net Zero Industry Act (NZIA, European Commission, 2023b). While the EU, for decarbonisation purposes, needed to respond to the risks of excessive reliance on China, these two proposed laws are unfortunately unlikely to achieve this goal. European countries might also increase costs even further by implementing narrowly defined plans to secure critical raw materials for their own use, instead of sharing the procurement for the whole EU or beyond. Le Mouel and Poitiers (2023) proposed that the EU creates an international strategy for critical raw materials, using instruments such as investment and export credits to diversify global supply chains.

The US has taken a different approach with its Inflation Reduction Act (IRA), which offers large public subsidies to encourage reshoring of production to reduce reliance on China. This approach is too costly for other economies to replicate; although estimates vary widely, some project the total cost of the IRA will top $1 trillion over the next decade, mainly because tax credits under the act are uncapped (Evenett and Hufbauer, 2023). Moreover, China can make de-risking even more expensive for Europe if it retaliates, either by imposing export controls on intermediate products or by stockpiling.

Finally, comparisons of the average costs of producing green tech in different parts of the world show that reshoring to the US or the EU would make decarbonisation much more expensive. This would, however, not necessarily be the case if renewables were manufactured in other emerging economies, such as India and other ASEAN countries, since their prices are comparable to those of China (Figure 17).

[8] Qianer Liu and Tim Bradshaw, 'China Imposes Export Curbs on Chipmaking Metals', Financial Times, 3 July 2023, https://www.ft.com/content/6dca353c-70d8-4d38-a368-b342a6450d95.
[9] Mai Nguyen, 'China's Rare Earths Dominance in Focus After it Limits Germanium and Gallium Exports', Reuters, 5 July 2023, https://www.reuters.com/markets/commodities/chinas-rare-earths-dominance-focus-after-mineral- export-curbs-2023-07-05/

Figure 17: Solar PV module manufacturing cost per region, $/watt



5. A novel approach: from reshoring to a green tech partnership

While reshoring the production of renewables would be very costly and may not be feasible in a reasonable amount of time, a green tech partnership could serve the purpose of derisking the production of green tech from China while decarbonizing, but at a much lower cost. Our proposal aims at bringing together every country which has both a comparative advantage and decarbonisation goals.

The efficiency gains from such partnership hinge on the ability to attract members that bring a diversity of comparative advantages but whose interests in decarbonisation are aligned. Coordinated specialisation would allow the partnership to cover the full supply chain, which is necessary since critical dependences from China exist for all aspects, from extraction and refining to manufacturing and even innovation. Coordinated specialisation would also help with economies of scale so that such de-risking from China makes sense economically in the medium term.

This partnership should be envisaged as a supplementary supply chain, which necessarily excludes China in order to diversify supply to reduce risks. The partnership is not intended to replace the existing China-centric supply chain but to complement it. With this objective in mind, the EU should aim at bringing in the US as major consumer of green tech, but also with the necessary innovation and financing capacity, as well as resource-rich countries and low-cost manufacturers, all of which are currently too dependent on China for their decarbonisation.

5.1. Objectives and advantages

A green tech partnership based on coordinated specialisation would aim at creating a cross-border supply chain to produce renewables technologies among incentive-compatible countries. The advantages would include: (i) reducing the risks of concentration by diversifying extraction, refining and production sites through a strategy of coordinated specialisation; (ii) lowering the cost of reduced reliance on China compared to alternative approaches, such as reshoring, (iii) securing enough manufacturing of green tech to meet decarbonisation targets;

and (iv) widening the range of technologies used for clean tech by coordinating investment in innovation, so that decarbonisation becomes as cheap as possible. Only through a partnership of countries with different comparative advantages can a fully integrated supply chain be created at a reasonable cost.

For those countries with large reserves of critical raw materials, the partnership would reduce their dependence on a single buyer (monopsony) and give them more bargaining power in selling their natural resources to partners that also offer help in moving up the value chain in clean-tech production. They could also be in charge of refining and/or manufacturing.

For countries with few natural resources but abundant low-cost manufacturing capacity, including India, Mexico, Turkey and other countries in Southeast Asia, the partnership would offer access to both raw materials and markets for finished goods. Partner countries where innovation is more developed would need to offer pooling of intellectual property, such as patents, so that more countries can be involved in manufacturing clean tech.

For the EU, a broader international partnership would be more attractive than trying to de-risk on its own. It is even harder for the EU to try to reshore production than it is for the US, which is making available large subsidies to this end under the IRA. By contrast, in the EU, public funds for industrial policy to support reshoring of clean tech are mainly held at national level, which creates other problems. In particular, the EU's largest countries, in particular those with more fiscal space such as Germany, are clearly in a better position than smaller or more indebted states to subsidise the reshoring of production of renewable technologies. This is bound to fragment the single market, which is essential for the good functioning of the EU project.

Finally, the partnership should help mitigate technological path dependence, which may arise from the excessive concentration not only of production, but also R&D in one country.

As for China, its participation in the partnership would go against the objective of creating a supplementary supply chain to reduce reliance on China. In fact, given China's global dominance of green tech, its participation would imply that the new supply chain would collude with the existing one, defeating the partnership's purpose.

The fact that China would not be a member of the green tech partnership does not equate to substituting China's production. The demand is set to grow so much that all global production will be needed. Furthermore, China would also benefit from the technological diversification the partnership could generate, given that Chinese producers are also dependent on raw materials that may not be available in sufficient quantities, even from the supply chains.

6. How to start building the green tech partnership

Setting up a new green tech partnership won't be easy, especially if many countries are included. While the green tech partnership will need to be shaped by the interested parties, below are suggestions on: (1) where to start with the institutional framework; (2) how to align incentives; and (3) different rationales for membership.

6.1. Where to start with the institutional framework?

The design of a green tech partnership must rely on the alignment of incentives, either through good will or, possibly, a formal agreement. While the latter would be preferable, it would still need to remain open to allow for market forces to operate.

The first question is what might be the best group or institution to discuss the creation of such a partnership. The G7 is simply too narrow and larger groupings, such as the G20 or the Conference of the Parties to the United Nations Framework Convention on Climate Change might not be manageable, also because China's reaction to the creation of a supplementary supply chain might be such that no such proposal would really move forward.

Given these considerations, and the urgency of reducing reliance on China while maintaining decarbonisation goals, the most pragmatic approach might be to 'mini-lateralise' cur- rent frameworks for discussion and decision-making. These include the trade and technology councils (TTCs) already set up by the US and EU, and those used by the EU and Japan and the EU and India. The starting point would already be different from the G7, since India could become one of the founding members through its presence in TTCs, including with the EU. From this narrow group of core countries with existing TTCs, other countries may step into the partner- ship based on objective criteria, such as having a relevant comparative advantage, and also being incentive-aligned.

6.2. Tools to align incentives

The first set of incentives relates to access to resources through reduced barriers, such as trade and investment agreements. While major economies – certainly the US and the EU – are already setting up strategic alliances with countries rich in critical materials, doing so at the level of the partnership would be much more effective and cost efficient. The partnership would offer access to the partnership's combined markets free of tariffs and other trade barriers. For the US, though, this might not be feasible for the foreseeable future, given a bipartisan preference for the status quo, in terms of trade and investment agreements.

Other incentives would thus need to be explored, such as offering free transfer of technology to those partners that aim at extracting, refining or/and manufacturing. Long-term contracts could be offered to green producers in this new ecosystem for public procurement of clean tech in partner countries. Finally, patents should be shared inside the partnership, but some form of investment screening might be needed to avoid leakage of new technologies to production sites where dirty energy is used.

Beyond the industrial policy concerns of tech transfer leakage, a second rationale for patent-sharing would be the need to reduce the technological path-dependence that might occur if China were to adopt the technologies developed by the partners. Finally, access to finance would be another important asset which could be put in common in this partnership. This could be achieved through foreign direct investment into the countries where green tech will be manufactured, or other sources of funding related to the green transition.

It is hard to tell whether the above measures will be enough for such a partnership to take shape. As a second best, given the importance of reducing reliance on China while decarbonising, two instruments come to mind, which are being used by the US or the EU in the context of de-risking: subsidies and carbon taxes.

Of the two, taxes are known to be superior, but that does not mean they will be more feasible (Gugler et al, 2021). The US IRA is already based on subsidies, while the EU prefers carbon pricing. When moving to a partnership, rather than reshoring as an objective, incentivising green tech production using subsidies will probably lead to a spaghetti bowl of subsidies, at high cost and yielding large inefficiencies. Carbon pricing is not perfect either, because it is hard to make it compatible with World Trade Organisation rules.

7. Conclusions

The EU is hugely dependent on China for the green tech needed for decarbonisation. It is risky to depend on a single source of production of key renewable technologies because of the potential for weaponisation of this dependence, and because of China's own needs and factors beyond the government's control, including climate disasters.

An alternative solution to country-by-country de-risking (i.e. reshoring) would be creation of a green tech partnership aimed at increasing both the scale and diversity of the supply of renewable energy technologies. Members of the partnership would be chosen based on incentive alignment and buy-in to a common goal of meeting decarbonisation targets. The guiding principle would be coordinated specialisation, under the principle of comparative advantage.

Because China's current dominance of the supply chain is based on lower production costs as well as the control of extraction and refining and top-notch innovation, the only way for a supplementary supply chain to be sustainable is to introduce policies that will generate interest in this supplementary supply chain. Those policies should free-up the transfer of technologies within the partnership and also providing financing to those with more economies of scale to refine and manufacture.

The membership to this partnership should be wider than the G7 including producers of critical materials and low-cost manufacturers, as long as they have the same common goal, ensuring incentive compatibility. Even if China stays out of this supply chain, it can benefit in as far as the demand is huge and a supplementary supply chain reduces the risk of path dependence.

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