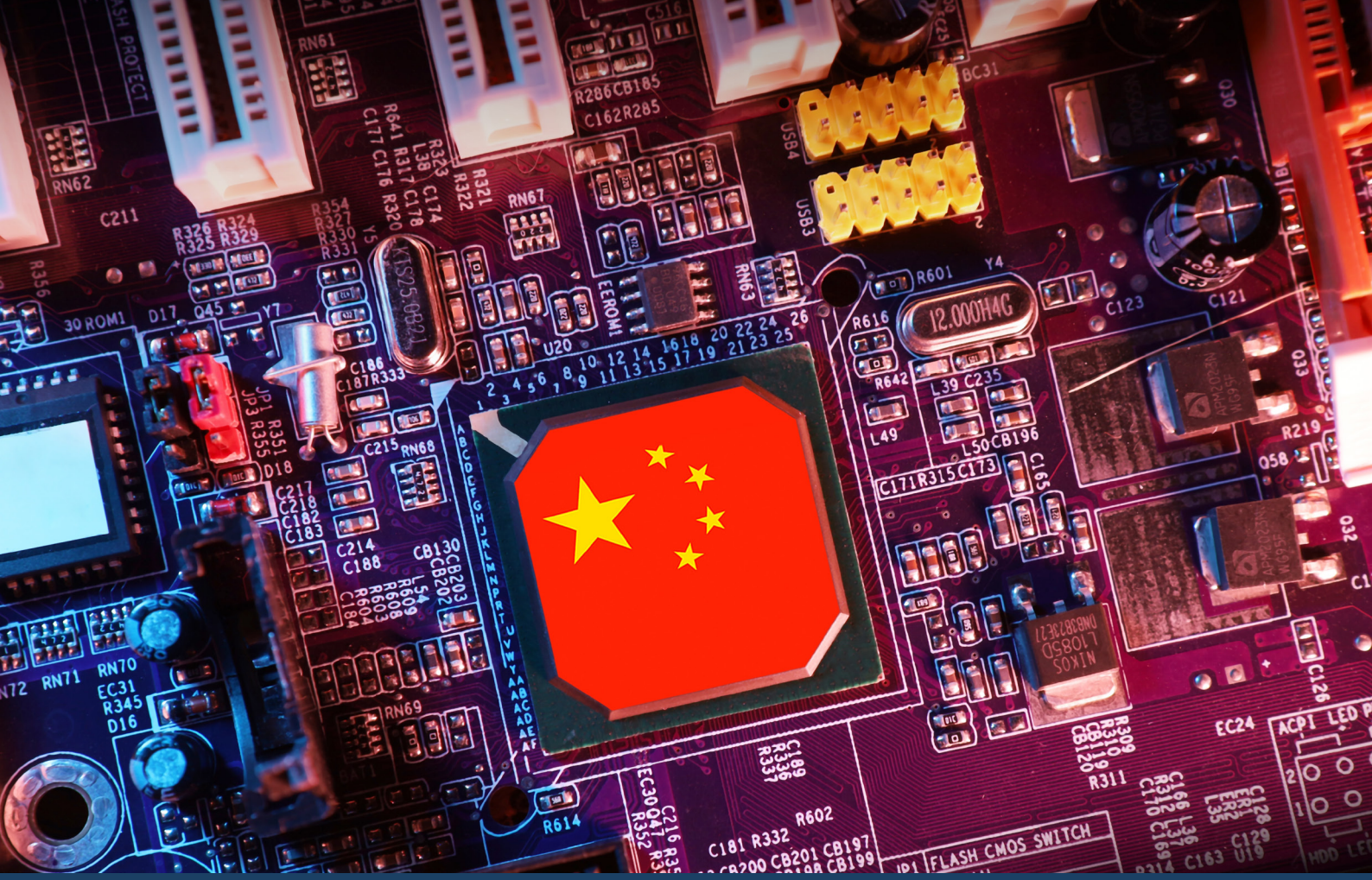

Manufacturing Vulnerabilities: Chinese Minerals, Semiconductors and Green Technologies in the EU

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Summary

Industrial policy is an important part of China's economic statecraft in the 21st century. Strategies such as *Made in China 2025* are supported by outbound investments and trade and therefore have geoeconomic implications for the EU. This report studies the EU's economic dependencies and vulnerabilities vis-à-vis China in certain strategic sectors, namely critical raw materials, the semiconductor industry, the electric-vehicle industry, and the energy sector.

The report shows that the EU has considerable import dependency on China for certain critical raw materials and inputs used for the production of semiconductors and green technology. The report also lists a number of Chinese investments, including acquisitions in the semiconductor industry and energy sector, as well as new battery plant investments. Chinese state involvement in the studied investments is prevalent but varies depending on the sector. The pattern of investments is largely in line with China's industrial policy goals. There are various vulnerabilities and geoeconomic risks associated with Chinese investments and trade in the studied sectors: technology transfer (including dual-use technologies), Chinese market dominance, the establishment of economic chokepoints, security concerns related to Chinese ownership of critical infrastructure, and Chinese influence over decision-making processes within the EU.

Keywords: EU, China, industrial policy, Made in China 2025, semiconductor industry, electric-vehicle industry, EV, energy sector, the green transition, critical raw materials, geoeconomic risks.

Sammanfattning

Industripolitik är en viktig del av Kinas ekonomiska statskonst på 2000-talet. Strategier som *Made in China 2025* understöds av utgående investeringar och handel, och har därmed geoekonomiska implikationer för EU. Den här rapporten studerar EU:s ekonomiska beroenden och sårbarheter gentemot Kina i vissa strategiska sektorer, nämligen kritiska råvaror, halvledarindustrin, elbilsindustrin, samt energisektorn.

Rapporten visar att EU har betydande importberoenden visavi Kina för kritiska råvaror och insatsvaror som används för produktionen av halvledare och gröna teknologier. Rapporten listar även ett antal kinesiska investeringar, inklusive företagsförvärv inom halvledarindustrin och energisektorn, samt nyetableringar av batterifabriker. Kinesisk statlig inblandning i de studerade investeringarna är vanligt förekommande, men med sektorsvis variation. Investeringsmönstret är i stort sett i linje med Kinas industripolitiska mål. Det finns diverse sårbarheter och geoekonomiska risker med kinesiska investeringar och handel i de studerade sektorerna, i termer av teknologiöverföring, inklusive av teknologier med dubbla användningsområden, kinesisk marknadsdominans, etableringen av ekonomiska kvävningspunkter, säkerhetsrelaterade problem kopplat till kinesiskt infrastrukturägande, samt kinesiskt inflytande över beslutsprocesser inom EU.

Nyckelord: EU, Kina, industripolitik, Made in China 2025, halvledarindustrin, elbilsindustrin, EV, energisektorn, den gröna omställningen, kritiska råvaror, geoekonomiska risker.

Preface

This report focuses on the EU's dependencies on China and the vulnerabilities this creates in strategic sectors. Within the project, Defence Economics and Materiel Supply, financed by the Swedish Ministry of Defence, we at the Swedish Defence Research Agency (FOI) have, over the past two years, accumulated knowledge and built up our competence within the field of geoeconomics. In recent years, the economic components of interstate rivalry have received intensive scrutiny, drawing significant attention to this field. After many years of globalisation and increased international trade, several countries are now contemplating the protection of vulnerable sectors and taking precautions regarding their dependencies on geopolitical rivals.

Maria Ädel (FOI)

Project Manager, Defence Economics and Materiel Supply

Stockholm, 13 December 2023

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We wish to thank the reviewers, Max J. Zenglein, at the Mercator Institute for China Studies, and Oscar Almén, at the Swedish Defence Research Agency (FOI), for helpful comments and fruitful discussions. Thanks also goes to Richard Langlais for thorough language-editing, and Lena Engelmark for layout-fixes. Lastly, we would like to show our appreciation to Jared Mondschein, at RAND Corporation, as well as Daniel Eidenskog, Johan Öhgren, Robert Malmqvist, and Roger Bodén, at FOI, for sharing valuable technical expertise and insights regarding the semiconductor industry.

Tobias Junerfält and Emil Wannheden (FOI)

Stockholm, 12 January 2024

Executive summary

As China's economy has expanded and climbed global value chains, EU-China economic relations have become increasingly conflictual. China's industries have become competitive and an important supplier of inputs to sectors of strategic importance for the EU. At the same time, the Chinese Communist Party sees investments and trade with the EU as a means to achieve its ambitious industrial policy goals, as well as to further its foreign policy interests and synergies between its civilian and defence industries. The combination of China's extraterritorial industrial ambitions and the risks associated with Chinese state involvement in Chinese foreign business ventures threatens the economic and national security interests of EU member states.

The authors have identified, using an inductive approach, a number of economic dependencies and vulnerabilities relating to Chinese investments and trade in critical raw materials, the semiconductor industry, the electric-vehicle industry, and the energy sector. These sectors are interconnected through their value chains. Critical raw materials are furthest upstream, followed by the semiconductor industry, with the EV industry and the energy sector representing end applications.

The main findings of this report are as follows:

- Because of the EU's import dependency on China for critical raw materials, it is severely vulnerable to manipulation and interruption of the trade flows from China. China is the main import source for seven out of 16 Strategic Raw Materials, as identified by the EU, including bismuth, gallium, germanium, rare-earth elements for permanent magnets, magnesium, natural battery-grade graphite, and tungsten. The EU's dependency on China is even greater if China's control over global supply chains for critical raw materials is taken into account, since China can influence third countries that export to the EU. The EU's dependency on China for rare-earth elements, crucial not least for the electric-vehicle industry and the energy sector, is especially noteworthy.
- Chinese acquisitions of EU semiconductor companies come with the severe risk of technology transfer, including sensitive dual-use technologies. There have been Chinese acquisitions of companies across the value chain in the EU semiconductor industry, including in chip design, front- and back-end chip manufacturing, as well as in the inputs they require. The authors identified 15 Chinese acquisitions of semiconductor companies based in Finland, France, Italy, the Netherlands and Sweden. The acquired companies represent various product segments, all of which have dual-use potential, including microelectromechanical systems, radio-frequency power applications, compound semiconductors, optoelectronics, and printed-circuit boards. Chinese semiconductor investments in the EU may also strengthen China's industrial competitiveness in other sectors, such as the electric-vehicle industry and the energy sector.
- Chinese investments in EU battery plants may further strengthen China's already dominant global position in electric-vehicle battery production. Moreover, Chinese electric-vehicle exports to the EU have increased dramatically in the past few years, but are currently not an important import dependency for the EU.
- Chinese investments in EU power plants and electricity grids have created severe vulnerabilities for the EU member states, related to Chinese access to critical infrastructure and possible influence over political and regulatory processes. Chinese companies are assessed as owning around 0.4 percent of EU power generation capacity. In addition, the EU is dependent on China for imports of solar panels and for inputs used for the production of solar panels and wind turbines.

- Chinese investments in the EU's strategic sectors contribute to Chinese industrial-policy goals. Chinese semiconductor investments across the value chain help China to close technology gaps, while Chinese investments in electric-vehicle battery production are in line with China's ambitions to have a dominant automotive industry. Chinese energy investments are consistent with the goals of its Belt and Road Initiative to connect the Eurasian landmass and facilitate Chinese influence over economic and political decision-making within the EU.
- Taken together, such economic vulnerabilities create geoeconomic risks for the EU. China can instrumentalise import dependencies; strengthen its market dominance in certain sectors or product segments and thereby erode EU competitiveness; use its political and commercial influence for foreign policy goals; gain access to company infrastructure and business networks; and acquire EU technology. These geo-economic risks are especially noteworthy in cases where they may be exploited by the Chinese military and defence industry.
- The degree of ownership concentration and direct state affiliation varies between the studied sectors. It is highest in the energy sector, but also salient in the semi-conductor industry. Some of the examined companies have direct links to China's military and defence sector. The Chinese battery-plant greenfield investments are largely made by private firms.
- The Chinese government uses both hard and soft pressure to direct investments toward party-state interests, regardless of the degree of direct state ownership. Given the lack of transparency, it is difficult to disentangle investments made on commercial grounds from those made in service of industrial-policy goals. It is crucial to assume that the Chinese government has some kind of influence over all Chinese-owned companies, particularly in strategic sectors such as those studied in this report.
- However, the degree of efficient control that the Chinese government can exercise is limited. Increased centralisation of state power by the Chinese Communist Party brings coordination challenges in terms of higher transaction costs and the sharing of relevant information. Moreover, it is not necessarily in the interest of the Chinese government to utilise all of the EU's economic vulnerabilities identified in this report, since the repercussions for the Chinese economy might be severe, not least due to supply-chain interdependencies.

Abbreviations

AI	Artificial Intelligence
BRI	Belt and Road Initiative
CATL	Contemporary Amperex Technology Co. Limited
CCP	The Chinese Communist Party
CGN	China General Nuclear Power Group
CRM	Critical Raw Material
CTG	China Three Gorges Corporation
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
EV	Electric vehicle
FDI	Foreign direct investment
GaN	Gallium nitride
GFRP	Glass-fibre-reinforced polymer
IEA	International Energy Agency
IoT	Internet of Things
IP	Intellectual property
M&A	Mergers and acquisitions
MCF	Military-Civil Fusion
MEMS	Microelectromechanical systems
MERICS	Mercator Institute for China Studies
MIC2025	Made in China 2025
MoU	Memorandum of understanding
NSIG	National Silicon Industry Group
PCB	Printed-circuit board
PLA	People’s Liberation Army
RF	Radio frequency
SASAC	State-owned Assets Supervision and Administration Commission
SGCC	State Grid Corporation of China
SMIC	Semiconductor Manufacturing International Corporation
SOE	State-owned enterprise
SPIC	State Power Investment Corporation
SRM	Strategic Raw Material
SVOLT	SVOLT Energy Technology

Table of Contents

1 Introduction

China's role in the world economy has changed radically since the turn of the millennium. A popularly acknowledged starting point for China's transformation into an economic superpower is 2001, the year when China became a member of the World Trade Organization and the importance of Chinese exports in value chains across the world increased dramatically. Twenty years later, in 2021, China "has established itself as the world's manufacturing powerhouse," representing 30.5 percent of global manufacturing in terms of added value, double that of the EU's 15.6 percent.[1] Even though Western multinational companies and their presence in China have played an important part in China's economic journey, the domestic Chinese industry has become increasingly competitive.

As China's economy has expanded, advanced and climbed global value chains, EU-China economic relations are diverging. Economic exchange between the EU and China, two of the world's largest economies, increasingly seems to be characterised by competition and conflict rather than collaboration and mutual benefits. China's cost competitiveness and foreign direct investment (FDI) across more and more industries have resulted in expanding economic dependencies for the European Union (EU) vis-à-vis China. In addition, these developments have taken place in parallel with China's extensive industrial and foreign-policy goals. China's ambitions should be seen in the context of its one-party system, its political economy characterised by extensive and multifarious state involvement, and its open promotion of synergies between China's civilian and defence industries. For the EU, this has meant a growing threat perception regarding the security-related risks of economic exchange with China. These include the transfer of dual-use and other technologies, access to critical infrastructure, leakage of sensitive information, influence over political and commercial decision-making, and the use of market dominance as political leverage against the EU.

The perceived threat from China is now underpinning the EU's own industrial-policy goals, with their close ties to the EU's green ambitions and security interests. In a September 2023 speech, the president of the European Commission, Ursula von der Leyen, identified the need for "responding to an assertive China" as one of the EU's main geopolitical challenges. In the same speech, she reiterated the EU's goals and main strategy for a green and digital transition, expressed in the European Green Deal. The Green Deal is a framework that contains a host of different policies and strategies with the aim of transforming the EU's economy. Moreover, von der Leyen suggested that the EU's industrial ambitions are closely tied to the security of the union: "It is an economic and national security imperative to preserve a European edge on critical and emerging technologies."[2]

Von der Leyen suggested that EU companies are facing unfair trade practices abroad and that state subsidies are skewing the competitiveness of their competitors. She also pointed out who the EU's main adversary is in this regard: "We have not forgotten how China's unfair trade practices affected our solar industry." Decreasing the reliance on external parties, not least China, is one of the objectives of the Green Deal. In her speech, Von der Leyen also underlined the EU's efforts towards self-sufficiency: "We have started making ourselves more independent in critical sectors, like energy, chips or raw materials" and "from wind to steel, from batteries to electric vehicles, our ambition is crystal clear: the future of our clean tech industry has to be made in Europe."[3]

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[1] UNIDO, *International Yearbook of Industrial Statistics: Edition 2022* (Vienna, Austria: United Nations Industrial Development Organization, February 2023) 39, 98, https://www.unido.org/resources-publications-flagship-publications/international-yearbook-industrial-statistics.

[2] Ursula von der Leyen, "2023 State of the Union Address by President von der Leyen," Transcript of speech delivered at the European Parliament, Strasbourg, France, 13 September, 2023, https://ec.europa.eu/commission/presscorner/detail/ov/speech_23_4426.

[3] von der Leyen, "2023 State of the Union address."

At the same time, China is an important trade partner for the EU. In 2022, China was the single largest import source for the EU, representing 20.8 percent of its total imports of goods. Moreover, Chinese exports to the EU have increased consistently in the past decade, especially in the last couple of years. The value of imported goods from China went from EUR 385 billion in 2020 to EUR 626 billion in 2022. The main bulk of Chinese goods consisted of machinery, vehicles, and other manufactured goods.[4] Meanwhile, Chinese foreign direct investment (FDI) in the EU peaked in the middle of the 2010s and has decreased since. Furthermore, Chinese FDI has shifted its focus in targeted sectors of the EU in recent years. While investments previously largely flowed to sectors such as energy and infrastructure, the automotive industry is now one of the major recipient sectors, as battery-plant greenfield investments have been announced across the EU.[5] However, even though recent shifts in trends in investment patterns are relevant, there are also accumulated Chinese investments across the EU, including in the sectors that the European Commission identifies as critical. Moreover, some imports are particularly crucial to the EU's green ambitions.

China's economic rise and its use of geoeconomics or economic statecraft in relation to other countries around the world are nothing new, and the phenomenon has been well studied.[6] However, what is new, at least in the EU, is an increased emphasis on the need for a coherent long-term industrial strategy for responding to the challenge posed by China's economic influence. The supply-chain issues stemming from the Covid-19 pandemic and Russia's war against Ukraine have reinforced this conviction. In addition, the interruption of deliveries of Russian pipeline gas to the EU in the autumn of 2022 caused substantial economic damage, and demonstrated that little had been done to address the EU's economic dependency on potentially antagonistic countries. The EU would appear to have sleepwalked into similar dependencies with regard to China.

1.1 Purpose and research questions

Studying the EU's economic dependencies in terms of investments and imports from China has thus taken on a new urgency. The concern is that the dependencies are related to the new, strategic sectors that will power the EU's future decarbonised and digitalised economy: critical raw materials, renewable energy, electric vehicles (EV), and semiconductors, among other sectors. While the EU was able to substitute Russian gas in 2022–2023 with gas imports from other sources relatively quickly, it is much more time-consuming, difficult and expensive to develop a new domestic industry for, say, solar-panel production. Furthermore, it is a daunting task to break free from dependencies related to the extraction and processing of critical raw materials. Furthermore, some of these dependencies represent considerable vulnerabilities that China could exploit for geoeconomic purposes.

In addition, the reliance on investments and imports from China has raised numerous questions about the connected security-related risks. However, it is not always clear to what degree these dependencies constitute a security threat. Is a Chinese investment in a wind-power park a national-security threat? What about the acquisition of a semiconductor company producing equipment for chip manufacturing or the building of a new battery plant? This report, in addition to highlighting some of the EU's economic dependencies and vulnerabilities towards China, analyses the associated geoeconomic and security-related risks.

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[4] "China-EU – International trade in goods statistics," Eurostat, February 2023, accessed 10 October, 2023, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=China-EU_-_international_trade_in_goods_statistics.

[5] Agatha Kratz et al., *Chinese FDI in Europe: 2022 Update* (Rhodium Group and MERICS, May 2023), 5, 10–1, https://rhg.com/research/chinese-fdi-in-europe-2022-update/. Germany has the largest accumulated stock of Chinese FDI among the EU member states. Meanwhile, if non-EU members are included, the UK is the largest recipient of Chinese FDI in Europe.

[6] For example, see Robert D. Blackwill and Jennifer Harris, *War By Other Means: Geoeconomics and Statecraft* (Cambridge: Harvard University Press, 2016); William J. Norris, *Chinese Economic Statecraft: Commercial Actors, Grand Strategy, and State Control (*Ithaca: Cornell University Press, 2016); and Oscar Almén and Christopher Weidacher Hsiung, *China's Economic Influence in the Arctic Region: The Nordic and Russian cases*, FOI-R--5326--SE (Stockholm, Sweden: Swedish Defence Research Agency, June 2022).

The primary purpose of this report is thus to study economic dependencies and vulnerabilities within certain sectors considered strategic for the EU, and how they can be used by China for geoeconomic purposes. The sectors of the EU economy in question are critical raw materials, the semiconductor industry, the EV industry, and the energy sector. The rationale for studying these sectors is that EU policymakers consider them among the most important for the green transition, and for the underlying strategies related to digitalisation and increased tech self-sufficiency, but also because of their importance to China's industrial and foreign-policy ambitions.

A secondary purpose of the report is to obtain a deeper understanding of the EU's strategic industries in order to be able to provide better assessments of related geoeconomic risks. It is therefore also of interest to study not only the value-chain structures and cross-sectoral interdependencies, but also how they tie into China's industrial ambitions. *Made in China 2025* is an industrial policy programme of central importance for these ambitions. As such, it is essential to include a close analysis of its relevance and role for the purpose of this report (see Section 2.1.1 for further treatment of this policy).

The research questions addressed here are as follows:

a) What are some of the most important economic dependencies and vulnerabilities vis-à-vis China in the studied sectors?
b) What similarities and differences are there in the studied sectors in terms of economic vulnerabilities towards China?
c) How are the studied investments related to the policy goals of *Made in China 2025*?
d) What is the potential for China to coordinate investments in the studied sectors?
e) What geoeconomic tools can China use to exploit the identified vulnerabilities?

1.2 Method and definitions

Before delving into the method used in this report, some key concepts used throughout need to be defined.

"*Geoeconomics*" is herein defined as "using economic means in interstate rivalry to achieve foreign policy goals or promote national interests."[7] For present purposes, geoeconomics and "*economic statecraft*" are interchangeable.

"*Foreign direct investments (FDI)*" refers to ownership stakes or other business investments in companies or new subsidiaries in a foreign country. FDI can consist of acquisition of both company equity and assets, as well as of "*greenfield investments*," that is, investments done "from the ground up," through the establishment of new production facilities, infrastructure, offices, etc.

A "*dependency*" is an economic relationship in terms of Chinese FDI or a significant share of imports from China.[8]

A dependency can also be a "*vulnerability*." A classic example is a high share of imports from China of a certain intermediary input, such as a refined metal that would be difficult to import from other countries. This is an example of a vulnerability that constitutes a

[7] This definition of geoeconomics is inspired by that of Blackwill and Harris, *War By Other Means*, 20. Blackwill and Harris define geoeconomics as "The use of economic instruments to promote and defend national interests, and to produce beneficial geopolitical results; and the effects of other nations' economic actions on a country's geopolitical goals." For further theoretical discussion on the concept of geoeconomics, see Evelina Bonnier and Peter Wikman, *Hur kan geoekonomisk rivalitet analyseras utifrån en strategisk ansats?* FOI-R--5474--SE (Stockholm, Sweden: Swedish Defence Research Agency, November 2021), https://www.foi.se/rapportsammanfattning?reportNo=FOI-R--5214--SE.

[8] The definitions of vulnerability and dependency are informed by the discussion in Jikon Lai and Amalina Anuar, *Measures of economic vulnerability and inter-dependency in the global economy*, Working Paper No. 333 (Singapore: S. Rajaratatnam School of International Studies of Singapore, January 2021), 2–5, https://www.rsis.edu.sg/wp-content/uploads/2021/01/WP333.pdf.

"*chokepoint*." A chokepoint can be described as "the potential to use market dominance in certain industries or product segments as leverage in interstate rivalry."[9]

A "*geoeconomic tool*" refers to ways in which China could instrumentalise existing economic vulnerabilities as leverage to force political concessions from the EU, or otherwise threaten EU's security interests. The greater the vulnerability, the more efficient the geoeconomic tool. China's potential use of geoeconomic tools poses "*geoeconomic risks*" for the EU.

As for the method of this study, the authors used an inductive approach. First, it was necessary to choose the sectors to be studied. This was done on the basis of their strategic importance to both the EU and China. Throughout the study, the authors identified and analysed, from the bottom up, sector-specific dependencies, vulnerabilities and geoeconomic tools and risks, based on the studied sources.

The different types of dependencies, vulnerabilities and geoeconomic tools identified throughout the report are summarised in Table 1. Interestingly, China can use geo-economic tools of one type to increase the effectiveness of geoeconomic tools of another type. Also, associated geoeconomic risks tend to overlap. For example, China has used subsidies to establish market dominance in certain segments, which then creates chokepoints and in turn also facilitates technology transfer and surveillance. As part of the conclusion, Chapter 7 discusses the differences in the vulnerabilities and associated geoeconomic tools and risks in the sectors studied.

Table 1. Dependencies, vulnerabilities and geoeconomic tools

	Dependency	**Vulnerability**	**Geoeconomic tool**
Trade in goods	High share of Chinese imports	Chokepoint, due to lack of alternative suppliers	Chinese export controls, such as quotas or embargos
		Market dominance	Chinese subsidies and dumping
FDI	Chinese ownership of companies and infrastructure	Technology transfer	Chinese appropriation of technology
		Political influence	Chinese influence over political and regulatory decision-making processes
		Private sector influence	Influencing business and investment decisions in a way that favours Chinese foreign policy goals
		Surveillance and access	Surveillance, espionage, and cyber-attacks by Chinese military and intelligence agencies

Notes: *Quotas*: limitation of exports; *embargo*: prohibition of exports; *dumping*: exporting at a low price to gain a market advantage.

1.3 Delimitations

This report aims to scrutinise China's potential to use geoeconomic measures against the EU, grounded in two assumptions: firstly, that China regards the EU as a current or potential target, and, secondly, that China is the driving force behind the relevant geoeconomic measures. The latter assumption does not question whether the EU is a geoeconomic actor in its own right, which it undoubtedly is, or its ability to influence China through economic means, which it certainly possesses. Rather, the research interest here is to examine the potential geoeconomic risks facing the EU.

[9] This definition is inspired by John Lee and Jan-Peter Kleinhans, *Mapping China's semiconductor ecosystem in global context: Strategic Dimensions and Conclusions* (Stiftung Neue Verantwortung and MERICS, June 2021), 9, https://merics.org/sites/default/files/2021-06/China%E2%80%99s%20Semiconductor%20Ecosystem_0.pdf.

As mentioned above, the sectors studied here are critical raw materials, the semi-conductor industry, the EV industry, and the energy sector. The authors identified these as among the most critical and strategic sectors, due to their importance for both Chinese and EU industrial and foreign-policy goals, and their importance to questions of national security within the EU. The EU is currently engaged in a wide debate regarding the critical importance of the chosen sectors, which has already led to policy responses such as the Critical Raw Materials Act, the European Chips Act, and an EU anti-subsidy probe into EV imports from China.[10] However, as an issue that will occupy the EU for many years to come, these policy initiatives should only be seen as the first step in managing it. The relation of the chosen sectors to China's industrial ambitions is discussed in more detail in Chapter 2. There are other industries and sectors that could have also been included, due to their strategic importance, such as infrastructure, transport, machine tools, railway equipment, and agricultural equipment. However, for delimitation purposes, these industries and sectors have not been studied here.

Further, this report restricts its focus to China's economic influence within EU member states. This delimitation entails the exclusion of various European countries, not least the UK. Motivating the delimitation is the need to make the research scope more manageable. The focus on the EU and the choice of economic sectors and industries discussed here is also driven by the fact that the European Commission is not only a major geoeconomic actor in those same sectors and industries, but also considers them to be crucial. Initiatives and actions undertaken by the European Commission, such as industrial policy initiatives and sanctions regimes, are likely to have a greater direct impact on EU member states than non-member states.

1.3.1 Selected aspects of economic exchange

To pursue its aims, the report considers Chinese FDI in EU countries and the EU's imports from China, and how these dependencies create economic vulnerabilities that could be exploited by China for geoeconomic purposes. The report does not analyse EU FDI in China and EU exports to China.

In general terms, some chapters discuss Chinese FDI exclusively and others Chinese imports, while others cover both (a more specific outline is provided in Sections 1.3.2 and 1.5). This is both motivated by the need to narrow the research scope, and because sometimes one aspect seems more relevant to consider than another. The analysis of sectors representing different types of dependencies that is carried out herein also allows the report as a whole to be able to provide a diversity of perspectives.

The intentions of the owners and employees of the companies acquired by Chinese investors are not analysed. The fact that a company has been acquired by Chinese owners does not, in and of itself, say anything about the intentions or even the degree of awareness that the company's previous owner, or its leadership, have regarding the way that their products or services fit into wider Chinese ambitions.

1.3.2 Sector-specific delimitations

The chapter on critical raw materials discusses the EU's import dependencies on China, especially in processed or refined materials. FDI in critical raw materials is not considered. Moreover, many different commodities could be defined as critical raw materials, but this report only focuses on metals and minerals that the European Commission has identified as especially critical for the EU's tech-related policy ambitions. The sectors studied in this report are part of these ambitions.

[10] "Critical Raw Materials Act," European Commission, accessed 15 November, 2023, https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en; "European Chips Act," European Commission, accessed 16 October, 2023, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-chips-act_en; Gisela Grieger, *EU anti-subsidy probe into electric vehicle imports from China* (European Parliamentary Research Service, October 2023), https://www.europarl.europa.eu/RegData/etudes/ATAG/2023/754553/EPRS_ATA(2023)754553_EN.pdf.

The chapter on the semiconductor industry considers Chinese FDI. Furthermore, the focus is on the qualitative aspects of the acquired companies, in terms of product segments and end markets, rather than quantitative aspects, such as revenue or production capacity. While imports from China and the quantitative aspects of FDI are relevant topics, FDI and qualitative aspects are emphasised here due to concern about the potential risk of leaking proprietary secrets on dual-use technologies and products within the semiconductor industry to China. Moreover, Section 4.1 describes selected parts of the semiconductor value chain in more detail.

The chapter on the EV industry discusses Chinese FDI in battery plants and the EU's import of Chinese EVs.

The chapter on the energy sector considers Chinese investments in solar- and wind-power plants and EU electricity-grid operators, as well as the EU's reliance on imports from China of inputs and products necessary for the solar- and wind-power industries.

1.4 Sources

The main sources relied on here are comprised of previous studies by European and US think tanks, research institutes, and academics studying Chinese economic influence. These are complemented by up-to-date mapping and analysis of FDI and trade data.

Previous studies by the Swedish Defence Research Agency (FOI) have served as important inspiration for this study.[11] Moreover, various other research organisations and think tanks, many of which have a China focus, have also been major sources. Among others, this includes the Mercator Institute for China Studies (MERICS) and Stiftung Neue Verantwortung in Germany, and the Center for Strategic and International Studies and Rhodium Group in the US. Additionally, news-media articles, including those from industry-specific media, and the International Energy Agency (IEA), have frequently been used as references for sector-specific statistics and analyses.

The Netherlands-based and China-focused data intelligence company, Datenna, has been a major source for data and analysis on the Chinese investments studied in this report, especially for the semiconductor industry. Datenna's *China-EU FDI Radar* provides an easily accessible and informative overview, although not exhaustive, of Chinese FDI in various economic sectors in Europe.[12] Company websites, as a source for open, specific information about the studied acquisitions and investors, also served a crucial role for the chapter on the semiconductor industry. For the energy sector, an important source of data has been Boston University's Global Development Policy Center database, *China's Global Power*.[13] Moreover, EU organs, such as various Directorates-General, have been referenced for information and data on the EU's dependencies on China, not least when it comes to critical raw materials.

As suggested above, much of the data and information underpinning this report has been gathered from European and US sources. Other than describing Chinese industrial policy ambitions, the Chinese perspective on the studied investments and trade is beyond the scope of this report.

For each of the studied sectors, the authors try to provide a representative picture of the extent of the EU's dependencies that are associated with Chinese investments and trade. However, assessing the degree of Chinese ownership and trade flows is difficult due to the lack of openly available and high-quality data. The number of acquisitions and business deals is large, and analysing them individually is time-consuming, even when

[11] Notably, see Almén and Weidacher Hsiung, *China's Economic Influence in the Arctic Region*; and Oscar Almén, *Kinesiska investeringar i Sverige: en kartläggning*, FOI-R--5474--SE (Stockholm, Sweden: Swedish Defence Research Agency, June 2023), https://www.foi.se/rapportsammanfattning?reportNo=FOI-R--5474--SE.
[12] "China-EU FDI Radar," Datenna, accessed 20 July, 2023, https://www.datenna.com/china-eu-fdi-radar.
[13] "China's Global Power Database," Boston University Global Development Policy Center, accessed 30 August, 2023, https://www.bu.edu/cgp/.

data and information are available. Chapter 4, on the semiconductor industry, is an example of an attempt to study companies individually, which is described in more detail in Appendix A. An example of a lack of data quality is in the area of critical raw materials. Data on the EU's dependencies on China for its critical raw materials, as identified by the European Commission, are not necessarily exhaustive. This is partly due to limitations regarding the availability and quality of trade-related data in the underlying study by the European Commission.[14] For example, the EU may have further dependencies on China for both extraction and processing of various important metals and minerals.

Moreover, assessing dependencies and vulnerabilities in relation to Chinese investments and imports of Chinese raw materials and inputs is difficult, since properly combining interrelated data presupposes knowledge of the supply chain structures of the different industries. There may be instances in this report where the authors' lack of such detailed technical knowledge may result in underestimating or overestimating existing vulnerabilities from a holistic perspective. However, the intent has been to make only claims supported by the openly available information accessed from the studied sources.

1.5 Outline

The rest of the report is organised as follows.

Chapter 2 provides an overview of modern Chinese industrial policy, the interaction between the Chinese state and the private sector, and the implications for the EU.

Similar to the way industrial value chains are categorised into upstream and downstream segments, the order of Chapters 3–6 is reflective of the value-chain hierarchy between the studied sectors of the EU economy. Furthest "upstream" is Chapter 3, which analyses Chinese exports of critical raw materials of special importance to the EU's strategic sectors. A bit further "downstream," Chapter 4 analyses Chinese investments in the EU semiconductor industry, focusing on a number of selected semiconductor companies and their position in the semiconductor value chain.

Further downstream in the chapter hierarchy are end-application sectors, with upstream dependencies related to both Chapters 3 and 4. Chapter 5 analyses Chinese influence over the EU EV industry, particularly the battery segment, and Chinese EV exports to the EU. Chapter 6 analyses Chinese influence on the EU energy sector. The objective is to analyse Chinese investments in EU power plants and electricity-grid operators, and the EU's dependence on Chinese exports in the wind- and solar-power industries.

Chapter 7 presents conclusions with respect to the research questions. It also provides a discussion on the future of EU-China economic relations, especially from the perspective of geoeconomics. Moreover, there are suggestions for future research to complement the findings of this report.

[14] Milan Grohol and Constanze Veeh, *Study on the Critical Raw Materials for the EU: 2023 Final Report* (Brussels, Belgium: Directorate-General for Internal Markets, Industry, Entrepreneurship and SMEs, March 2023), https://op.europa.eu/en/publication-detail/-/publication/57318397-fdd4-11ed-a05c-01aa75ed71a1.

2 China’s extraterritorial industrial policy

This chapter describes China’s economic statecraft in terms of the country’s contemporary industrial policy, including its stated purpose, the role of foreign companies in achieving China’s industrial ambitions, the nature of interaction between the Chinese state and the Chinese private sector, and how foreign criticism and rivalry affect its strategic goals. Also discussed are the implications of Chinese industrial policy goals for the EU. China’s aim for its industrial policy is to make it both self-sufficient and world-leading in strategic industries. To this end, the Chinese Communist Party (CCP) has actively shaped a multifaceted system of state control to steer investments by Chinese companies towards its strategic goals. Foreign companies not only play various roles for China’s state-led industrial aims, but they also constitute an important source of technologies and know-how, not least. China’s industrial policy ambitions pose a challenge to the EU, which, at the same time as having important economic relations with China, also has to deal with the security-related risks that come with certain Chinese investments and imports.

2.1 China’s industrial policy in the 21st century

China actively uses industrial policy to promote its economic development, foreign policy goals, and national interests. Much of its efforts take place inside its borders, targeting the domestic industry. At the same time, a major cause of the considerable growth and advancement experienced by the Chinese economy in recent decades has been its integration with the world economy and export-led growth. China remains dependent on trade with the surrounding world, while also striving towards reduced international dependencies. To achieve this, the Chinese state complements domestic industrial policy with state-led efforts to encourage investments abroad. Chinese investments in other countries play an important role in serving the development of its domestic industry in the short run, allowing for a higher degree of self-sufficiency in the long run. International economic exchange, in terms of both investments and trade, is also a way for China to increase its influence abroad. Industrial policy efforts that stretch beyond China’s borders are an important component of Chinese economic statecraft, in the sense of being “state manipulation of international economic activities for strategic purposes.”[15] It could also be referred to as an “extraterritorial industrial policy.”

2.1.1 Made in China 2025

By extension, China’s conduct of economic statecraft in the EU during the 21st century is part of its domestic industrial policy and broader tech ambitions. It also reflects China’s expanding economic power. In fact, China’s use of active industrial policy has a history dating to at least the late 1970s and the economic reforms initiated by Deng Xiaoping after the death of Mao Zedong. However, its industrial policy efforts have been ramped up during the first and second decades of the 21st century, during which the Chinese state has introduced a series of industrial policy programmes with a focus on technological progress. The Chinese approach to industrial policy has been inspired by the history of other East Asian states, namely Japan, South Korea, Taiwan, and Singapore, all of which experienced state-led industrial modernisation. The arguably most important and ambitious of the Chinese industrial policy strategies in recent years is *Made in China 2025* (henceforth MIC2025).[16]

[15] This definition of economic statecraft can be found in Norris, *Chinese Economic Statecraft*, 3.

[16] Björn Cappelin, *Kinas industripolitik: nulägesbild, riktningen framöver och konsekvenser för Sverige* (Stockholm, Sweden: Utrikespolitiska institutet, August 2022), 4–5, https://kinacentrum.se/publikationer/kinas-industripolitik-nulagesbild-riktningen-framover-och-konsekvenser-for-sverige/; Max J. Zenglein and Anna

China launched MIC2025 in 2015. The strategy identifies ten industries, all of which are tech-related, in which the CCP ultimately has goals for China to become self-sufficient and, in some cases, world-leading before the party's centenary in 2049. Among these are "next-generation IT," "energy-saving and new-energy vehicles" and "energy equipment." China unleashed a wave of sector-level policy targets and funding schemes along with MIC2025. Domestically, it follows that provincial and municipal governments in China need to operationalise MIC2025 in their local policy plans, based on local preconditions. In practice, however, this results not only in enthusiastic endeavours towards developing local industries of relevance to the national goals, but also half-hearted efforts with the primary purpose of obtaining state funding. The objectives of MIC2025 are primarily to be achieved through the development of China's domestic industry, but its important components include acquiring international technological know-how through investments and trade, among other means.[17]

2.1.2 Multiple roles for foreign companies

Foreign tech companies play at least three different roles in China's domestic MIC2025 goals. In sectors where Chinese companies have reached sufficient competitiveness and foreign companies do not pose a market threat, China is more open to investments from abroad. The Chinese government even promotes such investments explicitly, partly as a way to show good faith to the international business community. The automotive industry is an example of an economic sector that can be used as a "bargaining chip" for China, given that the domestic automotive industry, especially the EV segment, is nowadays considered mature enough to withstand foreign competition. Another category of foreign tech companies is "willing tech partners," companies whose products and know-how are useful for China's tech ambitions and which are willing to localise important production in China. China actively encourages such companies to expand into its domestic market. The current status of Chinese consumer electronics is an example of how China has successfully integrated or absorbed foreign companies and their know-how into domestic value chains. China's electronics industry used to have a narrow focus on assembling foreign PCs and other electronics goods, but today consumer electronics brands from Chinese companies such as Huawei and Lenovo have reached international fame.[18]

A third category of foreign tech companies is "hard-to-get tech targets," that is, dominant market actors that are unwilling to localise their core business in China. The Chinese government approaches the challenge of gaining access to high-end technology from such companies in different ways, including offering them special treatment if they localise their business in China. Another option is to acquire their know-how outside of China in some way, either through direct acquisition or by other means, such as joint R&D, venture capital, or paying for intellectual property (IP) licenses. The third option is to employ illegal measures, such as industrial espionage and cyberattacks, or methods that are more inconspicuous, such as targeted recruitment of foreign talent.[19]

2.1.3 Ever blurrier lines between the state and the private sector

There are largely three types of Chinese companies: state-owned enterprises (SOEs), mixed-ownership firms and private firms. Although there have been exceptions, Chinese

Holzmann, *Evolving Made in China 2025: China's industrial policy in the quest for global tech leadership* (Berlin, Germany: MERICS, July 2019), 9, 14, https://merics.org/en/report/evolving-made-china-2025.

[17] Zenglein and Holzmann, *Evolving Made in China 2025*, 8, 12–3, 20, 24, 31. Apart from next-generation IT, energy-saving and new-energy vehicles, and energy equipment, the remaining seven core industries identified in MIC2025 are the following: biomedicine and high-performance medical equipment, new materials, agricultural equipment, advanced railway transportation equipment, maritime engineering equipment and high-tech ships, aviation and space equipment, and high-end computerised machines and robots.

[18] Zenglein and Holzmann, *Evolving Made in China 2025*, 19, 49–50.

[19] Zenglein and Holzmann, *Evolving Made in China 2025*, 50–1.

SOEs are generally expected to comply with state policies.[20] During the 2010s, SOE governance reforms have entailed an increase in the importance of CCP committees in SOE decision-making. Party committees are now expected to initiate strategic company decisions rather than just review them. In addition, increased party committee influence has also affected mixed-ownership firms, those with both the Chinese state and private investors as shareholders. Mixed-ownership firms have proliferated during the past couple of decades.[21] However, the private sector is China's largest economic sector and, in aggregate, private companies trump SOEs in terms of overall production capacity and labour-force size.[22] At the same time, since the 1990s, private companies have been obliged by law to establish party cells as a way for the CCP to maintain a certain degree of control over the private sector. During the 2010s, China's current leader, Xi Jinping, has renewed efforts towards increasing party-cell coverage. Even if many or most Chinese private companies today have party cells, which to a certain extent ensure adherence to state interests, this does not entail that the CCP micromanages company behaviour.[23] That being said, the increased importance of certain sectors for industrial policy goals has likely made more private companies the target of direct state interference, as the CCP now has a greater interest than earlier in aligning the private sector with strategic interests. Various examples of this trend are provided by the so-called "tech crackdown" that has been proceeding since 2020. Major private tech companies such as Alibaba and Tencent have been targeted by new and harsh regulations, implemented by the CCP in order to shape the tech sector to be more in line with "public interest" and strategic goals.[24]

It is worth emphasising that arbitrary exercise of power is not circumscribed in China, a one-party state controlled by the CCP, in the same way as in democratic countries. There is no rule of law in China, and the state can and will exercise direct power over private companies and their business decisions in matters deemed particularly important for party interests. In this context, the National Intelligence Law adopted in 2017 demands mention. The law gives China's national-intelligence apparatus the right to demand access to information of relevance to "national security" from its citizens. Additionally, this CCP-controlled apparatus has precedence in defining what constitutes matters of "national security," including information obtained from or related to the foreign ventures of Chinese private companies.[25] Consequently, even in cases where direct state involvement is missing in the initial phase of a company's business venture abroad, it does not follow that future direct state involvement can be ruled out.

Even in cases where "hard" pressure in terms of direct state involvement is absent, there is still "soft" pressure, in terms of a variety of incentive structures, put in place by the Chinese state in order to steer business ventures by both SOEs and private companies, domestically and abroad, towards the fulfilment of its policy targets. Private companies are expected to support the development of SOEs, exemplified by the aforementioned proliferation of mixed-ownership firms. State subsidies and a wide array of financial tools, such as favourable loans and tax incentives, are made available to companies willing to invest in strategic sectors pointed out in MIC2025, with the coordinated aid of

[20] William J. Norris's monography on the topic of Chinese economic statecraft provides a variety of examples of how the Chinese state has experienced both success and failure in exercising control over SOEs, depending on factors such as intra-state rivalries, the degree of convergence between commercial and political goals, and market structures. For more details, see Norris, *Chinese Economic Statecraft.*

[21] Barry Naughton and Briana Boland, *CCP Inc.: The Reshaping of China's State Capitalist System* (Washington, DC: Center for Strategic and International Studies, January 2023), 9–10, 18, https://www.csis.org/analysis/ccp-inc-reshaping-chinas-state-capitalist-system.

[22] Magnus Petersson et al., *Utländska direktinvesteringar i skyddsvärda branscher: En studie av risker, branscher och investerare*, FOI-R--5069--SE (Stockholm, Sweden: Swedish Defence Research Agency, December 2020), 51, https://www.foi.se/rapportsammanfattning?reportNo=FOI-R--5069--SE.

[23] Jude Blanchette, "Against Atrophy: Party Organisations in Private Firms," Made in China Journal, 18 April, 2019, https://madeinchinajournal.com/2019/04/18/against-atrophy-party-organisations-in-private-firms/.

[24] Chang Che and Jeremy Goldkorn, "China's 'Big Tech crackdown': A guide," The China Project, 2 August, 2021, https://thechinaproject.com/2021/08/02/chinas-big-tech-crackdown-a-guide/.

[25] Petersson et al., *Utländska direktinvesteringar i skyddsvärda branscher*, 50–2.

state-owned banks and investment funds. This has obvious implications in terms of market distortions, to the extent that non-Chinese companies do not have access to the same economic advantages when competing with their Chinese counterparts.[26]

China's state-initiated investment funds (or "government guidance funds") are nominally independent but are often explicitly set up for the promotion of certain industries. Investment funds receive both multichannel public funding and private funding, which makes their financial structure complex and pinpointing their funding sources difficult. For example, public funding can be traced back to both the Chinese central bank, the People's Bank of China, and the State-owned Assets Supervision and Administration Commission (SASAC). SASAC is a state organ tasked with managing Chinese investment firms and SOEs, and reports directly to the State Council, that is, the Chinese government. Moreover, there is an overall state dominance of China's financial system and capital markets. Together, this gives the Chinese state a multitude of more or less direct means to provide financial support and manipulate investment decisions, not only by SOEs, but also by private companies.[27] Furthermore, regulatory obstacles, such as capital controls and outbound investment screening also serve as "soft" pressure that steers the overseas investment behaviour of Chinese companies. While contributing to lower outbound Chinese FDI overall, it also follows that outbound investments in strategic sectors are more likely to be "greenlighted" than non-prioritised investments are, thus further strengthening an investment pattern in line with industrial policy goals.[28]

2.1.4 Sustaining state ambitions amidst international scrutiny

China's tech-related industrial policy ambitions have had a cold reception in the US and the EU, China's largest trade partners. The means that China uses in its attempts to achieve its objectives have been particularly criticised, which often relates to the lack of transparency regarding the nature of state involvement in Chinese investments abroad. Furthermore, certain investments entail a risk of technology theft within crucial Western high-tech sectors.[29] Moreover, the Chinese government openly promotes synergy between the domestic defence industry and the civilian sector, a strategy known as Military-Civil Fusion (MCF). These efforts are not new, nor are they exclusive to China. However, efforts to further MCF have received increased emphasis by the current Chinese leader, Xi Jinping. Even if China's potential success in adapting technologies from civilian industries to achieve military innovation varies, depending on many different factors, there is nevertheless a risk associated with leaking European dual-use technologies into the wrong hands.[30]

As a way of managing foreign scrutiny, the Chinese state has made efforts to tone down, or rather cloak, its ambitions for MIC2025. In the meantime, the implementation of its strategic goals has continued unabated. Becoming a technological superpower remains important to the Chinese political leadership, not just to fulfil geopolitical goals, but also to increase the rate of self-sufficiency and sustain the competitiveness of the domestic economy. An illustration of these continuing ambitions is the considerable overlap between MIC2025 and the industries prioritised in the latest five-year plan, adopted in 2021. There is also significant cross-fertilisation between MIC2025 and the Belt and Road Initiative (BRI), the vast infrastructure project launched in 2013 with the objective of improving China's connections with the rest of the world, including Europe. MIC2025 also synergises with other Chinese industrial and economic strategies, such as those aimed at increased innovation, digitalisation, utilisation of artificial intelligence (AI),

[26] Zenglein and Holzmann, *Evolving Made in China 2025*, 8, 12, 46.
[27] Naughton and Boland, *CCP Inc*., 14–7.
[28] Agatha Kratz et al., *Chinese FDI in Europe: 2021 Update* (Rhodium Group and MERICS, April 2022), 4, 16, https://merics.org/en/report/chinese-fdi-europe-2021-update.
[29] Zenglein and Holzmann, *Evolving Made in China 2025*, 8, 43.
[30] Richard A. Bitzinger, "China's Shift from Civil-Military Integration to Military-Civil Fusion," *Asia Policy* 16, no. 1 (January 2021): 6, https://www.rsis.edu.sg/wp-content/uploads/2022/05/Asia-Policy-16.1-Jan-2021-Richard-Bitzinger.pdf.

and global standard-setting. The goals of MIC2025 are thus intertwined with not only domestic political and economic goals but also those of China's foreign policy. Disagreement among China's political leadership concerning the most efficient way to reach the goals of MIC2025, for example, regarding inherent contradictions between promoting market mechanisms while also providing extensive state support, is likely to be more influential when policy decisions are actually being made than through complaints from abroad.[31]

Increased US-China rivalry in recent years could also entail a higher degree of targeted efforts from the Chinese state in steering investment decisions by private companies, as hitherto unsuccessful ambitions toward higher self-reliance in specific industries have become even more acute. A fresh example of this is the "Little Giants" initiative, a state-led programme for fostering new companies, especially in manufacturing, in policy-important tech industries currently characterised by a high degree of private ownership.[32]

2.2 Implications of Chinese industrial policy for the EU

Chinese industrial policy ambitions and the party state's influence over Chinese business have several implications for the EU. China is one of the EU's most important trade partners and a major supplier of various critical goods, not least related to the EU's green transition, and in many cases still a welcome source of investment. At the same time, Chinese investments are often characterised by a lack of transparency concerning the type and degree of state involvement, whether direct or indirect, and are perceived as coming with the risk of supporting state-led ambitions not necessarily in the interest of the EU. In its economic exchange with China, the EU is thus faced with the problem of having to balance economic benefits against security- and foreign-policy risks.

Chinese investments in and trade with the tech-related sectors of the EU economy have garnered increasing attention in recent years. EU exports of advanced technologies to China soared during the 2010s, in parallel with heightened risk-awareness for the unwanted technology transfers entailed by these exports. Part of the attention is due to concern among EU countries about how increased access to new technology for China's tech companies could be used as part of its military build-up. A pertinent example is how products stemming from the semiconductor industry and its crucial inputs, such as various rare minerals, have an obvious dual-use character. This fact is already reflected by EU export control legislation and by global export control regimes such as the Wassenaar Arrangement. The European tech sector is also of interest to the US, and has become part of the broader, global rivalry between the US and China. The US has increased its pressure on European political and industrial leaders to limit China's access to European technology and know-how.[33] A notable example of export controls is that of Dutch semiconductor giant ASML, which in the late 2010s and early 2020s became embroiled in US-China global tech rivalry. After the US applied pressure to the Dutch government, the export of the company's state-of-the-art chip manufacturing equipment to China has been blocked.[34]

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[31] Zenglein and Holzmann, *Evolving Made in China 2025*, 8–9, 29–30, 32, 35, 43; Cappelin, *Kinas industripolitik*, 10–1. The goals of MIC2025 have been updated and made more detailed since the launch of the strategy in 2015. As of 2018, there is a number of different policy targets regarding self-sufficiency rate, i.e., the extent to which domestic industries should replace foreign suppliers, as well as regarding global ambitions for the Chinese tech sector. For example, there are ambitious goals of an 80–100 percent self-sufficiency rate by 2025 or 2030 for the Chinese EV industry.

[32] Naughton and Boland, *CCP Inc*., 15–6, 19.

[33] Noah Barkin, *Export controls and the US-China tech war: Policy challenges for Europe* (Berlin, Germany: MERICS, March 2020), 5–8, https://merics.org/en/report/export-controls-and-us-china-tech-war.

[34] Siladitya Ray, "Shares Of Europe's Most Valuable Tech Firm Fall Amid New U.S.-Led Efforts To Restrict Chip Exports To China," *Forbes*, 30 June, 2023, https://www.forbes.com/sites/siladityaray/2023/06/30/shares-of-europes-most-valuable-tech-firm-fall-amid-new-us-led-efforts-to-restrict-chip-exports-to-china/.

However, the EU response to US pressure has been mixed. While there is a broad transatlantic consensus on the need to safeguard security and certain foreign-policy interests, such as preventing Western technology ending up in the hands of the Chinese military and/or defence industry, there remains disagreement on the appropriate means and their scope. For instance, whether export controls are an efficient means of stopping Chinese technological and, by extension, military ambitions, or if such measures pose a threat to the supply chains and innovativeness of European companies, is still a subject of debate. Even if it can be argued that EU member states, as well as the European Commission, have become increasingly sceptical of China, not everyone agrees on the necessity of impeding overall Chinese technological progress. Moreover, the EU private sector will likely want to continue seeking economic advantages from mutual investment and trade with China. In some cases, there is also scepticism regarding US ulterior motives, namely that the perceived purpose behind certain attempts to ostensibly curb China's influence over European companies is to benefit the US domestic industry at the expense of others.[35]

The same accusation could naturally be levelled against certain European political actors, as they are sometimes perceived to be blocking investments in tech companies based on local or national economic interests rather than conventional security concerns such as the risk of leaking sensitive information or dual-use technologies. However, it is not only countries such as China and Russia that perceive economic matters as an intrinsic part of national security; this is also true for the EU and, for example, the US and Japan, even if there are different perspectives on what is within and outside the scope of economic security.[36]

[35] Barkin, *Export controls and the US-China tech war*, 5.
[36] See, for example, Jun Osawa, *How Japan Defines Economic Security* (Washington, DC: Wilson Center, 2023), https://www.wilsoncenter.org/publication/how-japan-defines-economic-security; European Commission, "An EU approach to enhance economic security," press release, 20 June, 2023, https://ec.europa.eu/commission/presscorner/detail/en/IP_23_3358.

3 Critical raw materials

This chapter lists a number of metals and minerals of crucial importance to the sectors studied in this report, namely the semiconductor and EV industries and the energy sector, of which China is the main supplier. It also discusses the EU's geoeconomic risks associated with China's supply-chain dominance.

The chapter illustrates that China's share of supply varies for different raw materials, but rare-earth elements are a prominent example of the EU's dependence upon China. In addition, taking into account China's control over global supply chains for numerous critical raw materials, the EU's dependence upon China becomes even more pronounced, and potentially leading to various chokepoints. The importance of access to certain raw materials to fulfil the EU's industrial policy targets related to the green transition makes it vulnerable to Chinese geoeconomic measures, such as embargos and price manipulation. At the same time, in some cases, it would be plausible for the EU to reduce its current dependence on China. Moreover, China might hurt its own industries' supply chains by indiscriminately targeting the EU and its allies with geoeconomic measures.

3.1 Chinese raw material exports to the EU

In March 2023, the European Commission presented its Critical Raw Materials Act, a regulatory proposal aimed at increasing the security of supply of certain materials deemed necessary for the EU's strategic ambitions, stipulated in such concepts as "the green and digital transition" and "strategic autonomy." The act is part of the European Green Deal. Based on economic importance and supply risk, the latest version of the policy proposal identifies 34 different metals and minerals as Critical Raw Materials (CRM), out of which 16 are so-called Strategic Raw Materials (SRM). The European Commission judges SRMs as being of special importance for the EU's strategic sectors, including the semiconductor and EV industries, as well as the energy sector.[37] Many of the raw materials the EU identifies as having critical or strategic value also have broader, global importance, not least for the great power competition between the US and China.[38]

The Critical Raw Materials Act is aimed at developing all stages of the EU domestic value chain for the supply of SRMs, including capacity for extraction, processing and recycling. Furthermore, the act proposes SRM import diversification as well as stockpiling.[39] Whether the European Commission's initiative will prove successful or not is unclear. Nevertheless, motivating factors behind the act include the perceived risks of geopolitical spillover effects on critical supply chains together with a lack of supplier diversification for certain materials. China is at the centre of these issues.

Currently, the EU is to a large degree import-dependent when it comes to many of the crucial upstream inputs, in terms of metals and minerals, to the EU's strategic sectors, and China is often the main supplier. In 2023, China was identified as the largest supplier to the EU for 10 of 34 CRMs, either in the extraction or the processing stage. Moreover,

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[37] Guillaume Ragonnaud, *Critical raw materials act* (Brussels, Belgium: European Parliamentary Research Service, May 2023), 1–2, 4, https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2023)747898; European Commission, *ANNEXES to the Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020* (Brussels, Belgium: European Commission, March 2023), 1–4, https://eur-lex.europa.eu/resource.html?uri=cellar:903d35cc-c4a2-11ed-a05c-01aa75ed71a1.0001.02/DOC_2&format=PDF. The SRMs are the following: bismuth, boron (metallurgy-grade), cobalt, copper, gallium, germanium, lithium (battery-grade), magnesium metal, manganese (battery-grade), natural graphite (battery-grade), nickel (battery-grade), platinum group metals, rare-earth elements for magnets, silicon metal, titanium metal, and tungsten.

[38] See, for example, Niklas H. Rossbach, *Sällsynta metaller och stormaktsrivalitet: En översikt om nya strategiska resurser och risken för råvarukonflikter*, FOI-R--5478--SE (Stockholm, Sweden: Swedish Defence Research Agency, June 2023), https://www.foi.se/rest-api/report/FOI-R--5478--SE.

[39] Ragonnaud, *Critical raw materials act*, 6–9.

out of 16 SRMs, seven have China as their main source: bismuth, gallium, germanium, rare-earth elements, magnesium, natural graphite, and tungsten.[40] Table 2 lists the metals and minerals identified as SRMs in 2023, and for which China is the EU's main source. Table 2 also shows China's global supply share for the listed SRMs, which gives an indication of the EU's potential for supplier diversification.

Table 2. EU SRMs in 2023 with China as main supplier

SRM	Part of value chain	EU import reliance (%)	China's share of total supplies to the EU (%)	China's global supply share (%)	Selected end-products
Bismuth	Processing	71	65	70	Solid rocket propellant, low melting point alloys
Gallium	Processing	98	71	94	Semiconductors, photovoltaic cells
Germanium	Processing	42	45[41]	83	Optoelectronics
Rare-earth elements (for magnets)[42]	Processing	100	100/85[43]	100/85	Permanent magnets for electric motors, batteries, catalysts
Magnesium	Processing	100	97	91	Lightweight alloys, e.g., for automotives, electronics
Natural graphite (battery-grade)	Extraction	99	40	67	Batteries
Tungsten	Processing	80	32	86	Alloys for defence technology and electronics

Sources: Grohol and Veeh, *Study on the Critical Raw Materials for the EU*, 23, 26–28, 47–50; European Commission, *ANNEXES to the Proposal*, 1.

The sections below provide examples of the connection between certain critical raw materials mainly imported to the EU from China and the specific industries studied in the following chapters of this report. However, it should be noted that many CRMs and SRMs are used across the EU's strategic sectors and that the selected end-products in Table 2 are not exhaustive. For example, the semiconductor industry is also to some extent dependent on certain rare-earth elements.

3.1.1 Semiconductor industry

Table 2 lists several SRMs that constitute inputs to the semiconductor industry, namely processed gallium, germanium, tungsten and magnesium, for which China is currently the EU's main supplier. Bismuth also has some actual or potential uses within the semiconductor industry. There are other examples of CRMs that are critical to the semiconductor industry that, on a global scale, are mainly extracted or processed in

[40] Grohol and Veeh, *Study on the Critical Raw Materials for the EU*, 26–8. On a global level, China's importance as a raw material supplier is even greater: the largest supplier to 21 out of 34 CRMs is China.

[41] As reported in Grohol and Veeh, *Study on the Critical Raw Materials for the EU*, 40, 48. Inconsistencies are due to data limitations.

[42] Rare-earth elements are a group of 17 different metals, but the European Commission lists only 7 out of 17 as SRMs, based on their use in magnet production. These are neodymium, praseodymium, terbium, dysprosium, gadolinium, samarium and cerium.

[43] The European Commission's list of rare-earth elements that are SRMs can be divided into two groups: heavy rare-earth elements (HREE) and light rare-earth elements (LREE). On average, 100 percent of HREE and 85 percent of LREE imported to the EU come from China. These numbers are the same for China's global share of HREE and LREE supply. HREE that are also SRMs include dysprosium, gadolinium and terbium. LREE SRMs include neodymium, praseodymium, samarium and cerium.

China, but for which the EU currently has other major sources. Such CRMs include arsenic (Belgium is its main source) and silicon metal (Norway, France).[44]

3.1.2 Electric vehicle industry

The EU's EV industry likewise depends on China for certain raw materials, not least for the production of batteries and magnets. Table 2 lists several SRMs for which China is the EU's main source, namely processed rare-earth elements and magnesium, as well as natural graphite extraction.[45] Furthermore, cobalt is another SRM and an important input to the EV industry, not least for batteries. Even though trade data for cobalt is subject to confidentiality, the EU likely depends on importing cobalt that is extracted in the Democratic Republic of Congo and then processed in Finland and Belgium.[46] However, China is a considerable stakeholder in the Congolese mining industry, representing around two-thirds of total production. The EU is thus likely to be more or less dependent on cobalt mined by Chinese companies.[47] China's control over the cobalt supply chain is illustrated by the fact that China represents most (60 percent) of global cobalt-processing capacity.[48]

Other CRMs with special relevance to the EV industry, which are dominated by China on a global scale, include nickel, lithium, scandium and coking coal. Battery-grade nickel and lithium are among the SRMs. As for nickel, Indonesia and China are the single largest global actors in extracting and processing it, respectively. However, the EU has a diversified supply of nickel, with Finland as the largest supplier in the extracting stage and Russia in the processing stage.[49] At the same time, Chinese investments in the Indonesian nickel industry might entail a larger role for China in the future.[50] Global supply of scandium is dominated by China, followed by Russia, but the EU's primary source is the UK. The EU's supply of coking coal largely comes from within the union; Poland and Germany are the single largest suppliers of extracted and processed coking coal. However, China dominates the global market for both extraction and processing. As for lithium, the EU's primary source of processed lithium by far is Chile, which is also the second largest lithium extractor globally after Australia. At the same time, China represents more than half of the global lithium-processing capacity.[51]

3.1.3 Energy sector

Moreover, China has significant control over the supply chain for the minerals necessary for renewable energy equipment, such as solar- and wind power. Apart from gallium, for which the EU is dependent upon Chinese imports, China also has influence over the global supply of silicon metal. Both of these are important for the semiconductor industry and for solar panel production.[52] However, in the energy sector, the EU's greatest import dependencies vis-à-vis China are probably in the extraction and processing of various rare-earth elements, as shown in Table 2, above. For example, wind-turbine production requires neodymium, praseodymium, dysprosium and terbium.[53]

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[44] Grohol and Veeh, *Study on the Critical Raw Materials*, 36, 47–9, 83.
[45] China also dominates the graphite-processing segment on a global scale, even though trade data for refined graphite shipped to the EU is unavailable, see IEA, *Global Supply Chains of EV Batteries* (International Energy Agency, July 2022), 27, 29, https://www.iea.org/reports/global-supply-chains-of-ev-batteries.
[46] Grohol and Veeh, *Study on the Critical Raw Materials*, 38, 47, 10, 81, 108.
[47] Carina Gunnarson and Olivier Milland, *Afrika och kapplöpningen om strategiska resurser,* FOI Memo 8179 (Stockholm, Sweden: Swedish Defence Research Agency, May 2023), 3, https://foi.se/rapportsammanfattning?reportNo=FOI%20Memo%208179.
[48] Grohol and Veeh, *Study on the Critical Raw Materials*, 81.
[49] Grohol and Veeh, *Study on the Critical Raw Materials*, 4, 96, 111–2; European Commission, *ANNEXES to the Proposal*, 1.
[50] Agnes Chang and Keith Bradsher, "Can the World Make an Electric Car Battery Without China?" *New York Times*, 16 May, 2023, https://www.nytimes.com/interactive/2023/05/16/business/china-ev-battery.html.
[51] Grohol and Veeh, *Study on the Critical Raw Materials*, 4, 47, 81–2, 87, 90, 108, 111–2.
[52] Grohol and Veeh, *Study on the Critical Raw Materials*, 49, 109.
[53] Rossbach, *Sällsynta metaller och stormaktsrivalitet*, 34.

3.2 Geoeconomic risks

China's dominant global market position for a variety of critical raw materials, many of which are crucial inputs for tech-related industries, is of significance for China's ability to exercise geoeconomic measures, including against the EU. In July 2023, China's willingness to utilise its raw material dominance was illustrated by the Chinese state's announcement that export controls would be imposed upon gallium and germanium, a move that can be seen as a response to the various export controls on semiconductor equipment implemented by the US and its allies in recent years. Even though the US is likely to be the main target, the EU is affected one way or another and also risks being exposed to targeted measures in the future.[54] On that note, it appears that Sweden has already been targeted by such a measure, as Swedish battery companies have felt the impact of plummeting graphite imports from China since 2020. The alleged reason is a halt in granting licenses for exporting graphite to Sweden.[55]

However, mineral market dominance does not necessarily equal market monopoly. China's ability to leverage its current position in the tech supply chain might be potent in the short run and in some cases, but it is not absolute. China does not control the entire range of materials used in conjunction with gallium and germanium. Moreover, Chinese export controls targeting EU tech industries upstream might hurt China's own tech industry further downstream; various sectors of the Chinese economy, such as energy, telecom, and the EV industry, are dependent on foreign-sourced power semiconductors, currently exempt from US chip-related export controls. In the long-term perspective, there are also ways for European countries and the US to circumvent China's mineral-related export controls to some extent, for example, by recycling other materials or by rebuilding historical extraction and processing capacity.[56] The greatest leverage China has against the EU in the realm of critical and strategic raw materials is probably its role as a supplier of processed rare-earth elements, without which the prospects for the EU's green ambitions seem bleak.

Although the main EU supplier of a significant share of the SRMs identified by the European Commission is China, there are also many SRMs that are mainly sourced from other countries. However, it does not necessarily follow that the EU is not also, to some extent, dependent upon China for those SRMs, or CRMs. A case in point is cobalt, which is primarily mined in the Democratic Republic of the Congo but largely by Chinese companies. It is seldom enough to identify the first-tier supplier of a certain item in order to establish the degree of dependency towards a certain country. Likewise, even though the EU has limited direct dependencies on China when it comes to, for example, scandium, lithium, nickel or coking coal, there are indirect dependencies due to the structure of global supply chains. China has invested heavily in critical raw materials across the world and now dominates much of the global market for both unprocessed and processed metals and minerals.[57] Consequently, China has the means, for example, to manipulate overall supply and market prices. China's role as a global supplier can thus be of direct or indirect relevance to the EU, even in cases where China is not the main EU supplier.

Another example of the importance of China's dominant role as a global supplier of certain critical raw materials and the implications for the vulnerability of the EU towards China is provided by the case of Silmet, an Estonian company that processes rare earths. Silmet is an exception when it comes to the EU's otherwise unimpressive role within rare-earth processing, a market dominated by China. However, Silmet's Canadian parent company, Neo Performance Materials, has a history of financial and personal ties to the Chinese state, including the PLA, while also locating production in China and being

[54] John Seaman, *China's Weaponization of Gallium and Germanium* (Paris, France: French Institute of International Relations, July 2023), 1, https://www.ifri.org/en/publications/briefings-de-lifri/chinas-weaponization-gallium-and-germanium-pitfalls-leveraging.
[55] "Why is China blocking graphite exports to Sweden?" *Economist*, 22 July, 2023, https://www.economist.com/business/2023/06/22/why-is-china-blocking-graphite-exports-to-sweden.
[56] Seaman, *China's Weaponization of Gallium and Germanium*, 2–4.
[57] See, for example, IEA, *Critical Minerals Market Review 2023* (International Energy Agency, July 2023), https://www.iea.org/reports/critical-minerals-market-review-2023.

dependent upon the Chinese market for a large portion of its revenue. Silmet, through its parent company, is thus vulnerable to various kinds of pressure from China, which in turn could exacerbate supply-chain issues for rare-earth elements within the EU.[58]

[58] Frank Jüris, *China and Rare Earths: Risks to Supply Chain Resilience in Europe* (Tallinn, Estonia: International Centre for Defence and Security, May 2023), 1–11, https://icds.ee/en/china-and-rare-earths-risks-to-supply-chain-resilience-in-europe/.

4 Semiconductor industry – Design, manufacturing and inputs

This chapter enumerates a number of EU semiconductor companies acquired by Chinese investors, followed by a walk-through of the pattern of Chinese state involvement. In relation to the acquired companies, there is also a discussion of dual-use potential, alignment with Chinese industrial-policy goals, as well as geoeconomic risks for the EU.

The chapter illustrates how there have been Chinese investments across the semiconductor value chain, that the Chinese state's involvement has been prevalent, and that the investments contribute to various MIC2025 goals. Geoeconomic risks mainly concern the potential for important technology transfers, especially of dual-use technologies, and how sensitive know-how might end up fuelling China's military capabilities. Another risk is that of contributing towards the competitiveness and self-sufficiency of the Chinese semiconductor industry, with potential synergy effects for its EV industry and energy sector. If China manages to establish chokepoints in certain product or supply chain segments, this could have negative geoeconomic implications for the EU.

4.1 Chinese FDI in the EU

China remains dependent on advanced semiconductor components from abroad, especially to achieve its policy goals regarding the self-reliance and technological superiority of its domestic tech industry. Semiconductors can be seen as one of the "foundational technologies" for China's tech ambitions and an important pillar of "next-generation IT," one of the ten tech industries emphasised in MIC2025. Moreover, as suggested above, the Chinese state actively encourages Chinese companies to invest in accordance with industrial-policy goals. The National Integrated Circuit Industry Investment Fund (also known as the "National IC Fund" or the "Big Fund") is a key institution connected to China's goals for the semiconductor industry.[59]

One way to describe the semiconductor value chain is to divide it into four different production steps: chip design, front-end manufacturing (also known as wafer fabrication), back-end manufacturing (also known as assembly, test, and packaging), and end production, that is, when the chips from upstream are integrated into finished electronics. In addition, there are various inputs that are crucial to the different steps in the value chain, such as design software, IP, tools and equipment, chemicals, and wafers.[60] Furthest upstream, the semiconductor industry is also dependent on the extraction and processing of various minerals, as illustrated in Chapter 3, above.

During the past decade or so, a number of semiconductor companies within the EU have come under Chinese ownership. There are also cases where companies have been sold onwards, with non-Chinese entities as the ultimate beneficiaries. In other cases, the ultimate beneficiary has changed from one Chinese entity to another. At the time of writing, Table 3, below, lists 15 Chinese-owned companies that focus on Chinese FDI directed toward chip design, front-end and back-end manufacturing, as well as inputs thereof, in the earlier stages of the semiconductor value chain. The listed acquisitions were in Finland, France, Italy, the Netherlands, and Sweden. For the methodology and references represented by Table 3, see Appendix A.

[59] Zenglein and Holzmann, *Evolving Made in China 2025*, 10, 20–1, 44, 69.

[60] For an overview of the relation between certain inputs and certain steps of the production process, see, for example, Lee and Kleinhans, *Mapping China's semiconductor ecosystem,* 7. End production is here treated as a monolith, but in practice there are different types and tiers of end production, including for example electronic manufacturing services (EMS) and original equipment manufacturers (OEM). Some EMS and OEM companies have certain production capabilities that can be defined as back-end manufacturing.

Table 3. Selected cases of Chinese investments in the EU semiconductor industry

Country	Company name	Chinese investor	Type of investment (degree of ownership, %), year of investment	Example products and end markets (part of value chain)
Finland	Prism Microwave	Tongyu Communication	Acquisition of equity (100), 2016	RF filtering solutions, e.g., for telecom (back-end manufacturing)[i]
Finland	Okmetic	NSIG	Acquisition of equity (100), 2016	150–200 mm silicon wafers, e.g., for MEMS and sensors (input to front-end manufacturing)[ii]
Finland	OptoFidelity	Changyuan Group	Acquisition of equity (100), 2017	Testing solutions for chips and PCBs (inputs for back-end manufacturing)[iii]
Finland	Beneq	SRI Intellectual	Acquisition of equity (100), 2018	ALD equipment, e.g., for compound semiconductors and MEMS (inputs for front-end manufacturing)[iv]
France	Linxens	Ziguang Liansheng	Acquisition of equity (100), 2018	Microconnectors, RFID antennas, e.g., for telecom (chip design, front-end manufacturing)[v]
France	Asteelflash	Universal Scientific Industrial (Shanghai)	Acquisition of equity (100), 2020	PCB assembly, e.g., for automotives, defense, telecom (back-end manufacturing)[vi]
Italy	Lfoundry	Wuxi Xichanweixin Semiconductor[vii]	Acquisition of equity (100), 2019[viii]	Analog and mixed-signal technology, e.g., for automotives, RF, optoelectronics (110–150 mm wafer fabrication, front-end manufacturing)[ix]
Italy	Lumentum (subsidiary)	Advanced Fiber Resources (Zhuhai)	Acquisition of assets (100), 2019	Lithium niobate optical components, e.g., for telecom (front-end and back-end manufacturing)[x]
Netherlands	Ampleon	Jianguang Asset Management (JAC Capital)	Acquisition of assets (77), 2015[xi]	RF power, including compound (GaN) tech, e.g., for telecom and military (front-end and back-end manufacturing)[xii]
Netherlands	Nexperia	Wingtech Technology[xiii]	Acquisition of equity (100)[xiv], 2019	Diodes and power semiconductors, e.g., for automotives (front-end manufacturing)[xv]
Netherlands	Anteryon	Jingfang Optoelectronics (WLOPT)	Acquisition of equity (73), 2019[xvi]	Optical sensors and components (inputs to front-end and back-end manufacturing)[xvii]
Sweden	Imego	Imego AB (HK) Co Ltd[xviii]	Acquisition of equity (100), 2014[xix]	MEMS sensors (chip design)[xx]
Sweden	Silex Microsystems	GAE[xxi]	Acquisition of equity (98), 2015	MEMS (200 mm wafer fabrication, front-end manufacturing)[xxii]
Sweden	Fineline Nordic	Fineline Global, Shenzhen Fastprint[xxiii]	Acquisition of equity (75), 2015[xxiv]	PCB, e.g., for automotives, telecom, military (back-end manufacturing)[xxv]
Sweden	CADint Sweden	Fineline Nordic,[xxvi] Shenzhen Fastprint	Acquisition of equity (-)[xxvii], 2022	PCB, EDA/CAD design software (back-end manufacturing and inputs thereof)[xxviii]

Sources: Company websites; Datenna, “China-EU FDI Radar”; news articles; Almén, *Kinesiska investeringar i Sverige*.

It is also important to note that some of the acquired companies have kept expanding, either horizontally or vertically, through the acquisition of other companies. Fineline Nordic’s (previously Macer Sweden) acquisition of CADint Sweden in 2022 is one example. Such acquisitions are harder to map since they often do not receive as much media attention as the initial acquisition, that is, when the Chinese ownership of the company was first established. It can also be hard to determine the source of the decision

to expand from within the corporate structure. While this underscores the difficulty of mapping investment strategies and the extent of Chinese ownership, it is important to note that business expansion through the acquisition of other companies is not necessarily by itself undertaken for geoeconomic purposes.

Nevertheless, many of the acquisitions listed in Table 3, above, have been made by state-affiliated Chinese investors. The aforementioned National IC Fund has been a key actor for Chinese semiconductor investments in the EU. For instance, the National IC Fund funded the 2015 acquisition of Swedish semiconductor foundry Silex, specialising in microelectromechanical systems (MEMS), with the nominally private but state-affiliated Chinese firm, NavTech, as the current ultimate beneficiary.[61] Silex's manufacturing technology has since been exported to China, albeit seemingly in accordance with Swedish export control regulations regarding dual-use technologies, through a plant funded by the National IC Fund, in an industrial park organised by the Chinese state.[62] The National IC Fund is also indirectly a minority stakeholder in at least two other companies listed in Table 3: Anteryon, in the Netherlands, and Linxens, in France.[63]

Furthermore, in 2016, the Chinese company National Silicon Industry Group (NSIG) acquired the silicon wafer manufacturer, Okmetic, in Finland.[64] Together with other Chinese investors, the National IC Fund established NSIG in 2015 as a holding company for semiconductor investments.[65] In May 2022, NSIG announced that Okmetic will increase its wafer-production capacity in Finland through the construction of a new plant.[66] NSIG also has a minority share in the French semiconductor company Soitec.[67] In fact, the current president of NSIG used to be the CEO of Semiconductor Manufacturing International Corporation (SMIC), China's largest semiconductor foundry.[68] SMIC is partly state-owned, with the National IC Fund as one of its shareholders.[69] SMIC was behind the original acquisition of the Italian chip foundry, Lfoundry, back in 2016.[70] However, as seen in Table 3, Lfoundry is now majority-owned by Wuxi Xichanweixin Semiconductor, a company whose state affiliation has not been identified here.

Chinese state actors other than the National IC Fund have also been involved in Chinese investments in the EU semiconductor industry. In 2018, the Chinese company, SRI Intellectual, with Guohua Military-Civilian Integration Industry Development Fund and SASAC as ultimate beneficiaries, acquired Beneq, a Finland-based provider of atomic-

[61] OECD, *Measuring distortions in international markets: The semiconductor value chain*, OECD Trade Policy Papers No. 234 (Organisation for Economic Co-operation and Development, December 2019), 45, https://www.oecd-ilibrary.org/trade/measuring-distortions-in-international-markets_8fe4491d-en. NavTech allegedly has the Chinese air force, the PLAAF, as one of their customers; see, for example, Emily Feng, "How China acquired mastery of vital microchip technology," *Financial Times*, 29 January, 2019, https://www.ft.com/content/7cfb2f82-1ecc-11e9-b126-46fc3ad87c65.

[62] Feng, "How China acquired mastery of vital microchip technology"; Birgitta Forsberg, "Staten sålde spjutspetsbolag till Kina – under radarn," *Svenska Dagbladet*, 18 December, 2018, https://www.svd.se/a/21Od8R/staten-salde-spjutspetsbolag-till-kina-under-radarn.

[63] "The Acquisition of Anteryon," Datenna, 1 June, 2022, https://www.datenna.com/articles/the-acquisition-of-anteryon*"*; "The Acquisition of Linxens," Datenna, 11 July, 2022, https://www.datenna.com/articles/the-acquisition-of-linxens.

[64] Mikael Mattlin, "Kanariefågeln som tystnade. Finlands *gestalt shift* om kinesiska investeringar," *Internasjonal Politikk*, 78, no. 1 (February 2020): 59, https://tidsskriftet-ip.no/index.php/intpol/article/view/1797.

[65] "National Silicon Industry Group was established to promote the development of silicon material industry," NSIG, 11 November, 2015, http://nsig.com/en/news/2.

[66] Anne Kauranen, "Chinese NSIG's Finnish unit to build $422 million silicon wafer plant," *Reuters*, 10 May, 2022, https://www.reuters.com/technology/chinese-nsigs-finnish-unit-build-422-mln-silicon-wafer-plant-2022-05-10/.

[67] Datenna, *China-EU FDI Radar*; Ridha Loukil, "Pourquoi le fonds chinois NSIG abaisse sa participation dans Soitec sous le seuil de 10%," [Why the Chinese fund NSIG lowers its share in Soitec below the threshold of 10 percent] *L'Usine Nouvelle,* 16 March, 2023, https://www.usinenouvelle.com/article/pourquoi-le-fonds-chinois-nsig-abaisse-sa-participation-dans-soitec-sous-le-seuil-de-10.N2111841.

[68] "About Us," NSIG, accessed 31 July, 2023, http://nsig.com/en/about.

[69] OECD, *Measuring distortions in international markets*, 53.

[70] Datenna, "China-EU FDI Radar."

layer deposition (ALD) equipment.[71] The same year, Ziguang Liansheng, owned by Tsinghua Unigroup, acquired French chip manufacturer Linxens. Tsinghua Unigroup is ultimately owned by China's Tsinghua University, under the Ministry of Education. The year after, in 2019, Linxens announced plans for a major plant construction in Tianjin, China.[72] Reportedly, the construction of the plant has already been completed.[73]

Chinese state actors have been involved in all of the investments in the Dutch semiconductor industry listed in Table 3. In 2015, the Dutch semiconductor company, NXP Semiconductors, divested its radio-frequency (RF) power business to a Chinese investor, Jianguang Asset Management (JAC Capital), which named its new subsidiary Ampleon. JAC Capital is owned by a state-owned investment company, China Jianyin Investment (JIC), and the ultimate beneficiary appears to be China's State Council.[74] The following year, in 2016, NXP Semiconductors made another divestment to the same investors, which resulted in a new company, Nexperia.[75] In 2019, Nexperia was sold to a new Chinese investor, partially state-owned Wingtech Technology, with SASAC as one of its ultimate beneficiaries. [76] Furthermore, in 2019, Chinese company Jingfang Optoelectronics (abbreviated as WLOPT), together with a Dutch investment company, acquired optical components manufacturer Anteryon. However, WLOPT is ultimately owned by a Chinese government entity, Suzhou Industrial Park, through a scheme of state-controlled investment funds.[77]

The cases listed above suggest that the Chinese state has heavily engaged in semiconductor investments across the EU, through funding and/or ownership. Majority state ownership, albeit sometimes through multiple layers of, for example, holding companies and investment funds, is not uncommon. However, the likelihood of Chinese state affiliation when it comes to semiconductor investments is *a priori* high, whether in EU countries or elsewhere. For one, there is a designated investment fund, the National IC Fund, whose raison d'être is to promote the development of China's semiconductor industry as part of the goals of MIC2025. Through generous funding, this fund provides incentives for Chinese semiconductor companies to make investments not only domestically but also abroad.

Furthermore, the Chinese semiconductor industry continues to consolidate, with a decreasing number of actors. Except for smaller companies, most semiconductor companies in China have the state as shareholder.[78] It follows that outbound semiconductor investments are also likely to be done by partially or wholly state-owned companies. China's state organ for managing SOEs, SASAC, which reports to the State Council, is the ultimate beneficiary of such acquisitions. The Chinese state has been interested in developing the domestic semiconductor industry for a long time, dating back to the Mao

[71] "The Acquisition of Beneq," Datenna, 24 October, 2023, https://www.datenna.com/articles/acquisition-of-beneq.
[72] Datenna, "The Acquisition of Linxens." Ziguang Liansheng is owned by Tsinghua Unigroup, which in turn is owned by Tsinghua University's holding company.
[73] "Tech company completes plant construction in China's Tianjin," *Xinhua*, 13 July, 2020, http://www.xinhuanet.com/english/2020-07/13/c_139209124.htm.
[74] "Beijing Jianguang Asset Management Co., Ltd. (a subsidiary of JIC) completes acquisition of NXP Standard Product Business," JIC Group, 7 February, 2017, http://en.jic.cn/news/4667.html; "The Acquisition of Ampleon," Datenna, 30 May, 2022, https://www.datenna.com/articles/the-acquisition-of-ampleon. Information from a Chinese government website suggests that Wuxi Xichanweixin Semiconductor acquired Ampleon in July 2022, see "超百亿并购，跃升全球第二！" [After acquisition worth more than 10 billion, now ranks world second!] 无锡国家高新技术产业开发区（无锡市新吴区）[Wuxi National Hi-Tech Industrial Development Zone (Xinwu District)], 27 July, 2022, https://www.wnd.gov.cn/doc/2022/07/27/3719935.shtml. However, Ampleon's website does not provide information about a recent ownership transition.
[75] JIC Group, "Beijing Jianguang Asset Management."
[76] "New ownership opens up opportunities for Nexperia," Nexperia, 24 December, 2019, https://www.nexperia.com/about/news-events/press-releases/new-ownership-opens-up-opportunities-for-nexperia; Sam Shead, "The Chinese firm behind the acquisition of the UK's largest chip plant is state backed, analysis shows," *CNBC*, 7 July, 2021, https://www.cnbc.com/2021/07/07/nexperia-owner-wingtech-is-backed-by-chinese-government-analysis-says.html.
[77] Datenna, "The Acquisition of Anteryon."
[78] OECD, *Measuring distortions in international markets*, 52.

era. This is still true in the 21st century, even though there has been a shifting focus between different parts of the semiconductor value chain over the years. Moreover, the type of state involvement has changed towards more focused, targeted funding rather than direct intervention.[79] However, the investment focus of bureaucrats within the Chinese state has not always overlapped, nor can it be expected to do so, with that of commercial actors. Perfect coordination is simply not possible.

For some of the acquired companies listed in Table 3, the degree of state affiliation of the Chinese owners or their ultimate beneficiaries has not been identified here. These include Prism Microwave and OptoFidelity, in Finland; Asteelflash, in France; Lfoundry and Lumentum's former subsidiary, in Italy; and Imego, Fineline Nordic and its subsidiary CADint, in Sweden.

It is plausible that many or most of the acquired semiconductor companies listed in Table 3, including their previous owners, managers and employees, lack detailed knowledge about how the Chinese state and Chinese commercial actors interact, as well as about Chinese industrial policies or related laws, regulations, and incentive structures. It is also often, though not always, likely that the managers and employees of the acquired companies are unaware of the possibility that the downstream impact of their products or services is, to some extent, to fuel China's military or other foreign policy ambitions. Naturally, if the company openly and explicitly identifies the defence industry or military as one of its end markets, there is no such plausible deniability. In other cases, the complexity of supply chains can entail difficulties in properly understanding the significance of individual companies or products in a broader ecosystem. This holds true not only for external observers but also for the people in the midst of it all.

However, it does not follow that these investments should be considered independent or irrelevant to the interests of the Chinese party-state. There is an overall lack of transparency from Chinese investors, and the changes in China's political economy towards more extensive and diversified mechanisms for state control suggest that nominally private companies are also under some kind of "hard" or "soft" pressure from the Chinese state. Especially in strategic sectors such as the semiconductor industry, one could even argue that private Chinese companies bear a reverse burden of proof to guarantee their autonomy.

4.1.1 Dual-use potential related to Chinese semiconductor FDI

The semiconductor industry has come to be regarded, from a national security perspective, in the EU and elsewhere, as one of the more sensitive sectors. A primary cause of concern often raised is the dual-use nature of many of the products stemming from the semiconductor industry. It is true as a general statement that the semiconductor industry is characterised by dual-use technologies, and Table 3 above includes some companies whose products may have significant dual-use potential. In some cases, the dual-use aspects of the product portfolio of companies acquired by Chinese investors are obvious and even promoted by the companies themselves. However, in other cases, it would require more detailed investigation and technical expertise to determine whether specific products have significant military applications, or if they constitute goods mainly for civilian use. While discussion of specific products is outside the present scope, certain product segments can nevertheless be addressed.

Among the examined cases of Chinese semiconductor investments are at least three companies, namely Anteryon, Lfoundry and Lumentum's former subsidiary in Italy, that are involved in the manufacturing of optical components or their inputs. It is worth noting that optoelectronics is one of the technology areas in which China is highly dependent on foreign suppliers.[80] Optoelectronics as a category serves various purposes, including as inputs in terms of various tools and equipment for chip manufacturing. Certain

[79] For a brief overview of 21st century policy initiatives for the development of the Chinese semiconductor industry, see, for example, Lee and Kleinhans, *Mapping China's semiconductor ecosystem*, 12–15.
[80] Zenglein and Holzmann, *Evolving Made in China 2025*, 24.

optoelectronics can also have direct military use in, for example, sonar systems and sensors. Another example of dual-use potential is in products involving compound semiconductors. Notably, gallium nitride (GaN) semiconductors are so-called wide-bandgap semiconductors, with characteristics useful for, among other things, military applications such as radars. A third example is RF devices, which have numerous civilian uses, not least in telecom, but are also associated with military applications such as radars and electronic warfare. A fourth example is MEMS, used for civilian purposes in, for example, Internet of Things (IoT) devices, but also have military applications such as precision-guided munition.[81]

Dual-use utility also varies across the semiconductor value chain and within specific segments. For example, both advanced and less-advanced chip manufacturing are likely to result in dual-use products. Certain new technologies, such as military-use AI, require access to advanced chip manufacturing, but military equipment across the world still relies heavily on less-advanced chip manufacturing.[82] This suggests that foundry companies such as Silex and Lfoundry, whose chip manufacturing could at first glance be categorised as less advanced, might still have significant capabilities to produce dual-use chips. Additionally, segments of the value chain whose direct outputs do not have military applications, such as chip-manufacturing equipment or chip design, can still be of interest from a national-security perspective due to the dual-use nature of the downstream products and applications.[83] This is relevant in the context of the acquisition of Beneq, a provider of chip-manufacturing equipment, by its ultimate beneficiary owner, a Chinese state-owned development fund that has the purpose of promoting China's strategy of military-civil fusion.[84]

Dual-use potential also varies within each part of the value chain and different product segments, depending on a multitude of different characteristics, such as the degree of resistance to heat and radiation, pertaining to specific products. In summary, the line between what is and what is not to be considered dual-use is thus blurry, which also helps to explain why, when it comes to interpreting product applications and export control regulation, conflicts can arise between officials and private companies.

4.1.2 Alignment with Chinese industrial-policy goals

Improving any synergies between China's civilian and defence industries is an important component of China's technological ambitions and industrial policy goals. It follows that it is a crucial question whether Chinese semiconductor FDI in the EU has helped China's defence industry obtain access to previously unfamiliar or inaccessible know-how and technologies. Unfortunately, determining whether individual investments in EU semiconductor companies actually have the potential to fill existing technology gaps within the Chinese defence industry would require further investigation, and access to information that is not openly available. It should also be remembered that export-control regulations, which vary somewhat between each country targeted by Chinese semi-conductor investments, may or may not successfully prevent the transfer of dual-use technologies. However, it seems unlikely that it is possible to achieve a perfect national quarantine, so to speak, of know-how that directly or indirectly may facilitate China's production of dual-use technologies. For instance, it is likely out of bounds for demo-cratic states in the EU to completely prevent engineers or other key personnel in Chinese-owned semiconductor companies from exploring new career opportunities within their company's organisation, for example at a new factory in China. Nor does it seem possible to ascertain whether such individuals, while abroad, restrict the spread of their expertise within the limits of export control regulations. Taking into account such

[81] Hwaiyu Geng, *Semiconductor Manufacturing Handbook, Second Edition* (New York: McGraw-Hill Education, 2018), 39; Forsberg, "Staten sålde spjutspetsbolag till Kina."
[82] Chip advancement is popularly measured in nanometers. The dividing line between advanced and less advanced (also referred to as "legacy" or "mature") chips is somewhat arbitrary, but 10 nanometers is a common reference point.
[83] Lee and Kleinhans, *Mapping China's semiconductor ecosystem*, 10–11, 25, 39–40.
[84] Datenna, "The Acquisition of Beneq."

caveats, it is still difficult to determine the degree of the contribution that Chinese investments in the EU semiconductor industry make towards China's continued military modernisation.

Leaving aside for now the question of dual-use potential, Table 3, above, lists several Chinese investments in the EU semiconductor industry that seem to be aligned with China's industrial policy goals of closing technology gaps. For example, formerly Swedish semiconductor companies Imego and Silex, as well as Finnish Okmetic and Beneq, are involved in the design and manufacture of MEMS or their inputs. MEMS, as well as wide-bandgap semiconductors touched upon above, are areas of the semiconductor industry within which breakthroughs are sought, as China's 14th Five-Year Plan, from 2021, explicitly points out.[85] It should be noted that the investments in Sweden and Finland occurred several years before the publishing of the latest five-year plan. At the same time, these specifically targeted fields (MEMS, wide-bandgap semiconductors) are not necessarily new as of 2021 and seem to remain relevant.[86]

Moreover, Okmetic's silicon wafer production capacity can by itself contribute towards higher chip self-sufficiency for China. Increased production capacity of silicon wafers has been a key aspect of government policy targets since at least 2014, given their importance as an input in chip manufacturing. This is also a part of the semiconductor value chain where US sanctions have a more limited reach.[87] China has had some success in strengthening its market position in silicon-wafer production, even though the market is still dominated by other countries. NSIG, the owner of Okmetic, has been a central actor in these efforts.[88]

The overall investment pattern for Chinese FDI in the EU semiconductor industry suggests some degree of contribution towards fulfilling the goals of MIC2025. An important element of the MIC2025 policy goals is to achieve a higher degree of self-sufficiency for the targeted industries across the value chain, not least the semiconductor industry. There have been investments in companies within the EU across the semi-conductor value chain, including in chip design, front- and back-end manufacturing, and their inputs. Investments have also been made in a variety of different product segments, including, for example, MEMS, RF, compound semiconductors, optoelectronics and printed-circuit boards (PCB). Since their acquisition, several companies have also opened manufacturing plants in China, which brings the companies closer to a huge and perhaps new market. This could also be one of the most efficient ways for the Chinese government to gain access to new technology and know-how. Even if the owner of a plant is a nominally private Chinese firm, the Chinese government could ultimately choose, at some point, to nationalise it.

At the same time, China's stated goals for the semiconductor industry are far-reaching; for example, it aims for 70 percent chip self-sufficiency before 2025. The global semiconductor industry is characterised by a high degree of international dependencies and scattered monopolies or semi-monopolies throughout the value chain, which means

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[85] Ashwin Kaja, Ting Xiang and Sean Stein, "China's 14th Five-Year Plan (2021-2025): Spotlight on Semiconductors," Covington, 26 April, 2021, https://www.globalpolicywatch.com/2021/04/chinas-14th-five-year-plan-2021-2025-spotlight-on-semiconductors/; Lee and Kleinhans, *Mapping China's semiconductor ecosystem,* 17.

[86] For example, MEMS has been officially identified as a prioritised area of chip manufacturing since at least 2014, when the Guideline for the Promotion of the Development of the National Integrated Circuit Industry, which preceded MIC2025, was announced by China's State Council. The Chinese version of the guidelines is available at, for example, 重庆两江半导体产学研基地 [Chongqing Liangjiang Semiconductor Industrial Research Base], 国家集成电路产业发展推进纲要 [Guideline for the Promotion of the Development of the National Integrated Circuit Industry], accessed 9 August, 2023, http://www.csemi.com/uploads/soft/190223/chanyeguihua/3.pdf; for English, see World Trade Organization, *Guideline for the Promotion of the Development of the National Integrated Circuit Industry*, accessed 9 August, 2023, https://members.wto.org/CRNAttachments/2014/SCMQ2/law47.pdf.

[87] Lee and Kleinhans, *Mapping China's semiconductor ecosystem,* 49–51.

[88] Jack Wu, "China boosts silicon wafer production to strengthen resilience," *DIGITIMES Asia*, 31 July, 2023, https://www.digitimes.com/news/a20230727PD202/china-nsig-silicon-wafer.html.

that 70 percent domestic self-sufficiency is extremely ambitious, even unrealistic. As a whole, China's success in fulfilling policy goals related to the semiconductor industry has varied. For instance, in 2020, the self-sufficiency rate was approximately 16 percent, rather than the projected 40 percent.[89] Even though the National IC Fund is of central importance to the development of China's semiconductor industry at home and abroad, it does not seem to have fulfilled the wishes of the country's political leadership, as illustrated by the corruption charges directed against the fund's leadership during 2022.[90] The net contribution from Chinese FDI in the EU semiconductor industry towards fulfilling the goals of semiconductor self-sufficiency is likely to be marginal, from a purely quantitative perspective, but the potential for succeeding in important technology transfers should not be neglected.

4.2 Geoeconomic risks

The most severe geoeconomic risk related to Chinese investments in the EU semiconductor industry is that of technology transfers to China, more specifically the leaking of dual-use technologies, which might end up in its defence industry and military. This risk is even more pertinent considering the high degree of Chinese state involvement in semiconductor FDI in Europe, combined with the fact that China actively promotes civil-military synergies.

Chinese FDI in the EU semiconductor industry could increase China's semiconductor competitiveness over the EU. Barring a few exceptional companies, the EU's semiconductor industry does not hold a competitive position vis-à-vis China, neither in chip design nor in front- and back-end chip manufacturing. The EU is heavily reliant on other countries, such as the US, Taiwan, and Japan. The EU's strongest card is that it is a supplier of certain important inputs to chip design and manufacturing; a notable example is the Dutch company, ASML, and its monopoly over certain advanced front-end manufacturing equipment.[91] Perhaps the latest comprehensive semiconductor industrial policy initiative from the European Commission, the European Chips Act, will result in the EU's increased competitiveness and lower vulnerability vis-à-vis China, but the Act's success is still uncertain.

As mentioned above, there are differences in dual-use potential for different parts of the semiconductor value chain. This is also the case with other geoeconomic risks, such as the potential for China to establish economic chokepoints to be used for political pressure, related to the semiconductor industry. For example, the potential to establish an economic chokepoint within the chip-design segment is typically harder, for example, due to lower barriers to entry, than in certain other segments, such as advanced front-end manufacturing. However, if the current position of the Chinese semiconductor industry within the global industry does not change radically, China's possibilities to develop a dominant position in any of these segments will be limited. China's semiconductor ambitions have also been stymied by foreign geoeconomics, as both the chip-design and chip-manufacturing companies in China have been at the receiving end of US-led export controls in recent years. China's vulnerability towards such export controls is reflective of its domestic industry's continued lack of self-sufficiency regarding important inputs, such as various manufacturing equipment.[92] Some of the acquired companies listed in Table 3, above, such as Beneq, in Finland, or Anteryon, in the Netherlands, provide chip-

[89] See for example Nigel Inkster, Emily S. Weinstein, and John Lee, "Ask the Experts: Is China's Semiconductor Strategy Working?" London School of Economics, 1 September, 2022, https://blogs.lse.ac.uk/cff/2022/09/01/is-chinas-semiconductor-strategy-working/.

[90] Eduardo Jamarillo, "After a year of corruption scandals, China's national chip fund forges ahead," The China Project, 4 January, 2023, https://thechinaproject.com/2023/01/04/after-a-year-of-corruption-scandals-chinas-national-chip-fund-forges-ahead/.

[91] Lee and Kleinhans, *Mapping China's semiconductor ecosystem,* 57.

[92] Lee and Kleinhans, *Mapping China's semiconductor ecosystem,* 11, 22–5, 34–44.

manufacturing equipment that might to some extent both increase the competitiveness of the Chinese semiconductor industry and lower its susceptibility to US sanctions.

China's global market position in the semiconductor value chain is strongest in back-end manufacturing. In 2019, China represented 38 percent of value added in back-end manufacturing.[93] It is at this stage that fabricated wafers from upstream in the manufacturing process are diced into separate chips, followed by testing and packaging. This is also when the risk of espionage is greatest, at least in terms of the possibility of manipulating individual chips. Even though China currently represents a significant share of global production capacity in this market segment, it does not seem to be enough to establish a lasting chokepoint against the EU. For instance, Taiwan and Singapore also have significant back-end manufacturing capacity.[94] That said, the EU does have dependencies on China in back-end manufacturing, which cannot be neglected. Investing in advanced packaging might also be an alternative for China to improve the competitiveness of its semiconductor industry, in light of US export controls that make Chinese advances in front-end manufacturing more difficult. On this topic, the acquisition of EU semiconductor companies (such as OptoFidelity, Fineline Nordic, and Asteelflash, listed in Table 3, above) with expertise regarding PCB manufacturing or assembly, might contribute to China's already strong position in the PCB market segment, which can be regarded as part of back-end manufacturing.[95]

It should be further emphasised that there is considerable overlap between the semiconductor industry and other sectors, such as automobiles, telecom, and energy, of the EU economy. These and other sectors manufacture end-product electronics, such as EV components, antennas, and wind turbines, and are important sources of demand for upstream semiconductors. The primary markets for the products of many semiconductor companies, including those listed in Table 3, above, are the automotive and telecom sectors. There have also been Chinese investments, including by semiconductor companies, in the EU's various semiconductor-dependent sectors. Table 3's listing of Chinese investments in the EU semiconductor industry would have been considerably longer if end-product electronics were included.[96] Furthermore, the acquisition of end-producing companies can entail gaining access to previously inaccessible suppliers, upstream, and customers, downstream.

There is thus potential for multiple synergy effects between Chinese semiconductor investments and investments in other sectors in the EU. Whether the necessary coordination capabilities exist between Chinese companies, including both private firms and SOEs, with their differences in organisation as well as business rationale, to draw advantage from such synergy effects or not is another question. To the extent that such coordination is possible, whether initiated by the companies themselves or the political authorities back in China, Chinese investments in the semiconductor industry could contribute towards policy goals associated with the other industries. Such synergies could potentially also supply China with new or enhanced geoeconomic tools in terms of being able to use other states' dependence on, for example, the Chinese EV industry as a chokepoint.

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[93] Antonio Varas et al., *Strengthening the Global Semiconductor Supply Chain in an Uncertain Era* (Boston Consulting Group and Semiconductor Industry Association, April 2021), 31, https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021_1.pdf.

[94] Lee and Kleinhans, *Mapping China's semiconductor ecosystem,* 52–6.

[95] Jan-Peter Kleinhans and John Lee, *China's rise in semiconductors and Europe: Recommendations for policy makers* (Stiftung Neue Verantwortung and MERICS, December 2021), 15–6, https://merics.org/sites/default/files/2021-12/MERICS%20SNV%20China%27s%20rise%20in%20semiconductors%20and%20Europe.pdf.

[96] For an overview of specific Chinese acquisitions within the EU in the automotive, telecom, energy, and other sectors, see Datenna, "China-EU FDI Radar."

5 Electric vehicle industry – Batteries and imported cars

This chapter provides an overview of Chinese investments in the EU's EV industry, with a focus on greenfield investments in battery plants. This overview includes a walk-through of Chinese state involvement, followed by a discussion of the alignment with China's industrial-policy goals, and an overview of recent trends in Chinese EV exports to the EU. Lastly, there is a discussion of the EU's geoeconomic risks associated with Chinese EV-related investments and exports.

The chapter illustrates that battery-plant investments done largely by Chinese private firms that operate within one of the MIC2025 strategic sectors have been a major focus for Chinese EV-related investments in the EU in recent years. The investments are made in the context of China's previous domestic industrial-policy efforts, its continued global ambitions for its EV industry, and the EU's relative openness to those investments. The EU's main geoeconomic risk from Chinese EV investments is likely that they contribute towards China's increased market monopolisation of the EV battery segment, which could end up being used as a chokepoint against the EU. The EU's green ambitions might serve to exacerbate this risk, but it is possible that it will also take measures to safeguard the competitiveness of its own industry.

5.1 Chinese FDI in the EU

In recent years, major Chinese battery companies have started expanding into the EU. In 2022, the construction of Chinese battery-plants in fact marked a shift in the trend of Chinese FDI in the EU; greenfield investments, rather than mergers and acquisitions (M&A), represented the lion's share of Chinese FDI.[97] Chinese battery companies have the prospect of representing 20 percent of European-based battery-production capacity by 2030. Thus far, the top investment has been the 100 GWh battery plant in Hungary by Contemporary Amperex Technology Co. Limited (CATL). Other significant battery-plant investments announced in recent years include a 50 GWh battery plant in Sweden, by Geely-owned Volvo Cars, in a joint venture with Swedish-owned Northvolt, and a 50 GWh battery plant in Spain, by Envision AESC. Furthermore, SVOLT Energy Technology (SVOLT) and CATL are constructing battery plants in Germany; Envision AESC is building another one in France; CALB, in Portugal; and EVE, in Hungary.[98] There have been further indications of plans by Chinese battery and/or automotive companies to invest in battery production in Europe. However, Table 4 below summarises confirmed investments as of October 2023.

Table 4. Chinese investments in EV battery plants in the EU since 2018

Target country	Chinese investor	Year of announcement	Projected capacity (GWh)
Hungary	CATL	2022	100
Spain	Envision AESC	2022	50
Sweden	Volvo (Geely)[99]	2021	50
France	Envision AESC	2021	30
Hungary	EVE	2023	28
Germany	SVOLT	2022	24
Germany	Gotion High-Tech	2022	18
Germany	SVOLT	2020	16
Portugal	CALB	2022	15
Germany	CATL	2018	14

Sources: Kratz et al., *Chinese FDI in Europe: 2022 Update*; Sebastian, "Watts the plan, Europe"; news reports.

[97] Kratz et al., *Chinese FDI in Europe: 2022 Update*, 4–6, 12.
[98] Kratz et al., *Chinese FDI in Europe: 2022 Update*, 6, 14; Gregor Sebastian, "Watts the plan, Europe – Chinese battery investments on or off?" MERICS, 31 July, 2023, https://merics.org/en/comment/watts-plan-europe-chinese-battery-investments-or.
[99] The Volvo plant is a joint venture with Swedish battery company Northvolt.

Batteries are an important input for the EV industry, but the production of batteries is itself dependent on the supply of various subcomponents and, further upstream, the materials needed for their production. There have also been Chinese investments in such segments. These include, for example, a joint venture between the Chinese company, CNGR Advanced Material, and Finnish Minerals Group to construct a precursor production plant in Finland; a planned factory in Hungary for lithium-ion battery-separator films by Chinese SEMCORP; and the acquisition of the German machinery company, Ontec Automation, by Chinese Wuxi Lead Intelligent Equipment.[100]

The Chinese state has some direct presence in Chinese battery investments in the EU. Notably, battery company CALB is partially state-owned, with a city-government entity as the largest shareholder. CALB was originally spun off from Chinese defence giant Aviation Industry Corporation of China, which also retains a minor stake.[101]

The other major Chinese battery investors, including CATL, Envision AESC, Geely, EVE, Gotion High-Tech, and SVOLT, are all private companies. However, as in other industries targeted by China's industrial-policy goals, there are incentive structures in place to promote investments by both SOEs and private companies in the EV industry. Chinese battery companies have access to beneficial state loans and other financial means, as well as, for example, cheap subcomponents provided by state-affiliated battery-material producers.[102] The international path for Chinese battery companies was paved by the Chinese state during the 2010s as part of China's industrial policy ambitions. China excluded foreign battery companies, notably from Japan and South Korea, from doing business in China between 2015 and 2019, as a way to allow domestic companies to achieve competitiveness.[103] Additionally, domestic EV-purchasing subsidies were tied to certain capacity requirements for battery producers, which were tailored to Chinese battery companies. These are just some examples of how the Chinese government deliberately created national champions through protectionist measures.[104]

In this way, by using domestic industrial policy, China has successfully expanded its share of the global EV battery market. In 2021, CATL, CALB, Gotion High-Tech, Envision AESC, and SVOLT were all among the top ten largest battery manufacturers globally, with CATL as number one and representing a third of global market share.[105]

5.1.1 Alignment with Chinese industrial-policy goals

Greenfield investment in battery plants within the EU is part of the Chinese automotive industry's broader ambitions to become the global leader in EV manufacturing. It is also part of what appears to be a broadening of the investment scope within the sector, which had previously been focusing primarily on obtaining the minerals necessary for EV production in countries outside of Europe. It is notable that Europe is the world's second-largest market for EVs, after China. Moreover, the EU battery industry is still under development and seeking investments, including from China. It also makes sense for Chinese EV producers to invest in production capacity in the EU, not only in order to reduce shipping costs, but also to avoid tariffs and to become more resistant in general

[100] Kratz et al., *Chinese FDI in Europe: 2022 Update*, 14.
[101] Edward White and Cheng Leng, "Chinese battery group spun off from missile maker falls on trading debut," *Financial Times*, 6 October, 2022, https://www.ft.com/content/d97105e3-70c7-4d31-bbd7-1a0c7ed262c6; "Top 100 arms companies, 2021," Stockholm International Peace Research Institute, accessed 7 September, 2023, https://sipri.org/visualizations/arms-industry-2022/top-100-interactive.
[102] Sebastian, "Watts the plan, Europe."
[103] Gregor Sebastian and François Chimits, "'Made in China' electric vehicles could turn Sino-EU trade on its head," MERICS, 30 May, 2022, https://merics.org/en/comment/made-china-electric-vehicles-could-turn-sino-eu-trade-its-head.
[104] Anna Holzmann, "China's battery industry is powering up for global competition," MERICS, 24 October, 2018, https://merics.org/de/kommentar/chinas-battery-industry-powering-global-competition.
[105] Chris Randall, "CATL outgrows the battery competition," *Electrive*, 8 February, 2022, https://www.electrive.com/2022/02/08/catl-outgrows-the-battery-competition/. BYD, a major Chinese EV company, was also on the top ten list of global battery manufacturers in 2021, but has so far not invested in battery plants in the EU.

to political-lobbying efforts from competitors within the EU. Furthermore, the EU is currently a more attractive market than alternatives such as the US, especially in light of recent US policy measures–most notably the Inflation Reduction Act–that make it more difficult for Chinese companies to compete in the US market.[106]

The battery-plant greenfield investments are in line with China's industrial policy goals for the EV industry, for which there is an explicit MIC2025 policy target of achieving 90 percent domestic-market share for new energy vehicles by 2030.[107] Private companies, seemingly without active coordination from Chinese state actors, are predominant among the investors. However, the Chinese state has laid the path for Chinese battery companies to become internationally competitive through domestic industrial-policy efforts. The investments should also be seen in the context of China's political system, which is characterised by a complex web of control mechanisms for the Chinese state to influence investment decisions abroad. This web is difficult to disentangle, and the specific market-distortionary impact of, for example, tax incentives and state funding in specific cases would require further investigation.

5.2 Chinese electric-vehicle exports to the EU

China is a significant import source of electrical vehicles for the EU. In 2021, China stood for 43 percent of all electric-car imports to the EU.[108] This constituted around 10 percent of total EV sales in Europe. However, the bulk of EV exports from China to the EU is derived from subsidiaries of Western companies, especially Tesla. About a third comes from Chinese-owned European carmakers, whereas Chinese domestic brands account for just a few percent.[109] In 2022, only one year later, total EV exports from China to the 27 EU member countries amounted to a new record of 371,000 cars.[110]

While China is phasing out domestic subsidies for purchasing EVs, the preconditions for increased EV sales in the EU market, where EU's own EV purchasing subsidies also come into play, remain strong. The prospects for Chinese EV exports to Europe would thus appear bright. However, the automotive industry is an important economic sector within and throughout the EU, representing about 7 percent of gross domestic product and 10 percent of jobs in manufacturing. EU protectionist measures to safeguard its regional automotive industrial base, as well as security concerns regarding potential market monopolisation by Chinese companies, mainly of the important battery-production segment, could therefore turn into a backlash for Chinese EV exports.[111]

The on-going EU anti-subsidy probe against EV imports from China is indicative of the EU's raised threat awareness. At the same time, retaliatory trade measures from the EU might damage major European automotive companies, such as Volkswagen, BMW, Mercedes-Benz and Renault; they may wish to continue reaping the advantages of low-cost production in and access to China and its market. It is noteworthy that Western companies, not least Tesla, can also benefit from preferential treatment, such as tax benefits and favourable loans, when localising their production in China. This helps to explain the attractiveness of China as an export hub for Western-made EVs. However, investments in EV manufacturing within the EU, such as Tesla's Gigafactory Berlin-Brandenburg site, might at the same time serve to counter the trend of increasing EV imports from China.[112]

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[106] Kratz et al., *Chinese FDI in Europe: 2022 Update*, 6, 12–5.
[107] Zenglein and Holzmann, *Evolving Made in China 2025*, 35.
[108] "International trade in hybrid and electric cars." Eurostat, October 2022, accessed 23 August, 2023, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_trade_in_hybrid_and_electric_cars.
[109] Sebastian and Chimits, "'Made in China' electric vehicles."
[110] Kratz et al., *Chinese FDI in Europe: 2022 Update*, 15.
[111] Sebastian and Chimits, "'Made in China' electric vehicles."
[112] Ilaria Mazzocco and Gregor Sebastian, *Electric Shock: Interpreting China's Electric Vehicle Export Boom* (Washington, DC: Center for Strategic and International Studies, September 2023), 6–8, https://www.csis.org/analysis/electric-shock-interpreting-chinas-electric-vehicle-export-boom.

5.3 Geoeconomic risks

Unlike the case of the semiconductor industry, it is not as obvious why increased Chinese dominance over the EV industry poses a geoeconomic risk and security threat to Europe. At the same time, the semiconductor industry and the EV industry are interlinked, not only since the manufacturing of EVs is dependent upon semiconductor components, but also because the industries have common dependencies upon China for certain critical minerals upstream, as shown in Chapter 3, above.

The main geoeconomic risk for the EU of Chinese investments in the EV industry would appear to be the potential for a Chinese state-led or state-supported market monopolisation of a crucial tech sector, or parts thereof. Regardless of whether the far-reaching MIC2025 goals for the EV industry are achieved or not, China is already a major actor within global EV manufacturing, even though it would be an exaggeration to call the current market position of China's EV industry a monopoly. Chinese entities represent a substantial share of global production capacity across the supply chain for EVs, notably in raw-material supply and EV-battery manufacturing. In 2022, 77 percent of global EV battery-cell production was in China, along with 70 percent and 85 percent, respectively, of cathodes and anodes, both crucial battery components. China has similar shares in the production of electrolytes and separators, other key battery components. Moreover, half of the global assembly of electric cars takes place in China.[113]

By contrast, in 2022, EV-battery manufacturers based in the EU only represented 7 percent of global production capacity. Meanwhile, the EU accounted for approximately 25 percent of global EV assembly, with Volkswagen as the largest company of European origin.[114] Increased Chinese dominance over the EV industry, backed by Chinese state aid, would have market distortionary effects that would affect the EU. Perhaps more importantly, it could give the Chinese government the ability to utilise the Chinese EV industry's control over the supply chain, especially the production of batteries and their components, as a chokepoint against the EU.[115] Given both consumer demand and the EU's green ambitions, EV demand seems unlikely to fall off soon. The EU has set a target that all new cars and vans should be zero-emission by 2035.[116] Dominance over the EV industry could thus give China an increasing opportunity to utilise such a chokepoint. Current and future successful Chinese EV-related FDI within the EU might be helpful towards that end, at least to the extent that the Chinese state is able to exert coordinated pressure on both private firms and SOEs, domestically and abroad.

On the other hand, Chinese battery-plant greenfield investments within the EU could also make it more appealing for Chinese actors in other parts of the EV supply chain to make corresponding local investments, not least in the production of battery components or the processing of critical minerals, given the potential for local synergy. If such investments were to occur, and as long as they did not exclusively function as suppliers for other Chinese companies, this could boost the EU's supply chain for domestically produced EVs. It could also potentially make it less attractive for China to use the EV industry as a geoeconomic tool for exerting pressure against the EU, as Chinese EV-related business interests in the EU would likely also suffer.[117] For instance, if China were to implement embargos on delivering certain critical raw materials or battery components to the EU, it would also have consequences for the supply chains of Chinese-owned battery plants in the EU. Chinese-owned battery plants in the EU could also

[113] Chang and Bradsher, "Can the World Make an Electric Car Battery Without China?"; IEA, *Global Supply Chains of EV Batteries*, 2, 5, 24, 33. Note that the Chinese shares of rare mineral supplies would be different if the global known and unknown mineral reserves, not only current mining capacity, were included.

[114] IEA, *Global Supply Chains of EV Batteries*, 20, 35.

[115] The risks mentioned here have previously been raised with regard to, e.g., China's control over the solar-panel industry; see, for example, John Hemmings, *Safeguarding our Systems: Managing Chinese Investment into the UK's Digital and Critical National Infrastructure* (London, UK: Henry Jackson Society, July 2017), 16, https://henryjacksonsociety.org/publications/safeguarding-our-systems/.

[116] European Commission, "Zero emission vehicles: first 'Fit for 55' deal will end the sale of new CO2 emitting cars in Europe by 2035," press release, 28 October, 2022, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_6462.

[117] Sebastian, "Watts the plan, Europe."

become the target of EU countermeasures to Chinese geoeconomics. However, considering that only a small share of the Chinese EV industry is located within the EU, accumulated investments would likely have to increase significantly before they deterred China from using the EV industry for geoeconomic purposes against the EU.

It is noteworthy that EU purchasing subsidies for EVs might be a boon for the Chinese EV industry and its growth opportunities through exports and, by extension, the Chinese state's goals for China to become a world-leading manufacturer of green vehicles. To the extent that this is true, it would also mean that the EU's EV subsidies could pose a threat to the competitiveness of the EU's own domestic automotive industry, by making it easier for market competitors in China, whether European-owned, Chinese-owned or joint ventures, to claim market share in the EU market. That said, as suggested above, the EU might choose to favour protectionist measures in order to save domestic jobs within the automotive and its support industries.[118] The question remains whether the EU's own state-led green ambitions, manifested by EV purchasing subsidies, come with a risk of giving China an enhanced long-term opportunity to create chokepoints through the market dominance of its automotive industry. From this perspective, Chinese FDI in the EV industry within the EU might be preferable to Chinese imports, and the former might even to some extent limit the geoeconomic risks associated with the latter. However, as suggested above, the Chinese government would likely be willing to forego the benefits of accumulated Chinese EV investments in the EU if it could employ the EV industry as a geoeconomic tool for foreign policy purposes.

Synergies between Chinese FDI in both the semiconductor industry and the EV industry might provide China with new opportunities to use its industries as geoeconomic tools. The distinction between the two industries is becoming more blurry, a case in point being that Chinese EV companies are increasing their efforts to establish their own chip production.[119]

[118] Sebastian and Chimits, "'Made in China' electric vehicles."
[119] Ward Zhou and Jill Shen, "Chinese EV makers Nio, Xpeng, and Li Auto expand bets on self-produced chips: Report," Technode, 10 October, 2022, https://technode.com/2022/10/10/chinese-ev-makers-nio-xpeng-and-li-auto-expand-bets-on-self-produced-chips-report/.

6 Energy sector – Power plants, grids and renewable energy

This chapter looks at Chinese energy-related investments in solar power plants and wind power parks, followed by a discussion of China's state involvement and alignment with its industrial policy goals. An overview of China's role as an exporter of important inputs to the renewable energy industry is also provided. Thereafter, there is a discussion of the geoeconomic risks for the EU that come with Chinese influence in its energy sector.

The chapter shows that the majority of the Chinese energy-related investments have been made in solar power plants and wind power parks spread out over Europe and in electricity grids and energy companies in Southern Europe (Greece, Italy, Malta, and Portugal). Chinese firms have also made a couple of unsuccessful attempts to make inroads in the EU nuclear energy market. The main geoeconomic risk here is related to the Chinese government's gaining direct or indirect ownership and influence over critical EU infrastructure. The chapter also demonstrates that there are geoeconomic risks concerning the EU's dependence on the import of the Chinese raw materials, intermediate inputs, and goods that are required for Europe's renewable energy industry. The problem of supply chain dependence mainly relates to production and access to the inputs needed to build the infrastructure for the green transition. While European energy companies may control certain segments of the supply chain and have the capacity to assemble, install, and operate green infrastructure, they are often dependent on Chinese suppliers to some degree, especially upstream.

6.1 Chinese FDI in the EU energy sector

The energy sector lies at the heart of China's geoeconomic ambitions. Up to two-thirds of its BRI investments have been in the energy sector, specifically power plants and grids.[120] Furthermore, as mentioned above, green energy and energy equipment are two of the focus industries in MIC2025.[121] The Chinese energy-related investments in the EU are but a small part of a megaproject, the Global Interconnection Initiative, to connect the European, Central Asian, and Chinese power grids by 2035, with the ostensible goal of facilitating the green transition and providing renewable energy to China's partners; it was presented by President Xi Jinping in 2015.[122]

The EU energy sector has received Chinese FDI in power plants and in electricity grids, including transmission and distribution networks.

6.1.1 Power plants

As of 2021, China had some degree of ownership over 122 operational power plants or installations in the EU, equal to around 3500 MW, or about 0.4 percent of total EU power-generation capacity.[123] Figure 1 shows the distribution of the Chinese investments over energy types, by generation capacity (MW). The majority of the generation capacity is in wind and solar power, spread out across many smaller power plants in the EU. There is only one Chinese-owned fossil-fuel power plant in the EU, namely the Delimara power station

[120] Thomas S. Eder and Jacob Mardell, "Powering the Belt and Road," MERICS, 27 June, 2019, https://www.merics.org/en/tracker/powering-belt-and-road.
[121] Zenglein and Holzmann, *Evolving Made in China 2025*.
[122] Clémence Pèlegrin and Hugo Marciot, "China's at the Gate of the European Power Grid," in *China's Ecological Power: Analysis, Critiques, and Perspectives* (Groupe d'études géopolitiques, September 2021), 6, https://geopolitique.eu/en/articles/chinas-at-the-gate-of-the-european-power-grid/.
[123] Boston University Global Development Policy Center. "China's Global Power Database"; Thomas Schlaak and Johannes Trüby, "The future of power: Scenarios to evolve the European electricity sector," Deloitte Insights, 19 July, 2021, https://www2.deloitte.com/us/en/insights/industry/power-and-utilities/renewable-power-generation-in-europe.html. This is assuming 950 GW of operational power generation capacity in the EU.

on Malta, which processes both oil and gas. There is also one very small Chinese-owned geothermal project in Hungary.

Almost all of the Chinese renewable energy investments in the EU are made by two state-owned companies: China General Nuclear Power Group (CGN) and China Three Gorges Corporation (CTG). As its name implies, CGN focuses mainly on nuclear power in China, but it has also invested overseas in renewable energy. CTG operates the Three Gorges Dam but also invests abroad, including in Europe. China Huaneng Group and the State Power Investment Corporation (SPIC), both of which are state-owned, partially own the gas and oil power plant.[124]

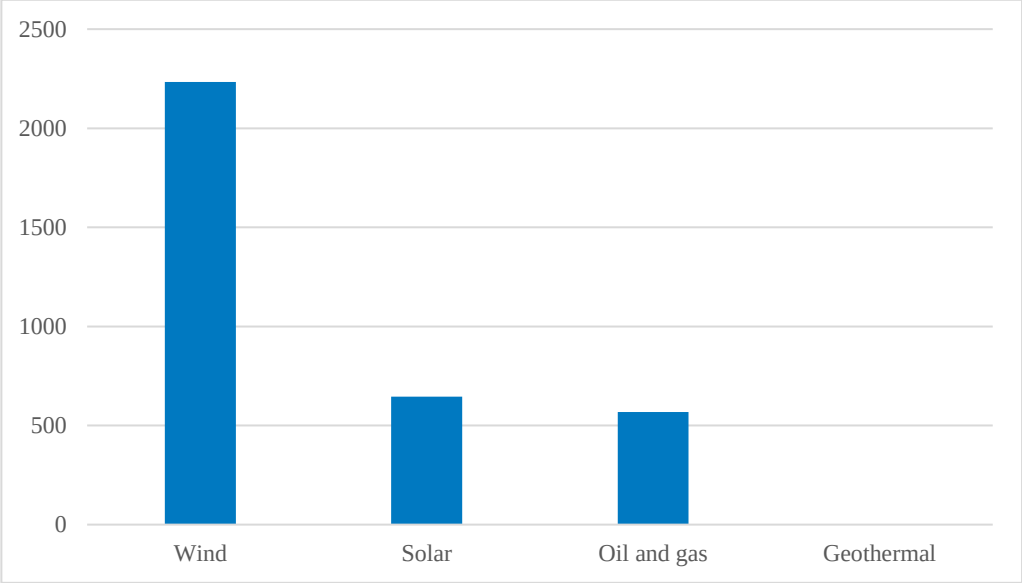

Figure 1. Chinese-owned EU power plants by energy types, *MW capacity*.
Source: Boston University Global Development Policy Center, "China's Global Power Database."
Notes: The Dutch gas-power plants previously owned by Chinese companies have been excluded from the dataset, since it appears they have been sold to new owners.

The Chinese wind power investments are spread out across Europe. By 2021, Chinese companies had invested in operational wind assets in Belgium, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, Poland, Spain, and Sweden. In addition, Chinese companies had sold wind turbines used in wind power parks in Croatia, Denmark, Finland, France, Germany, Greece, and Italy.[125] One of the earliest investments occurred in 2011, when CTG became the largest shareholder of Portuguese electricity producer Energias de Portugal, which is one of the world's largest producers of wind energy.[126]

Some of these deals garnered media attention in their respective countries. Sweden is an interesting example in this regard. In Sweden, CGN owns a 75 percent stake in the Markbygden Wind Farm, which is Europe's largest onshore wind-power park, with a 644 MW generation capacity. CGN's ownership of Swedish wind-power parks corresponds to 7 percent of total Swedish wind-power capacity, making CGN the single biggest owner in the Swedish wind-power market.[127] Other examples include the first European offshore wind-power park, supplied by a Chinese company, in the bay of Taranto, Italy, which opened in 2022. The wind park is notable because it was the first completely Chinese-built offshore

[124] Boston University Global Development Policy Center, "China's Global Power Database."
[125] Chenyuan Diao et al., "Expansion opportunities beckon for China's wind companies," Wood Mackenzie, 7 February, 2023, https://www.woodmac.com/news/opinion/china-wind-expansion/.
[126] "The Acquisition of EDP," Datenna, 3 June, 2022, https://www.datenna.com/articles/the-acquisition-of-edp.
[127] Almén, *Kinesiska investeringar i Sverige*.

wind park in Europe.[128] In Croatia, the country's largest wind-power park, at Senj, opened in 2022, was constructed by the Chinese state-owned company, Norinco International, China's largest industrial defence company.[129]

China has concentrated its solar-power investments in Italy and Spain, with a smaller number of investments also made in Bulgaria, Czechia, Hungary, France, the Netherlands, and Romania.[130] Most of the investments were made in 2020. The solar-power plants are generally quite small, under 100 MW capacity. The largest one has 101 MW capacity and is located in Groningen, the Netherlands.

Chinese companies have also attempted to invest in EU nuclear-energy power plants, so far with limited success. China developed its nuclear industry starting in the 1980s in close cooperation with France. Today, China and France balance between competition and cooperation in the nuclear field. France is building a number of nuclear reactors in China, and China is using French technology in its own nuclear-power plants, including those it is exporting to third countries.[131] CGN cancelled its attempt to pursue a joint venture with a Romanian firm to build a nuclear-power plant in Romania in 2020.[132] Given that there are no other current plans for Chinese investments in EU nuclear-power plants, it seems unlikely that a Chinese firm will win a bid to build a nuclear-power plant in the EU in the near future.

6.1.2 Electricity transmission and distribution networks

China started investing in European electricity grids in the early 2010s, at a time when the EU had liberalised the electricity transmission and distribution markets and many European countries, particularly in the South, experienced economic difficulties because of the Eurozone crisis. The objective of the investments is to ensure both influence and profitability. Since transmission and distribution networks are often national monopoly assets, they can grant a large degree of influence.[133]

Table 5 summarises successful and unsuccessful attempts by Chinese companies to acquire stakes in EU electricity grids and transmission and distribution networks since 2011. Most of the investments were made by the state-owned State Grid Corporation of China (SGCC), which is the largest utility and the third-largest company in the world, operating approximately 80 percent of China's electricity grid.[134]

[128] Craig Richard, "Italian developer Renexia launches first Europe's offshore wind farm with Chinese turbines," *Windpower Monthly*, 22 April, 2022, https://www.windpowermonthly.com/article/1753719/italian-developer-renexia-launches-first-europes-offshore-wind-farm-chinese-turbines.

[129] Vladimir Spasic, "Norinco completes Senj wind farm, Croatia's biggest so far," *Balkan Green Energy News*, 23 November, 2021, https://balkangreenenergynews.com/norinco-completes-senj-wind-farm-croatia-biggest-so-far/; Stockholm International Peace Research Institute. "Top 100 arms companies, 2021."

[130] Boston University Global Development Policy Center, "China's Global Power Database."

[131] Mathilde Teissonnière, "Civil Nuclear Energy in China," in *China's Ecological Power: Analysis, Critiques, and Perspectives* (Groupe d'études géopolitiques, September 2021), https://geopolitique.eu/en/articles/civil-nuclear-energy-in-china/.

[132] Madalin Necsutu, "Romania Cancels Deal With China to Build Nuclear Reactors," *Balkan Insight*, 27 May, 2020, https://balkaninsight.com/2020/05/27/romania-cancels-deal-with-china-to-build-nuclear-reactors/.

[133] Nabil Wakim, "Comment la Chine achète l'Europe de l'énergie," *Le Monde*, 29 August, 2018, https://www.lemonde.fr/economie/article/2018/08/29/la-chine-achete-l-europe-de-l-energie_5347305_3234.html; Pèlegrin,and Marciot, "China's at the Gate."; "Global 500 2023," Fortune, accessed 21 December, 2023, https://fortune.com/ranking/global500/.

[134] Nicolas Mazzucchi, *China and European electricity networks: Strategy and issues* (Fondation pour la Recherche Stratégique, September 2018), 10, https://www.frstrategie.org/sites/default/files/documents/publications/notes/2018/201817.pdf.

Table 5. Chronological overview of attempts by Chinese firms to acquire EU electricity grids and transmission and distribution networks

Year	Country	Successful/ Unsuccessful	Acquired company	Acquiring company	Stake (%)
2011	Portugal	Successful, 2018 takeover bid blocked	Energias de Portugal	CTG	23.3
2012	Portugal	Successful	Redes Energéticas Nacionais	SGCC	25
2012	Spain	Unsuccessful	Red Eléctrica de España and Enagas	SGCC	Unknown
2014	Malta	Successful	Enermalta	Shanghai Electric	33
2014	Italy	Successful	Cassa Depositi e Prestiti Reti	SGCC	35
2016	Greece	Successful	Independent Power Transmission Operator	SGCC	24
2016	Belgium	Unsuccessful	Eandis	SGCC	14
2018	Luxembourg	Successful	Encevo	China Southern Power Grid	25
2018	Germany	Unsuccessful	50Hertz	SGCC	20

Sources: Mazzucchi, *China and European electricity networks;* John Seaman, Mikko Huotari, Miguel Otero-Iglesias, ed., *Chinese Investment in Europe: A Country-Level Approach* (European Think-tank Network on China, December 2017); news articles.

In 2011, CTG established a strategic partnership with Energias de Portugal, the largest Portuguese electric-utility company, and acquired 23.27 percent of its shares, becoming its largest shareholder. In 2018, CTG attempted to take over the company, but the bid was blocked by the other shareholders.[135] In 2012, SGCC bought a 25 percent stake in Portugal's national power grid company, Redes Energéticas Nacionais.[136] Both of the acquisitions took place in the context of privatisation conducted under the Economic Adjustment Programme for Portugal, organised by the IMF and the European Commission in order to help Portugal cope with its financial crisis.

In 2014, Shanghai Electric bought a 33 percent stake in Malta's only energy company, Enermalta, which manages and develops the national electricity grid, including the Italy-Malta interconnector and the Delimara power plant.[137] Also in 2014, SGCC bought a 35 percent stake in the Italian holding company, Cassa Depositi e Prestiti Reti, gaining a blocking minority over the activities of the Italian national gas-network operator, SNAM, and electricity-grid operator, Terna. In 2016, SGCC acquired 24 percent of Greece's Independent Power Transmission Operator. In 2018, the China Southern Power Grid bought

[135] "Shareholders block China's €9bn bid for Energias de Portugal," *Euractiv*, 25 April, 2019, https://www.euractiv.com/section/electricity/news/shareholders-block-chinas-e9bn-bid-for-energias-de-portugal/.

[136] Carlos Rodrigues, "Chinese Investment in Portugal: Gaining Access to Cutting-Edge Knowledge and Extending Global Influence," in *Chinese Investment in Europe: A Country-Level Approach*, ed. John Seaman, Mikko Huotari, and Miguel Otero-Iglesias (European Think-tank Network on China, December 2017), 120, https://merics.org/en/report/chinese-investment-europe-country-level-approach.

[137] Ivan Camilleri, "China deal puts energy sovereignty in question," *Times of Malta*, 14 March, 2014, https://timesofmalta.com/articles/view/China-deal-puts-energy-sovereignty-in-question.

a 25 percent stake in Luxembourgian grid operator and energy provider Encevo.[138] However, Chinese attempts to buy stakes in Belgian, German, and Spanish network companies were blocked because of security concerns.[139]

The pattern that emerges indicates that there is, or has been, a clear Chinese strategy to attempt to acquire majority or blocking minority shareholdings in EU grid operators to gain influence over EU electricity grids. The investments listed above have given Chinese state-owned companies significant influence over the transmission networks in Southern Europe, one of the frontiers through which the BRI is meant to connect China with Europe. In addition, they indirectly gave SGCC access to the European Network of Transmission System Operators for Electricity (ENTSO-E) and, consequently, knowledge about the functioning of the entire EU electricity network and its potential vulnerabilities. ENTSO-E is an important body that supports the implementation of EU energy policy and drafts long-term plans for the development of the EU's electrical grids.[140]

While Chinese investments in renewable energy continued during and after the Covid-19 pandemic, there seems to have been a decrease in attempts to acquire EU energy companies and grid operators since 2018. This is likely a part of the broader trend of a decrease in Chinese investments in sensitive sectors, following increased investment screening in EU countries.[141]

All of the aforementioned companies (CGN, CTG, China Southern Power Grid, China Huaneng Group, SGCC, Norinco, and SPIC), with the exception of Shanghai Electric, are state-owned and overseen by SASAC. CGN and CTG account for the overwhelming majority of renewable investments in the EU, while SGCC owns important stakes in grid operators in Greece, Italy, and Portugal. Therefore, there is a very high degree of state involvement in these investments. It is notable that almost all Chinese FDI in the EU energy sector has been made by a handful of very large state-owned companies. The concentration of ownership likely facilitates the coordination of strategic investment decisions.

While none of these companies have been sanctioned by the EU, both CGN and CTG have been subjected to economic restrictions by the US because of alleged ties to China's military and defence sectors. In 2019, the US Department of Commerce forbade American companies from selling to CGN, stating that the company and its subsidiaries "engaged in or enabled efforts to acquire advanced US nuclear technology and material for diversion to military uses in China."[142] CTG has also been sanctioned by the US because of alleged links to the People's Liberation Army (PLA).[143] The possibility of links to the PLA underscores the risks of allowing the companies to have ownership over critical infrastructure that is potentially vulnerable to cyberattacks. Furthermore, the SGCC is a global innovation leader in smart grids and AI applications in the electricity-grid sector.[144] SGCC thus likely has the technical capability to influence and/or monitor grid operators. Since the SGCC has the ambition of becoming a global intellectual monopoly, it could also try to influence EU electricity grids at the regulatory level.[145]

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[138] Sudip Kar-Gupta and Inti Landauro, "China Southern Power Grid buys 25 percent in European utility Encevo," *Reuters*, 31 July, 2018, https://www.reuters.com/article/us-encevo-m-a-cn-sthrn-pwr-idUSKBN1KL1V8.
[139] Mazzucchi, *China and European electricity networks*, 7–8.
[140] Mazzucchi, *China and European electricity networks*, 9.
[141] Kratz et al., *Chinese FDI in Europe: 2022 Update*, 3, 5.
[142] Bureau of Industry and Security, *Addition of Certain Entities to the Entity List, Revision of Entries on the Entity List, and Removal of Entities From the Entity List* (Washington, DC: Bureau of Industry and Security, August 2019), https://www.federalregister.gov/documents/2019/08/14/2019-17409/addition-of-certain-entities-to-the-entity-list-revision-of-entries-on-the-entity-list-and-removal.
[143] Ana Swanson, "Trump Bars Investment in Chinese Firms With Military Ties," *New York Times*, 12 November, 2020, https://www.nytimes.com/2020/11/12/business/economy/trump-china-investment-ban.html.
[144] Cecilia Rikap, "Becoming an intellectual monopoly by relying on the national innovation system: the State Grid Corporation of China's experience," *Research Policy* 51, no. 4 (May 2022): 2, https://doi.org/10.1016/j.respol.2021.104472.
[145] Mazzuchi, *China and European electricity networks*, 10.

6.1.3 Alignment with Chinese industrial-policy goals

China's investments in EU renewable-energy power plants and grid operators help further the goals of both the BRI and MIC2025. Expanding the market share of renewable energy equipment, including solar panels and wind turbines (discussed below), is an important part of MIC2025. Seen from the perspective of the BRI, the European electricity grid is one component of an ambition to string together all Eurasian electricity grids by developing transmission networks between Europe and Asia. In the long run, this could allow for the export of Chinese energy to Europe and, theoretically, make Europe dependent on Chinese electricity.[146]

The five EU member states that have seen Chinese investments in their electricity grids (Greece, Italy, Luxembourg, Malta, Portugal) have also signed BRI Memorandums of Understanding (MoUs), though Italy refused to renew its MoU in 2023. [147]

6.2 Chinese energy-related exports to the EU

China is an important exporter to the EU of inputs and equipment used in the renewable energy industry. The following section analyses the dependency on Chinese imports in the solar- and wind-power sectors.

6.2.1 Solar power

China is home to the world's ten largest suppliers of solar-photovoltaic equipment and, during the last decade, it has come to dominate global solar-panel production chains. The manufacture of a solar panel requires the production of polysilicon, silicon ingots and wafers, solar cells, and final assembly into solar modules. China's global share in each of these production steps exceeds 80 percent; for solar silicon wafers, it is 97 percent. Meanwhile, the EU's global share of this production is very limited: between 1–3 percent for wafers, solar modules, and solar cells, while for polysilicon it is around 11 percent (Table 6). The concentration of production in China has enabled economies of scale that have drastically reduced the costs of solar power during the last decade, helping to speed up the green transition.[148]

Table 6. China and the EU's global shares in the production stages of solar panels in 2022

	Solar polysilicon	**Solar silicon wafers**	**Solar cells**	**Solar modules**
China	~79 percent	~97 percent	~85 percent	~75 percent
EU	~11 percent	~1 percent	<1 percent	~3 percent

Sources: Bettoli et al., *Building a competitive solar-PV supply chain in Europe*; International Energy Agency, *Special Report on Solar PV*, 58–9.

In the early 2010s, the EU had a significant share of global solar-panel production, but EU producers found it increasingly difficult to compete with Chinese firms that produced at lower cost thanks to larger economies of scale and state subsidies. In 2013, the European Commission proposed anti-dumping tariffs on Chinese solar panels in an attempt to protect the European solar-panel industry. China threatened retaliatory tariffs on EU imports, notably on French wine and German cars. The dispute led to the EU's dropping the tariffs,

[146] Mazzucchi, *China and European electricity networks*, 9.

[147] Francesca Ghiretti, *The Belt and Road Initiative in the Eastern and Southern EU*, EUI RSC PP 2021/07 (Florence, Italy: European University Institute, June 2021), 2, 8, https://cadmus.eui.eu/handle/1814/71780; David Sacks, "Why is Italy withdrawing from China's Belt and Road Initiative?" *Council on Foreign Relations* (blog), 3 August, 2023, https://www.cfr.org/blog/why-italy-withdrawing-chinas-belt-and-road-initiative.

[148] IEA, *Special Report on Solar PV Global Supply Chains* (International Energy Agency, July 2022), https://www.iea.org/reports/solar-pv-global-supply-chains.

since France, Germany, and other member states did not want to imperil their trade relationship with China.[149] Since 2011, China has invested 10 times more than Europe in solar-photovoltaic production.[150] Since EU firms have struggled to be as cost-effective as Chinese firms, there has been little commercial rationale for investing in new production capacity. In order to re-establish a competitive European solar-power industry, the European Commission has launched an EU Solar Power Strategy and a Solar Photovoltaic Industry Alliance with ambitious goals. The strategy aims to bring over 320 GW of solar photovoltaic online by 2025 and almost 600 GW by 2030, compared to a total installed capacity of 162 GW in 2021.[151] Achieving these goals without relying on Chinese imports appears unrealistic.

According to analysis from McKinsey & Company, achieving competitiveness for EU solar-power firms is difficult but not impossible.[152] EU solar-power industry executives say that in order to invest in new production capacity, they would need both cooperation with Chinese firms and lower electricity prices, since silicon production is energy intensive.[153] In 2021, 91 percent of EU expenditure on solar-panel imports was spent on Chinese products.[154]

It is noteworthy that China's Xinjiang province, where the local Uighur population has been subjected to widespread human rights abuses, including forced labour, accounts for 40 percent of global polysilicon manufacturing. Polysilicon is a key component in both photovoltaic and semiconductor manufacturing. Virtually every silicon-based solar module contains silicon produced in Xinjiang.[155] Since both the EU and the US are considering introducing legislation that could curtail imports from Xinjiang, China has started moving some of its production to Inner Mongolia.[156]

6.2.2 Wind power

The history of the European and Chinese wind-power industries illustrates how some European renewable energy companies have gone from being indisputable global leaders to facing increased competition from Chinese firms. The Danish company, Vestas, pioneered wind-power technology and has long been the global leader in supplying and installing wind turbines. However, the Chinese company, Goldwind, surpassed Vestas in globally installed wind-power capacity in 2022.[157] Goldwind was founded in 1998, and its predecessor company pioneered the first Chinese wind-power park with the help of Vestas turbines and a USD 3.2 million grant from the Danish government. Subsequently, when domestic Chinese companies had acquired the technology and know-how to build their own wind

[149] Yuan Yang, Alice Hancock, and Laura Pitel, "Solar power: Europe attempts to get out of China's shadow," *Financial Times*, 23 March, 2023, https://www.ft.com/content/009d8434-9c12-48fd-8c93-d06d0b86779e; Kjeld van Wieringen and Julia Hünteman, *Making solar a source of EU energy security* (European Parliamentary Research Service, July 2022), 1–2, https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/733587/EPRS_ATA(2022)733587_EN.pdf.

[150] IEA, *Special Report on Solar PV*.

[151] "Solar Energy," European Commission, accessed 8 August, 2023, https://energy.ec.europa.eu/topics/renewable-energy/solar-energy_en.

[152] Alberto Bettoli et al., "Building a competitive solar-PV supply chain in Europe," McKinsey & Company, 13 December, 2022, https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/building-a-competitive-solar-pv-supply-chain-in-europe.

[153] Yang, Hancock, and Pitel, "Solar power."

[154] "Europe hoarding Chinese solar panels as imports outpace installations; €7 billion sitting in warehouses," Rystad Energy, 20 July, 2023, https://www.rystadenergy.com/news/europe-chinese-solar-panels-imports-installations-storage.

[155] Aitor Hernández-Morales et al., "Fears over China's Muslim forced labor loom over EU solar power," *Politico*, 10 February, 2021, https://www.politico.eu/article/xinjiang-china-polysilicon-solar-energy-europe/.

[156] Yang, Hancock, and Pitel, "Solar power."

[157] 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/.

turbines, government regulations pushed Vestas and other Western companies out of the Chinese market.[158]

While the European and Chinese wind-power firms are locked out of each other's markets, they often rely on the same supply chains and suppliers, many of which originate in China. The production of wind turbines requires rare earth elements, which are to a large degree supplied and refined by Chinese companies (see Chapter 3). Europe's demand for rare-earth elements for the production of wind turbines is projected to double by 2030.[159] In addition, up to 70 percent of the components used in the manufacture of European wind turbines are imported from China.[160] One example is glass-fibre-reinforced polymer (GFRP), which is used to manufacture the blades of wind turbines. In 2022, China accounted for almost 60 percent of GFRP production. On the other hand, the construction of wind turbines requires the production of roller bearings, which is almost entirely based in Europe and the US.[161]

Since it is expensive to transport large wind turbines, they are generally manufactured in Europe rather than imported from China. In addition, the EU has imposed import duties on Chinese steel wind towers. Nevertheless, European firms are struggling with the challenge of maintaining profitability while needing to expand production capacity, a challenge that needs to be overcome if the EU wants to achieve its green energy goals without becoming dependent on Chinese imports. The three largest wind-turbine makers in Europe (Vestas, Siemens Gamesa Renewable Energy and General Electric), all reported large losses in 2022, raising fears that the European wind-power industry will repeat the experience of the European solar-power industry.[162] At present, manufacturing Chinese wind turbines costs about half as much as European ones.[163] The Chinese competitive advantage is derived not only from economies of scale and lower labour costs, but also from the fact that they have easy access to the inputs required for production. Much of the current financial difficulties experienced by European wind-turbine producers are connected to supply chain issues, logistical bottlenecks, and transport costs.[164]

6.3 Geoeconomic risks

China's transformation into a "renewable-energy superpower" presents both opportunities and threats for the EU. On one hand, importing from China can help speed up the green transition, and Chinese companies can form mutually beneficial partnerships with European energy companies. On the other hand, the EU's green transition risks becoming predicated on the import of energy-related goods from China, creating economic chokepoints that could be leveraged by China. The Chinese government sees the green transition as an opportunity to establish dominance over new technologies and economic sectors.

Chinese investment in EU energy generation is concentrated in the renewable-energy sector. As a share of the EU's total renewable-energy generation capacity, Chinese ownership is small but has been growing and accumulating steadily over time. The purpose of the energy-generation investments seems to be to gain a foothold in the European market and pioneer the use of Chinese technology and exports, further strengthening, in turn, the market position of Chinese renewable-energy companies.

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[158] Barry van Wyk, "Wind power bottlenecks between China and the West are slowing down green energy adoption," The China Project, 15 August, 2023, https://thechinaproject.com/2023/08/15/wind-power-supply-chain-bottlenecks-between-china-and-the-west-are-slowing-down-green-energy-adoption/.

[159] Joseph Webster, "Wind Turbines: How Dependent is the EU on China?" Energy Post, 25 April, 2023, https://energypost.eu/wind-turbines-how-dependent-is-the-eu-on-china/.

[160] Stanley Reed, "Europe's Wind Industry Is Stumbling When It's Needed Most," *New York Times*, 22 November, 2022, https://www.nytimes.com/2022/11/22/business/wind-power-europe.html.

[161] van Wyk, "Wind power bottlenecks."

[162] Reed, "Europe's Wind Industry Is Stumbling."

[163] van Wyk, "Wind power bottlenecks."

[164] Siemens Gamesa, *Why we need the European wind industry – and how to safeguard it*, accessed 6 September, 2023, https://www.siemensgamesa.com/en-int/explore/journal/security-wind-energy-white-paper.

In terms of influence, Chinese investments in EU power grids and grid operators are more significant. These investments have allowed the SGCC and, by extension, the Chinese government, to gain influence and information not only about individual power plants, but the entire European power grid. In addition, they have created opportunities for the Chinese government to influence the future regulation and development of the European power grid. The investments in European power grids should be seen in the context of the development of the BRI and the ambition of linking the European and Chinese grids in order to facilitate Chinese energy exports.[165]

Both power plants and power grids are considered critical infrastructure since they are essential to a state's security and national defence. Chinese ownership over these assets consequently also poses a security risk. Since the EU electricity grid is integrated, these investments constitute a security concern for all EU member states. Threats to such infrastructure are threats to the security of all EU members.

The risks of Chinese ownership of critical infrastructure can be categorised in the following way: first, the Chinese government can force Chinese companies to transfer data and information about the EU's critical infrastructure to the Chinese military, aiding intelligence efforts and increasing the vulnerability of EU members to cyberattacks or other antagonistic activities. Second, Chinese companies can be forced or encouraged to transfer sensitive technology and technical expertise. CGN's transfer of nuclear technology from the US to China is one such example. Third, companies with Chinese ownership can be pressured to alter their business plans in order to comply with China's foreign-policy goals. For example, an energy company could be pressured into favouring the development of projects that contribute to the BRI, while neglecting projects that would reinforce EU energy security. Fourth, by owning infrastructure, the Chinese become stakeholders in political processes at both the EU, national, and subnational levels. Again, this influence can be used to co-opt actors into conforming to Chinese foreign-policy objectives. For instance, Chinese greenfield investments can provide a large number of jobs and other benefits at the local level, but also undermine the democratic process by co-opting local elites and businesses and discouraging criticism and scrutiny of China. Lastly, there is a risk of China's sharing its information, technology, and influence with Russia. China-Russia relations have strengthened during Russia's war against Ukraine, and the possibility that China shares information and technology with Russia must be taken into account.[166]

The security-related risks appear especially salient in the EU energy sector when considering the combination of 1) the sensitivity of the infrastructure, and 2) the fact that the investments are made by a few, large state-owned companies that are closely linked to the Chinese government.

An additional consideration is that the security- and influence-related risks are not limited to FDI, and that FDI screening is thus not enough to limit Chinese influence. A Chinese company contracted to build critical infrastructure could also obtain sensitive information and technology, even if the company does not own or operate said infrastructure.[167] The construction of Croatia's largest wind-power park by Norinco, China's largest defence company and arms producer, is a vivid example of how a Chinese defence company can gain direct access to and information about EU critical infrastructure.

Beyond the security concerns, there is also a concern that more long-term structural economic vulnerabilities will be created. If European renewable-energy firms are put out of business by Chinese competition, it may be very costly and time-consuming to rebuild that industry if the need should arise. This has been clearly illustrated by the European solar-

[165] Mazzucchi, *China and European electricity networks*, 10.
[166] This list is an elaboration of analysis in Frank Jüris, *Security implications of China-owned critical infrastructure in the European Union* (Brussels, Belgium: Directorate-General for External Policies of the Union, June 2023), 33–4, https://www.europarl.europa.eu/thinktank/en/document/EXPO_IDA(2023)702592.
[167] Jüris, *Security implications*, 12.

power industry, which succumbed to Chinese competition and is now in the process of being revived through a concerted effort of EU industrial policy. Although the EU wind-power industry is fairly large, EU policymakers and wind-power industry leaders are concerned about the possibility that the experience of the European solar-power industry will be repeated, and that EU producers will again find themselves squeezed out by Chinese competition. Currently, EU producers find it difficult to remain profitable, and Chinese producers are able to offer turbines at prices well below those of their European rivals.[168]

Overall, China currently has an important geoeconomic lever in relation to the EU in the area of renewable energy. The lack of EU investment in new production capacity has led to over-dependence on Chinese supply chains and political decisions in the energy arena, which has created economic chokepoints.[169] The dependency could be exploited in several different ways, for instance, by limiting certain exports in order to make the EU's green transition more costly and difficult, or by dumping cheap products on the EU market in order to put pressure on EU energy companies. Given China's dominance in certain segments of the green-energy supply chains, European officials have admitted that it is neither possible nor desirable to pursue the green transition without Chinese imports.[170] Notwithstanding that, China has still not managed to gain influence over the nuclear-energy sector, and it is unlikely to do so in the foreseeable future.

If the EU's renewable-energy industry can successfully expand production, diversify suppliers, transfer parts of the supply chain back to the EU, and reduce reliance on Chinese imports, then China's geoeconomic leverage in the energy sector will gradually become less powerful in the coming decades. This suggests China may currently have a "window of opportunity" to use geoeconomic measures in order to cement its present advantage in the renewable-energy sector. China will likely attempt to maintain its global dominance over selected sectors of renewable energy by continuing to invest in production capacity and exporting at a low cost.

[168] Reed, "Europe's Wind Industry is Stumbling."
[169] Agatha Kratz, Charlie Vest, and Janka Oertel, *Circuit Breakers: Securing Europe's Green Energy Supply Chains* (European Council on Foreign Relations and Rhodium Group, May 2022), https://ecfr.eu/publication/circuit-breakers-securing-europes-green-energy-supply-chains/.
[170] Alice Hancock and Andy Bounds, "Europe's green transition impossible without China, says Dutch minister," *Financial Times*, 28 May, 2023, https://www.ft.com/content/c080d5fa-395a-4611-b08f-4d5e8e2b28b8.

7 Conclusions and discussion

This chapter presents the conclusions drawn from addressing the report's research questions. It further explores potential future developments in EU-China economic relations, with an emphasis on geoeconomics. It also presents suggestions for future research that can complement the findings of this report.

7.1 Research questions

a) What are some of the most important economic dependencies and vulnerabilities vis-à-vis China in the studied sectors?

The EU has economic dependencies on China, and therefore vulnerabilities, in all four studied sectors. The vulnerabilities are summarised in Table 7. The authors have classified the vulnerabilities according to their likelihood and severity. "Likelihood" refers to the probability that the vulnerability is realised. A vulnerability is classified as "certain" if it is confirmed that it exists at present. "Likely" and "possible" refer to the probability that the vulnerability has been realised in the present, albeit unconfirmed, or that it may be realised in the future. "Severity" refers to the potential negative impact on the EU if the vulnerability should be exploited, and is assessed in relative terms. Low severity means a threat to a single company, minor economic damage, or influence at the local level. Medium severity signifies a threat to a specific economic sector. High severity implies a national security threat or threats to the broader economy. In Table 7, below, the background colours in each table cell indicate the degree of attention merited by each vulnerability, considering the combination of severity and likelihood. For the sake of clarification, note that vulnerabilities can vary in their scope; as an example, chokepoints might occur in specific market segments but not in the industry as a whole, for instance, in PCB manufacturing, but not across the entire back-end semiconductor-manufacturing industry.

Table 7. The EU's economic vulnerabilities towards China in the four studied sectors

LIKELIHOOD	SEVERITY: Low	Medium	High
Possible	• Technology transfer from EV-battery factories	• Chokepoint in EV battery production • Market dominance and chokepoint in wind turbines • Enhanced market dominance and chokepoints due to cross-sectoral synergies from semiconductor investments • Espionage in back-end semiconductor manufacturing • Chinese investments create increased resilience to EU countermeasures	• Chokepoint in back-end semiconductor manufacturing • Erosion of EU competitiveness in the semiconductor, energy and EV/battery sectors • Chokepoint in silicon wafers used for semiconductor manufacturing
Likely	• Political influence at the local level from FDI • Erosion of know-how in individual companies	• Influence over investment decisions in renewable energy, batteries and semiconductor manufacturing • Technology transfer from the renewable-energy sector • Leakage of sensitive information and access to EU private-sector infrastructure	• Semiconductor dual-use technology transfer • Influence over political and regulatory processes connected to energy infrastructure • Leakage of sensitive information and access to energy infrastructure to the Chinese military • Transfer of technology and sensitive information to antagonistic third parties, such as Russia • Chokepoint in certain critical raw materials
Certain	• Influence over individual companies and business networks	• Chokepoint in solar panels • Chokepoint in inputs used for the production of solar panels and wind turbines	• Chokepoint in rare-earth elements • Access to sensitive energy infrastructure

Considering each sector in turn, it is, first of all, evident that the EU is dependent on China for the supply of various metals and minerals that are used in strategic sectors, including the semiconductor industry, the EV industry, and the energy sector. China is the EU's largest supplier for 10 out of 34 identified CRMs. Crucially, China is the EU's largest supplier for seven out of 16 SRMs, including processed rare-earth elements, bismuth, gallium, germanium, tungsten, magnesium, and natural battery-grade graphite. Most of the refining capacity for these elements is located in China, and it would take time to build up that capacity in the EU or elsewhere. These dependencies create chokepoints and make the EU vulnerable to the interruption of trade flows from China. Some vulnerabilities are greater than others, a notable example being processed rare-earth elements, depending on the varying potential for the EU to diversify its suppliers. Moreover, China dominates international supply chains, not least the processing stage, for many of the remaining 24 CRMs. Given that the supply of CRMs affects many industries, the severity of this vulnerability is assessed as high.

In the EU's semiconductor industry, the dependencies consist of a number of EU semiconductor companies that now have Chinese owners. The acquired companies studied in this report illustrate that China has acquired prominent EU semiconductor companies across the value chain. These acquisitions constitute vulnerabilities to the EU due to the potential of technology transfers, not least of dual-use technologies, which might benefit China's semiconductor self-sufficiency, technological competitiveness, and military modernisation. This represents a severe vulnerability, although it is not certain to what extent it is being exploited. It is also uncertain to what extent espionage in back-end semiconductor manufacturing, another severe vulnerability, is exploited. The establishment of chokepoints in certain segments of back-end chip manufacturing would possibly be a severe vulnerability in the future.

In the EV industry, the EU has dependencies in the form of Chinese greenfield investments in new EV battery plants. These battery plants constitute vulnerabilities for the EU in the sense that they might further strengthen China's dominance over global EV battery production and, by extension, the EV industry as a whole. This threatens to erode EU's industrial competitiveness and make it more dependent on the Chinese EV industry. This vulnerability is of medium severity and may become a threat in the future. Since battery factories also provide many thousands of jobs and are a crucial ingredient in the EU's green transition, their ownership provides China with significant influence at the local and national levels. Lastly, the EU's imports of EVs from China have increased rapidly in the last two years, but the degree of dependency is currently low.

Lastly, in the energy sector, China has acquired a number of solar- and wind-power parks in the EU, though only a small proportion of the total. China has also managed to acquire some EU grid operators, particularly in Southern Europe. The Chinese acquisitions across the EU energy sector come with vulnerabilities such as the potential for technology transfers, access to sensitive infrastructure information, and influence over regulatory decision-making processes at the national and EU levels. Investments in energy infrastructure are especially problematic since they are assets that are important for national security. Ownership of these assets has EU-wide consequences, since they are part of an integrated transnational network and are vulnerable to surveillance, intelligence-gathering, and cyber-attacks. These are severe vulnerabilities, since they concern national-security assets that are shared by the EU member states. Ownership of power plants can also create a large degree of influence at the local level.

Moreover, the EU is currently wholly dependent on China for import of solar panels and inputs relating to their production. The EU is also dependent on China in parts of the wind-turbine supply chain. These are assessed as vulnerabilities of medium severity, as they could cripple segments of the EU renewable-energy industry.

b) What similarities and differences are there in the studied sectors in terms of economic vulnerabilities towards China?

The different sectors studied in this report have similarities pertaining to their economic vulnerabilities towards China. The EU's semiconductor industry, EV industry, and energy sector share a commonality: they all face vulnerabilities in their upstream supply chains for certain metals and minerals currently sourced from China. For instance, gallium is used in the semiconductor industry and the energy sector, while magnesium is used in both the EV and semiconductor industries. Rare-earth elements are used across the three sectors, not least for EV battery production, but also, for example, for wind turbines. At an aggregate level, the EV industry seems to be the sector with the greatest and most diversified exposure to the critical raw materials for which China is a dominant supplier to the EU or controls global supply (for example, lithium). The production of both EV batteries and their subcomponents, as well as of permanent magnets for EV motors, is highly dependent on rare-earth elements, cobalt, magnesium, and natural graphite that the EU mainly sources from China, with limited possibility for supplier diversification.

The sectors studied here share other materials than metals and minerals. Various kinds of silicon wafers are used in both front-end chip manufacturing and production of solar panels. China already controls the global supply of silicon wafers for solar panels and is increasing its market share in silicon wafers used for chip manufacturing. The similarity in supply-chain vulnerabilities shown by the different sectors is also a reflection of the fact that the semiconductor industry is itself an upstream supplier for both the EV industry and the energy sector. Various microelectronics end up not only in EVs but also in solar panels and wind turbines. Moreover, semiconductors are at the core of modernising the broader energy infrastructure so that it is in line with the EU's green ambitions. Notably, new and digitalised electricity grids, so-called smart grids, are supposed to underpin EU electrification efforts and to better integrate renewable energy, such as wind and solar power and, for example, facilitating the charging of EVs.[171] To monitor and manage power supply and demand, smart grids require technologies, such as sensors and power transformers, based on semiconductors.[172] Consequently, China's investments in or role as an import source for one of the studied sectors might also have upstream or downstream implications for vulnerabilities within other sectors.

The risk of technology transfer is highest with regard to China's semiconductor and energy-sector investments. Technologies used by both semiconductor and energy companies are potentially dual-use, which creates risks of technology transfer to China's military. This constitutes a severe vulnerability, but it is difficult to assess to what extent it is being exploited. The question of whether existing export-control regulation and investment-screening mechanisms have successfully served to prevent such potential technology transfers remains unanswered here. The risk of technology transfer is not as relevant in the context of battery-plant greenfield investments.

It is a similarity for all sectors that Chinese FDI creates the potential for political influence, at the very least at the local level. Investments in electricity grids also come with influence at the regulatory level. These types of influence at the technical and sub-national levels may be less visible than the influence created by larger projects, which in EU countries are discussed at the national level. In addition, Chinese ownership can lead to the leakage of sensitive information about company assets and infrastructure. Another risk common to all sectors is that, by acquiring EU companies, Chinese actors gain access to EU business networks and information about suppliers and customers. They also gain new relationships

[171] "Smart grids and meters." European Commission, accessed 27 November, 2023, https://energy.ec.europa.eu/topics/markets-and-consumers/smart-grids-and-meters_en.

[172] IEA, *Electricity Grids and Secure Energy Transitions* (International Energy Agency, November 2023), 24, https://iea.blob.core.windows.net/assets/ea2ff609-8180-4312-8de9-494bcf21696d/ElectricityGridsandSecureEnergyTransitions.pdf; "Smart Grids," International Energy Agency, updated 11 July, 2023, accessed 27 November, 2023, https://www.iea.org/energy-system/electricity/smart-grids#programmes.

with local decision-makers and business leaders, who are potentially susceptible to corruption.

c) How are the studied investments related to the policy goals of *Made in China 2025*?

The Chinese investments in the EU strategic sectors studied here seem to contribute towards Chinese industrial policy goals to some extent. For instance, Chinese investments have been made across the semiconductor value chain, including in product segments in which China seeks to close technology gaps, including dual-use technologies. Chinese investments in EV battery production are in line with China's ambitions to have a dominant automotive industry. Chinese energy investments are consistent with BRI goals to connect the Eurasian landmass, including through existing and new energy-related infrastructure and transmission networks, and will potentially allow China to export energy to Europe in the future.

However, the specific contribution of Chinese investments in the EU's strategic sectors towards China's achieving its industrial policy goals of a higher rate of self-sufficiency and technological competitiveness is difficult to measure or verify. Among other things, it depends on the extent to which increased production capacity and know-how gained by acquired companies and greenfield investments end up benefitting Chinese industry, rather than remaining within the EU. To determine this would require detailed investigation of specific companies and the flow of goods and knowledge, while also taking into account the impact of existing export-control legislation within the EU. For example, it is not certain whether the Chinese semiconductor FDI studied in this report has had a significant impact on China's semiconductor self-sufficiency rate, even though some investments might be important from a qualitative perspective. The different maturity of the different sectors matters here. While China is struggling to produce the most advanced semiconductors, it has already achieved competitiveness or even dominance in the production of renewable-energy equipment.

d) What is the potential for China to coordinate investments in the studied sectors?

Judging by the investment patterns presented in this report, there is reason to believe that the degree of coordination among Chinese actors that invest in the EU varies for different sectors. Chinese investments in the EU energy sector are an interesting case in this regard. Since Chinese investments in the energy sector have largely been made by a small number of large SOEs, all managed by SASAC, active coordination of investments towards Chinese strategic goals and CCP interests is likely to have been more prevalent and efficient in this sector. In the semiconductor investments, the degree of direct state involvement and active coordination also appears to be high, not least since the National IC Fund has been a recurring investor. As with the energy sector, SASAC has also been present in China's investments in the EU semiconductor industry. Chinese investments in the EU electric-vehicle industry, largely made by private automotive companies, appear less strategically coordinated, due to their lack of a common ultimate beneficiary owner. In this sector, Chinese state involvement would seem to have foremost taken the shape of previous domestic industrial policy efforts in China, paving the way for Chinese battery companies and their business ventures abroad.

The degree of ownership concentration and coordination in the energy sector and the semiconductor industry suggests that it will be easier for China to instrumentalise the EU's vulnerabilities in these sectors in the future. Chinese investments in battery plants, chiefly made by private companies, could also be instrumentalised. However, this would require a different approach, whether through regulations, party-cell coordination or economic incentives and disincentives.

However, increased involvement by the Chinese state in Chinese business ventures abroad could also increase the difficulties for the CCP in coordinating the business decisions of Chinese state-owned and private companies. Increased and more centralised state control

entails a need for a corresponding ability to coordinate upstream and downstream information-sharing as well as behaviour. This comes with the difficulties related to transaction costs and bureaucratisation, and the risks presented by inefficient and bad decision-making rather than perfect coordination. A high-level bureaucrat at a government agency in China might not have sufficient knowledge of how diverse local circumstances affect the likelihood of success in coordinating business decisions for a certain industry spread out across the EU. Even if the affected Chinese companies have the necessary knowledge, it might not reach the decision-makers with the proper timing. The impact of increased international scepticism towards Chinese business ventures exacerbates coordination issues. Western fears, imagined or otherwise, of a smooth and sinister top-down government machinery that coordinates Chinese business dealings in Europe or elsewhere might thus sometimes prove to be exaggerated.[173]

As suggested by the comparison of state involvement in the different sectors above, Chinese investments in the EU's strategic sectors should not be interpreted as the direct result of Chinese officials carefully micro-managing the implementation of Chinese industrial policy abroad. Rather, it is the outcome of a mix of direct state involvement and investments encouraged through various types of "soft" pressure, in the form of economic and financial incentive structures and regulations put in place by the Chinese government. All investments have some degree of state involvement, whether through direct ownership, funding, or at least official approval of the investment. However, this study, in many cases, could not identify the degree and nature of state involvement and coordination in Chinese investments, nor the role played by various economic incentives provided by the Chinese state. This is partly a reflection of the overall lack of transparency surrounding Chinese overseas investments. On that note, it is hard to deny that many or most of the Chinese investments studied in this report seem like examples of normal business behaviour. It is rational for Chinese investors, whether SOEs or private companies, to pursue, for example, higher production capacity and technological prowess in order to increase their competitiveness and claim a larger market share within their industries. This holds true regardless of whether these actions are carried out in service of the Chinese state or not.

There is reason to believe that certain investments constitute examples of "interest transformation," that is, investments driven by business rationales manufactured by China's political economy, which has been shaped by the Chinese government to incentivise investments in line with strategic industrial-policy goals.[174] Incentives and control mechanisms take many forms, such as different kinds of financial support, access to cheap inputs supplied by state-sponsored companies, and regulations that narrow the scope of possible outbound investments from China. In some cases, incentives and control mechanisms have in the past played an important role in shaping the industry in question, with repercussions for current market structures. In any case, whether there is initial state involvement or not, there is always the possibility that, in the future, the Chinese state could choose to get involved, either covertly or overtly. Ultimately, the Chinese government could, for example, force Chinese private companies to merge with SOEs or otherwise steer their investment behaviour to be in line with strategic goals.

e) What geoeconomic tools can China use to exploit the identified vulnerabilities?

China can exploit all the identified vulnerabilities presented in Table 7 by implementing different geoeconomic tools in a mutually reinforcing manner. For instance, Chinese companies can transfer EU technology, thereby eroding EU firms' competitiveness and, in the long run, establish economic chokepoints. The reverse can work as well: chokepoints can be exploited in order to hinder the development of a competitive EU industry, thereby cementing China's market dominance. This risk is evident in the case of solar-panel

[173] Naughton and Boland, *CCP Inc*., 34.
[174] The term "interest transformation" is used in Norris, *Chinese Economic Statecraft*, 107.

production: China could interrupt the supply of input necessary for the production of solar panels, thereby guaranteeing that it maintains a monopoly on solar-panel production.

Perhaps the most straightforward geoeconomic tool is to exploit chokepoints by declaring embargos or introducing export quotas and other export controls. An example of this is China's decision in July 2023 to introduce export controls on gallium and germanium, crucial for semiconductor manufacturing. However, the mere threat of introducing export restrictions can be used as a geoeconomic tool to force concessions from the EU. China is also able to influence the supply and therefore the world market price of certain critical raw materials, with consequences for EU supply chains.

Another geoeconomic tool, which might not be readily apparent, is the establishment of Chinese market dominance in certain sectors, products or value chains. Chinese state aid, such as subsidies and dumping of cheap products, can be used to capture large market share and put EU companies out of business. Chinese investments in the EU across an industry's value chain might also contribute to market dominance. Once market dominance is established, it might be difficult for EU companies to break into the market without costly economic aid and other industrial policy initiatives. Market dominance comes with profits for Chinese companies and state actors, while also creating economic dependencies and chokepoints.

As an example, in the not-so-distant future, Chinese-owned battery plants may represent a significant share of battery production within the EU. More importantly, they might contribute towards strengthening China's already dominant global position within EV battery production. Increased sector dominance due to battery-plant greenfield investments, together with China's control over supplies of critical metals and minerals, might create possibilities for China to use the EV industry as a chokepoint against the EU. The EU might itself contribute to the establishment of such a chokepoint by providing EV purchasing subsidies that boost imports of Chinese EVs and threaten the EU's own automotive industrial base.

An important general consideration is that dependencies and vulnerabilities can be damaging to the EU even if they are not exploited by China. Their mere existence can deter the EU and its member states from acting in a way that would provoke exploitation of the vulnerabilities. On the other hand, for China, to actually follow through on a threat might provoke adaptation measures and counter-reactions from the EU that diminish the severity of the vulnerability. Moreover, it might not always be desirable for China to utilise chokepoints, leaving aside the question of whether they are intentionally established for geoeconomic purposes or just a side-effect of market dominance, out of self-interest. For instance, imposing export controls on critical raw materials destined to EU companies can backfire on China in cases where the Chinese industry has upstream dependencies in terms of trade with such companies. The Chinese industry could also be faced with substantial losses in revenue if it was prevented from supplying goods or services, for example, related to back-end chip manufacturing, to the EU. Moreover, as is the case in the example of Chinese battery investments in the EU, accumulated Chinese investments might prevent China from exploiting chokepoints, at least if the investments are large enough to outweigh the potential benefits of harming the EU.

Some vulnerabilities and geoeconomic tools are more security-related than economic, even if they are created by economic means. Ownership of critical energy infrastructure can be used for surveillance or to leak information that could be used for cyberattacks. Technology transfers from semiconductor companies could be transferred for use within the Chinese military, and certain back-end manufacturing could also be exploited for surveillance and intelligence-gathering. Finally, China can also transfer technology, information, and intelligence from the EU to third parties such as Russia, which could in turn use it as leverage against the EU. It is difficult to assess to what extent surveillance, information leaks, and technology transfers take place, but the risks should not be neglected.

The geoeconomic risks identified in this report also need to be considered in a European or EU context, not just from the perspective of a single member state, company, or local government. Greenlighting a local Chinese investment could potentially carry consequences, both economic and security-related, for the entire Union. In addition, the cumulative effects of Chinese investments need to be considered. A single acquisition of a company, or a single decision to use a Chinese instead of an EU supplier, might not be very significant in and of itself. However, the cumulative effect of the total stock of Chinese acquisitions in certain sectors might contribute to Chinese market dominance or the possibility for China to establish economic chokepoints, which might in turn be used to hamstring the development and competitiveness of the EU economy. In turn, this might further harm the EU's resilience to geoeconomic pressure in the short term, and perhaps even in the medium to long term.

7.2 Discussion of future developments

Amid US-China global tech rivalry and a newfound realisation among EU member states concerning the risks related to certain forms of economic dependence upon authoritarian states and geopolitical rivals, investment screening for Chinese FDI in the EU has become stricter in recent years. In 2021, two-thirds of all EU member states had FDI screening legislation in place, and several member states are currently in the process of implementing screening mechanisms or amending existing ones.[175]

There are notable cases in Germany and Italy where Chinese semiconductor investments have been blocked in recent years. German cases in 2022 include the German government's blocking the acquisition of chip producer Elmos by the Chinese-owned semiconductor company Silex, based in Sweden, as well as disallowing an alleged planned takeover of ERS Electronics, a company specialised in wafer-test technology.[176] During 2020–2021, the Italian government blocked two Chinese investments in the Italian semiconductor industry, that of epitaxy-equipment manufacturer LPE, and that of an Italian subsidiary, specialising in screen-printing equipment, of US-based Applied Materials.[177] There are also examples of blocked Chinese investments in the EU energy sector. There are at least three cases from the 2010s when China failed in its attempts to acquire stakes in grid operators, namely Red Eléctrica de España, in Spain, Eandis, in Belgium, and 50Hertz, in Germany.[178]

The increasing share of greenfield investments in Chinese FDI, notably in battery plants, could be a reflection of stricter investment screening for M&As. M&As are also typically less welcomed by local populations, as they do not necessarily bring the same prospects of new job opportunities as do greenfield investments.[179] Moreover, the relative slump in Chinese investments in the EU in recent years can be partially explained by factors such as the COVID-19 pandemic, Chinese capital controls, and a realignment of domestic policy goals towards inward investments.[180] There are thus many factors, including China's domestic economic difficulties, which have affected and will continue to affect the shape and size of Chinese investments going forward. At the same time, it should be noted that the EU still appears relatively open to Chinese investments. Many of the semiconductor, automotive, and energy-sector investments listed in this report would have risked being

[175] European Commission, *Second Annual Report on the screening of foreign direct investments into the Union* (Brussels, Belgium: European Commission, September 2022), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022DC0433.
[176] Kratz et al., *Chinese FDI in Europe: 2022 Update*, 17; Andreas Rinke and Miranda Murray, "Germany blocks Chinese stake in two chipmakers over security concerns," *Reuters*, 10 November, 2022, https://www.reuters.com/markets/deals/germany-block-chinese-takeover-semiconductor-firm-ers-electronic-handelsblatt-2022-11-09/.
[177] Kratz et al., *Chinese FDI in Europe: 2021 Update*, 14; Giuseppe Fonte and Ella Cao, "Italy's Draghi vetoes third Chinese takeover this year," *Reuters*, 23 November, 2021, https://www.reuters.com/markets/deals/italys-draghi-vetoes-third-chinese-takeover-this-year-2021-11-23/.
[178] Mazzucchi, *China and European electricity networks*, 7–8, 10.
[179] Kratz et al., *Chinese FDI in Europe: 2021 Update*, 12.
[180] Kratz et al., *Chinese FDI in Europe: 2022 Update*, 4, 12, 20.

blocked in other countries, such as the US or Japan. Nevertheless, some of the investments in the EU occurred before investment-screening regimes were tightened, and would perhaps not have been successful today.

Moreover, a recently implemented EU regulation, effective as of July 2023, aims to make it harder for foreign investments to distort the EU's internal market through state subsidies.[181] This will likely further disincentivise some Chinese companies from investing in the EU, or incentivise additional measures to decrease China's transparency regarding the nature of its state support. However, recent EU industrial-policy initiatives, many of which have the primary or secondary aim of speeding up the green transition, might on the contrary prove beneficial for Chinese investors.[182] It is worth remembering that the EU probably cannot afford to exclude China as an economic partner and import source if it wants to fulfil its green ambitions and the targets in the European Green Deal.

There is undoubtedly a trend within the EU towards a larger emphasis on national security concerns related to strategic sectors of the economy, to some extent at the expense of conventional concerns such as economic efficiency, the importance of technological progress, and limiting political interference in the private sector. At the same time, the preconditions for the conventional concerns to be met when it comes to EU-China economic relations are not always in place. Firstly, certain Chinese investments in the EU are made by companies whose comparative advantages consist of, for example, financial support from the Chinese state and cheap manufacturing inputs from state-affiliated suppliers. Such investments are not based on economic efficiency and fair competition, and undermine the EU internal market's principles of competition on equal terms. Secondly, certain technological progress for China might be of benefit to the EU, due not least to its dependence on imports of raw materials and green technology from China. However, technological progress that benefits China but comes with various security-related risks rather than mutual benefits is not desirable for the EU. Lastly, if the ultimate counterpart in EU private-sector business decisions is a Chinese one-party state with extensive industrial and foreign-policy ambitions, political intervention from within the EU might sometimes be preferable.

The current trend in the EU seems unlikely to fade in the foreseeable future, unless the actual or potential drawbacks in limiting economic exchange with China within sectors identified as sensitive become too apparent. As with China, there is no guarantee that the EU's own industrial-policy initiatives to attain greater self-sufficiency will be successful. It is therefore too early to tell whether the backlash from China, in terms of geoeconomic or other types of countermeasures, will be more significant than the potential geoeconomic and security-related threats that would have been averted by limiting Chinese investments and trade in strategic EU sectors.

7.3 Future research

This report has only considered inward FDI, that is, Chinese investments in EU countries. It is apparent that more research is needed on Chinese FDI in individual EU countries, especially in sensitive sectors such as those studied in this report. There is a lack of openly available research and data on investments, ownership and acquisitions by Chinese-owned companies in the EU. Without such data it is difficult to assess geoeconomic risks relating to Chinese investments.

It would be of much relevance to compare the findings of this study with corresponding research on outward FDI, that is, investments in China made by EU companies in strategic sectors. This could allow, for example, a better understanding of the interdependencies

[181] The regulation in question can be found here: European Union, *Regulation (EU) 2022/2560 of the European Parliament and of the Council of 14 December 2022 on foreign subsidies distorting the internal market* (Official Journal of the European Union, December 2022), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2022.330.01.0001.01.ENG&toc=OJ%3AL%3A2022%3A330%3ATOC.

[182] Kratz et al., *Chinese FDI in Europe: 2022 Update*, 18–9, 21.

between EU countries and China, and put certain investments into better context. The German automotive industry's investments in China are a good example. In addition to, Germany, the Netherlands and France are major investors in China, as is the UK, a non-EU member state. In general, a small number of companies represent a large bulk of the total European FDI in China, and recent years have seen a focus on greenfield investments by existing investors rather than M&As or new investors.[183] In this context, it would also be of interest to learn more about how entry barriers and incentive structures related to Chinese industrial ambitions affect foreign companies investing in China, both in terms of benefits and disadvantages.[184] It is relevant to learn more about how China's sometimes contradictory juggling of targeted industrial policies with the promotion of market mechanisms impacts EU investors in China.

Similarly, there could be a comparison of EU import dependencies in the areas touched upon here, such as the EV industry, energy sector, and critical minerals, with the EU's exports to China related to strategic sectors. This could add deeper insights regarding EU-China trade interdependencies of special importance.

One of the areas studied here is Chinese FDI in the EU semiconductor industry. However, the EU is dependent on imports of certain machinery and electronics from China, some of which are likely related to the EU semiconductor industry. It is also known that the EU is to some extent dependent upon Chinese back-end chip manufacturing. Future research could thus focus on more in-depth analysis of Chinese exports of various electronics to the EU. It would also be of interest to compare the present findings related to Chinese semiconductor FDI with existing or further studies of China's domestic efforts to develop its semiconductor industry. These efforts are already extensive and are likely to continue. Among other things, such comparisons would make it possible to provide better assessments of the extent to which China's investments in the EU contribute to China's military modernisation and other foreign-policy goals.

Chapter 5, on the EV industry, focuses on Chinese battery investments in the EU and the EU's EV imports from China. These findings could be complemented by looking at Chinese investments in EV assembly in the EU, as well as investments in other parts of the EV value chain, such as automotive software, for which there are explicit MIC2025 policy targets.

Because the energy sector is broad, this study focuses on Chinese FDI in various power plants and electricity grids, as well as the EU's import dependencies related to solar- and wind power. Future studies could explore Chinese FDI in the EU's energy-related technologies, which are likely to have some degree of overlap with semiconductor and EV investments.

Moreover, EU industrial-policy initiatives and their potential to achieve the stated ambitions should be studied in more detail from an EU-China and geoeconomic perspective. If the result of recent initiatives by the European Commission, such as its Critical Raw Materials Act and the European Chips Act, falls short, EU's economic vulnerabilities towards China will need to be managed in other ways.

In addition to its findings, this report also discusses cases of investment where the degree and nature of state involvement have not been clearly identified. With access to additional data, future studies could contribute to a clearer understanding of investment patterns and the varied ways in which the Chinese state either exerts influence or remains detached from business decisions abroad.

[183] Agatha Kratz, Noah Barkin, and Lauren Dudley, "The Chosen Few: A Fresh Look at European FDI in China," Rhodium Group, 14 September, 2022, https://rhg.com/research/the-chosen-few/.

[184] See for example Alexander Brown, Kai von Carnap, Jeroen Groenewegen-Lau, and Gregor Sebastian, "5G applications in the energy sector + Provincial protectionism + Support for high-tech SMEs," MERICS, 7 June, 2023, https://merics.org/en/merics-briefs/5g-applications-energy-sector-provincial-protectionism-support-high-tech-smes.

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Appendix A: Methodology and references for Table 3. Selected cases of Chinese investments in the EU semiconductor industry

Table 3, in Section 4.1, above, contains a list of selected cases of EU semiconductor companies that at the time of writing have Chinese owners. The content of Table 3 is derived from various sources, including analysis by the present authors. The analysis focused on estimating the companies' positions in the semiconductor supply chain. The most important of the external sources is the results of previous research by the Netherlands-based company, Datenna, specialised in data-driven intelligence about China, which is to some extent available through the company's *China-EU FDI Radar*. For present purposes, the majority share investments in the sectors that Datenna refers to as "Information and Communications Technology (ICT)" and "Electronics and Electrical Equipment" were considered. However, not all investments within these sectors are included, as some investments seem to be of lesser relevance to the parts of the semiconductor value chain in focus here. Additionally, some of the other sources for Table 3 are a previous study from the Swedish Defence Research Agency (FOI), open information from company websites, and reports from news media.

It should be noted that many companies that can be defined as belonging to the semiconductor industry do not explicitly refer to themselves as semiconductor companies. In reality, the semiconductor industry is heterogeneous, which, for example, means that the value chain will differ for different end products and their area of application. The semiconductor industry also partially overlaps with end-application industries such as telecom, energy, and automotives. Certain companies within these industries also possess some chip design and/or manufacturing capabilities. Consequently, it is difficult to produce a complete and clearly defined list of Chinese semiconductor investments in the EU. Table 3 should thus be seen as a list of selected cases, focused upon certain types of Chinese semiconductor investments in the EU of special relevance to China's industrial-policy ambitions, which includes filling its technology gaps. That said, the intention of the present authors has been to conduct assessments independently of whether the cases presented in Table 3 are exhaustive or not.

Selected examples of the products and end markets presented in Table 3 are mainly based on what the companies in question present on their websites, in some cases complemented by external evaluations from other open sources, such as Datenna. The authors also provide their estimate of the relation between the selected products and the company's approximate position in the semiconductor value chain. Discussions with other researchers with technical expertise regarding the semiconductor industry have contributed to these estimates. Lastly, it should be emphasised that some semiconductor companies might partake in additional parts of the value chain through their product and service portfolios, and that their products may serve more end markets than those listed.

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